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Risk management and governance of chemicals in articles

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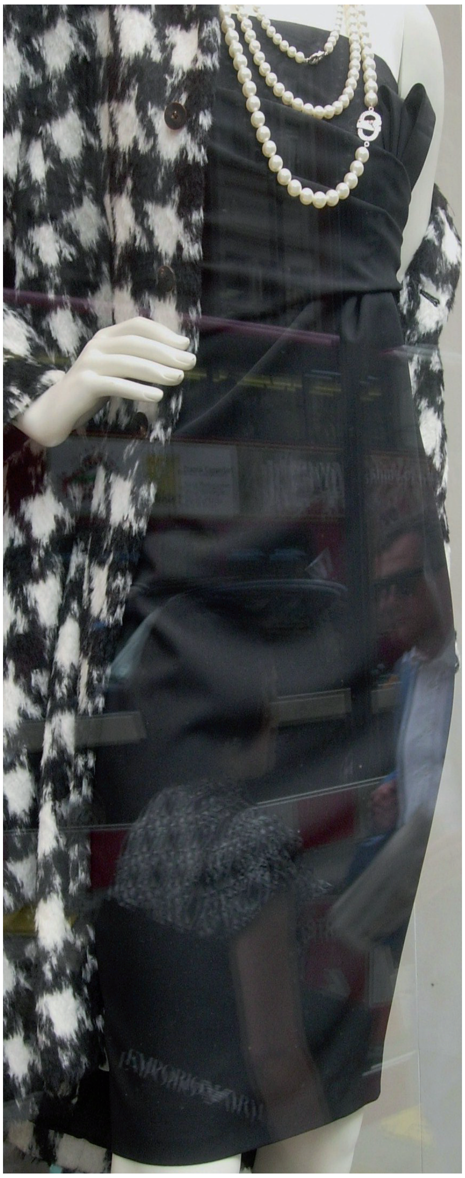


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Most of the initial work including information gathering and analysis and the writing of Chapters 2 and 3 was done by Piia Häkkinen. Among SYKE staff, Jaana Heiskanen, Kaija Kallio-Mannila and Mervi Leikoski in Chemicals Division, Ari Nissinen, Kristina Saarinen, Päivi Lindh and Tuomas Mattila in the Centre for Sustainable Consumption, and Timo Assmuth and Petrus Kautto in the Environmental Policy Centre contributed to the conduct and reporting of the study. Timo Assmuth was responsible for writing section 2.5 and most of the Chapters 4 and 5, and for editing of the whole report. In addition, Kimmo Silvo, Taina Nysten, Jaakko Mannio and Jukka Similä from SYKE as well as Pirkko Kivelä and Eliisa Irpola from the Ministry of the Environment participated in the development and steering of the project.

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The authors hope this work and publication will aid in the avoidance, reduction, management and wise governance of risks associated with chemicals in textiles, retaining and further increasing their benefits.

## CONTENTS

## List of abbreviations

| | |
|---|---|
| AAFA | American Apparel and Footwear Association |
| AEDT | European Association of Fashion Retailers |
| AFIRM | Apparel & Footwear International RSL Management Working Group |
| Ag | Silver |
| Al | Aluminium |
| AP | Alkyphenol |
| APEO | Alkylphenol ethoxylate |
| As | Arsenic |
| AVI | Aluehallintovirasto (Regional State Administrative Agency) |
| BBP | Butyl benzyl phthalate |
| BEUC | Bureau Européen des Unions de Consommateurs, Eur Consumer Organiz |
| BFR | Brominated Flame Retardant |
| BPD | Biocidal Products Directive |
| Cd | Cadmium |
| CFC | Chlorofluorocarbon |
| CiP | Chemicals in Products (a SAICM project) |
| Cl | Chlorine |
| CLRTAP | UN Convention on Long-Range Transport of Air Pollutants |
| CMC | Carboxymethyl cellulose |
| CMR | Carcinogenic, Mutagenic or toxic for Reproduction |
| Cr | Chromium |
| CSA | Chemical Safety Assessment |
| CSO | Civil society organization |
| Cu | Copper |
| DBT | Dibutyltin |
| DG-ECON | Directorate-General of Economic and Financial Affairs |
| DG-EMPL | Directorate-General of Employment, Social Affairs and Inclusion |
| DG-ENTER | Directorate-General of Enterprise and Industry of the EU |
| DG-ENV | Directorate-General of the Environment of the EU |
| DG-SANCO | Directorate-General of Health and Consumer Protection of the EU |
| DG-TRADE | Directorate-General of Trade |
| DINP | Di-isononyl phthalate |
| DMF | Dimethylfumarate (not to be confused with N,N-dimethylformamide) |
| DOT | Dioctyltin |
| ECC-Net | European Consumer Centers Network |
| ECHA | European Chemicals Agency |
| EDTA | Ethylenediaminetetraacetic acid |
| EDS | Endocrine disrupting substance |
| EEB | European Environment Bureau |
| EESC | European Economic and Social Committee |
| EKL | Erikoiskaupan/Muotikaupan Liitto (Finnish Association of Special/Fashion Trade) |
| ELY | Elinkeino-, Liikenne- ja Ympäristöviranomainen (Finnish Regional Centre for Economic Development, Transport and the Environment) |
| EP | European Parliament |
| EPD | Environmental Product Declaration |
| ETAD | Ecological and Toxicological Association of Dyestuffs Manufacturing Industry |
| Euratex | European Textile and Apparel Confederation |
| F | Fluorine |
| Fe | Iron |

| | |
|---|---|
| FTOH | Fluorotelomer alcohol |
| GM | Genetically modified |
| GPSD | General Product Safety Directive of the EU |
| GuT | Gemeinschaft umweltfreundlicher Teppichboden (community of eco-friendly carpets) |
| HBCD | Hexabromocyclododecane (also abbreviated HBCDD) |
| Hg | Mercury |
| IAF | International Apparel Federation |
| IE | Industrial Emissions (Directive) |
| IGO | Intergovernmental organization |
| INCI | International Nomenclature of Cosmetic Ingredients |
| ILO | International Labour Organization (of the UN) |
| IPP | Integrated Product Policy |
| IPPC | Integrated Pollution Prevention and Control (Directive) |
| ITAA | International Textile and Apparel Association |
| KETU | Product Register of Chemicals in Finland |
| KL | Kaupan Liitto (Federation of Finnish Commerce) |
| KTK | Kuluttajatutkimuskeskus (National Consumer Research Centre) |
| LOAEL | Lowest Observable Adverse Effect Level |
| NaOH | Sodium hydroxide |
| NCM | Nordic Council of Ministers |
| NGO | Non-governmental organization |
| NOAEL | No Observable Adverse Effect Level |
| NP | Nonylphenol |
| NPE | Nonylphenol ethoxylate |
| NTA | Nitrilotriacetic acid |
| OctaBDE | Octabromodiphenylether |
| OM | Oikeusministeriö (Finnish Ministry of Justice) |
| Pb | Lead |
| PBB | Polybrominated biphenyl |
| PBT | Persistent, Bioaccumulative and Toxic |
| PBDE | Polybrominated diphenyl ether |
| PCBs | Polychlorinated biphenyls |
| PCDD/Fs | Polychlorinated dibenzo-p-dioxins and dibenzofurans |
| PeCP | Pentachlorophenol (also abbreviated PCP) |
| PE | Polyethylene |
| PentaBDE | Pentabromodiphenylether |
| PFBS | Perfluorobutane sulphonate |
| PFC | Perfluorinated compound |
| PFOS | Perfluorooctane sulphonate / Perfluorinated sulphonates |
| POP | Persistent Organic Pollutant |
| PU | Polyurethane |
| PVA | Polyvinyl acetate |
| PVC | Polyvinyl chloride |
| RAPEX | Rapid Alert System for non-food consumer products |
| REACH | Registration, Evaluation, Authorisation and Restriction of Chemicals |
| RSL | Restricted Substance List (usually voluntarily set up by industry) |
| SAICM | Strategic Approach to International Chemicals Management |
| SCCP | Short-chained chlorinated paraffin |
| Si | Silicon |
| Sn | Tin |
| SSNC | Swedish Society for Nature Conservation |
| STM | Sosiaali- ja terveysministeriö (Finnish Ministry of Social Welfare and Health) |

| | |
|---|---|
| SVHC | Substances of Very High Concern |
| SYKE | Finnish Environment Institute |
| TBT(O) | Tributyltin (oxide) |
| TCE | Trichloroethene (also abbreviated TCEe to distinguish from trichloroethanes) |
| TeCE | Tetrachloroethene (also abbreviated TeCEe to distinguish from tetrachloroethanes) |
| TEM | Työ- ja elinkeinoministeriö (Finnish Ministry of Labour and Enterprise) |
| THL | Terveyden ja Hyvinvoinnin Laitos (Finnish Institute for Health and Welfare) |
| TPT | Triphenyltin |
| TTL | Työterveyslaitos (Finnish Occupational Health Institute) |
| Tukes | Turvallisuustekniikan keskus (Finnish Safety and Chemicals Agency) |
| Tulli | Tullihallitus, ml. Tullilaboratorio (Finnish Customs, incl. Customs Laboratory) |
| UKM | Ulkomaankauppaministeriö (Finnish Ministry of Foreign Trade) |
| UNECE | United Nations Economic Commission for Europe |
| UNEP | United Nations Environment Programme |
| UNIDO | United Nations International Development Organization |
| Valvira | Finnish National Supervisory Authority for Welfare and Health |
| VM | Valtionvarainministeriö (Finnish Ministry of Finance) |
| VNK | Valtioneuvoston kanslia (Finnish Prime Minister's Office) |
| VOC | Volatile organic compound |
| vPvB | very Persistent and very Bioaccumulative |
| WFD | Water Framework Directive of the EU |
| WHO | World Health Organization |
| WTO | World Trade Organization |
| YM | Ympäristöministeriö (Finnish Ministry of the Environment) |
| Zn | Zinc |

# 1 Introduction

## 1.1 Background

The National Programme on Dangerous Chemicals from 2006 identified chemicals in articles as an issue where improved risk management is needed (Ministry of the Environment, 2006, p. 74-79). A preliminary report "Control of chemicals in articles – Preliminary report" (Häkkinen, 2010) was published in order to describe the current situation of both legislative and voluntary control of chemicals in articles as well as to identify the deficiencies of management measures.

The present report will address the issue of control of chemicals in articles in more specific terms. In order to get a better understanding of the problem and the different actors on the field, a specific article group, textiles, was selected to illustrate the larger issue of the control of chemicals in articles, and to test and develop the general models, assumptions and conclusions.

Chemicals in textiles are particularly important and problematic in risk assessment, management and governance for several reasons, as explained below in more detail (1.2). The importance extends beyond regular areas of chemicals control, being situated in complex flows of products, wastes and materials. The textile articles pose some special challenges for risk management, for instance due to their production in developing economies, their circulation in globalized trade, rapid turnover, technological development, and intimate appreciation of the consumers.

Chemicals in textiles thus cause multi-dimensional risks, including environmental, safety and health risks notably to consumers but also to ecosystems in regions of production, use and disposal. They also carry important and characteristic benefits both in personal and other uses, and as such play considerable social, cultural and even symbolic roles in societies.

## 1.2 Aims and justification of the case study

In functional terms, the aim of this case study is to investigate a specific group of articles during their whole life cycle, and thereby to identify and analyze in concrete terms issues in the management of risks from chemicals in articles. As such, the key function of the case study is to illuminate more general aspects in the governance of products.

The overall aim of the study is to identify and describe deficiencies in risk management of chemicals in textile articles and to evaluate and propose means for its improvement.

Full-blown evaluation of risks and risk management measures and practices as well as possible goals, strategies and options is beyond this study, and that definite opinions on the best courses of action are not attempted. This is partly due to the extent of the task, and partly to the inherent and fundamental limitations in defining such courses which depend on valuation and judgment and political considerations. Instead of providing answers to such questions, the study focuses on the more fruitful goal of openly identifying questions and premises in answering them and on analyzing the requisite basic information for this. Thus, the approach is reflexive, not normative.

**Textiles were selected as a topic of case study due to number of reasons:**

1) Textiles present an important case due to the great **number of different articles** on the market, consisting of a variety of materials and with high turnover of the products. Also the total magnitude of these material flows is considerable.
2) Great **numbers of different chemicals**, many of them poorly known, are added to textiles during the production and finishing of these articles, in distribution and use phase and possibly also in recycling and reuse. These added chemicals interact with the chemicals in the textile matrices themselves, including many synthetic materials. This use of chemicals is accompanied by a rapid technological development whereby textiles are increasingly overlapping and combined with other products.
3) **Textiles are used by consumers in everyday life,** and thus carry great and multi-faceted social significance; they make a group of products that people are acutely interested in and deeply care about. They include both necessary and luxury products, are subject to massive marketing, and as such epitomize core ideas, forces and behaviours of consumer societies. They also therefore provide a focal case of influencing and coping with such behaviours.
4) Releases of **chemicals from textiles enter directly the environment**, especially in waste water effluents. Releases take place also to air and to soil in solid wastes, **in many cases indirectly**. The chemicals emitted, including breakdown and transformation products, cycle in ecosystems in many cases over prolonged periods and concentrate in biota. Chemical releases thus include a variety of direct and indirect fluxes that cause exposures of humans and other organisms in a multitude of ways. The risks and consequences are equally diverse, and include surprising cumulative effects.
5) Although the production of textile articles has declined in Finland and in the EU, increasing **amounts are imported to the country from outside the EU**. In this global production and trade a variety of chemicals including hazardous ones are used liberally, due to both lacking regulation and management and to particular needs such as preservation during transport and for other such as market economic reasons. The identification, assessment, management technically and institutionally and surveillance of chemicals in imported articles pose therefore a major issue to be addressed.
6) Due to these factors, chemicals in textiles present **a special challenge for risk management**, and specifically illustrate key problems and solutions in product-oriented environmental policy. As the European Commission (CEC, 2003) points out, these policies are facing challenges as the quantity of products in increasing, their variety and complexity increase and new types of products are created, the products are traded globally, and even by best design may cause significant environmental and other impacts. Besides, one of the possible strategies for the product-oriented environmental policies (Oosterhuis, Rubik and Scholl, 1996), lowering the product throughput, is excluded as politically unsuitable and in some cases conflicting with other pillars of sustainable development. (Kautto 2008, 18).

1.3

## Scope of the study

The case study was framed flexibly so as to allow both efficient focusing and consideration of key links of the focal themes with the broader context, to ensure a sufficiently integrated look at risks and risk management.

The case study was scoped to comprise all **life cycle stages** of textiles from the manufactured fabric. The production of the fibres and the fabric as well as previous stages of product design and demand management were excluded from the study as most of the chemical treatment is accomplished at later stages in the pre-treatment, dying and finishing of the fabric or textile. There is generally much information available on the production processes of the fabric and the releases of chemicals from them are in most countries more regulated than those of the finishing, use and end-of-use phases. The production of fabrics also takes often place outside Finland and the EU and has not been analyzed in depth in this study, focused on Finnish and EU conditions.

The pre-treatment, colouring and finishing are usually done to the fabric or knit, rarely to the finished textile article. Because the chemicals used in these processes can be found in the finished articles and end up in the environment, this stage is included in the study. The study addresses only chemical treatment of textiles, not mechanical, although chemicals may also be used e.g. as auxiliaries in mechanical treatment.

**Textiles** are a heterogeneous group of products. A dictionary definition of textiles is "filament, fibre or yarn that can be made into fabric or cloth, and the resulting material itself. The word originally referred only to woven fabrics but now includes knitted, bonded, felted, and tufted fabrics as well." (The Free dictionary 5.4.2011). Textiles are used for wearing apparel, household linens and bedding, upholstery, draperies, curtains, wall coverings, rugs and carpets, and widely in industry. This case study covers consumer textiles, e.g. clothing and apparel, and home and furniture textiles. Industrial and office textiles are mainly excluded. Leather products are also excluded. Textile articles that consist of also other materials (e.g. plastics) are however included in the study.

Many different **chemicals** are added to textiles in different life cycle stages. Many of these can be found in the finished articles and part of them end up in waste water or liquid after washing or chemical cleaning of textiles. All chemicals hazardous to the environment and used in textiles were *a priori* included in the study. However, the focus was not on identifying all chemical groups found in textile articles, but instead on highlighting important or representative examples of chemicals used in different life cycles of textiles and on reviewing the related environmental risks from the perspective of risk management. The focusing in terms of chemicals was therefore also influenced by the legislative and voluntary management procedures and conditions. The geographical scope contains releases of chemicals from textiles in Finland, either from textiles manufactured in Finland of imported to the country. The latter category extends the scope to global scale.

From both technological and product policy or governance points of view the topic of the study is **not limited to the chemicals added to textiles** or used in their subsequent treatment. Textile products and production technologies play a role in chemicals risk management also more indirectly, even in very concrete ways. For instance, the use of enzymes in cleaning agents and structural improvements in textiles themselves can significantly reduce the need for harmful chemicals for cleaning and preservation. Thus, alternative textile products and their production, consumption and treatment technologies need to be assessed more broadly, beyond specifically chemical issues, in order to discern more realistically what steering and technological solutions are efficient or otherwise advisable, and what kinds of possibilities, challenges and issues are involved.

Chemicals in textiles present many kinds of **risks:** risks to the environment, human health and safety, as well as economic, technological, political (for instance, trade political) and other risks. This case study is focused on environmental risks of textiles. This in itself is a broad framing which is not clear-cut, as environmental risks associated also with chemicals encompass not only eco-toxicological risks (most often in focus) but also other environmental risks such as those to natural resources, and can be extended to socio-economic risks in connection with environmental policies.

Moreover, environmental risks are closely linked with health and safety risks. In particular, toxicological risks to humans and eco-toxicological risks to other organisms are intertwined. Also in practical risk management these categories of risks cannot be strictly separated. For instance, existing regulations for chemicals in consumer products are in most cases mainly concerned with human health issues. Indeed, what matters to most people including both consumers and (among them) decision-makers are man-centred concerns of health and safety. Likewise, risks from chemicals cannot be considered in isolation from other including beneficial aspects of these chemicals, notably when evaluating options to substitute alternative chemicals. Consequently, many key questions in the management of environmental risks deal with how they are related to other risks such as health risks, and these relationships between environmental and other risks constitute a key area of assessment, management and governance to be accounted for.

The **geographical** scope of the study is focused on Finland and the releases of chemicals in textiles in Finland. This includes releases from imported textiles, although there is less information on their chemical contents. In terms of risk management, the scope necessarily is extended to the EU as a whole because Finland is part of that regime of governance. The influences of EU procedures in Finland and vice versa are thus part of the study, but at a more general level; risks and problems of textile chemicals in the whole community cannot naturally be dealt with in detail and regarding all other Member States. Further, the environmental impacts outside the EU, which are increasingly important in global ecosystems, trade and governance, are addressed only superficially, mainly to identify their links with the national and EU level risk issues.

In terms of **thematic areas** of risks management, the focus is on the availability and management of information on chemicals in textile articles, on legal issues and on voluntary control measures, as well as on the available supervisory measures of the authorities.

# 2 Chemicals used in textiles and related risks to the environment

2.1

## Overview of the life cycle of textiles

The life cycle of textiles comprises many different stages (Figure 1 and Table 1). The natural (e.g., cotton or wool), synthetic (e.g., polyester and acrylic) or semi-natural (e.g., viscose) raw materials or, increasingly, their combinations are processed into fibres. The fibres are spun into yarns, which are in most cases processed by knitting or weaving into textile fabrics. Textiles can however be manufactured either from fabrics or yarns, or directly from fibres as in fibre fabrics and non-woven products (Talvenmaa, 2002). Thus, there are alternative specific processes and routes for producing textile articles.

Most of the textiles today are made of mixed materials. These include a variety of types of mixtures, from mixed fibres (typically synthetic fibres woven in natural fibres to increase strength and durability), to fibres for colouring and texture and later-stage addition of pieces of other materials such as buttons, zippers and stripes.

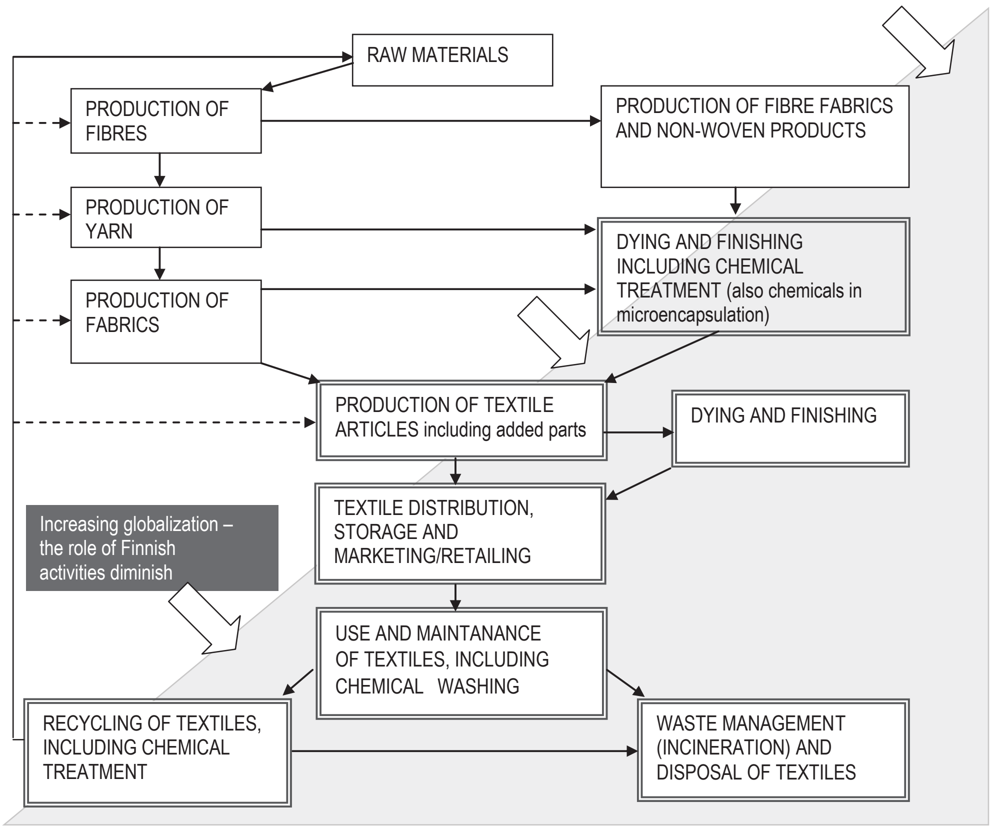


Figure 1. Life cycle stages of textiles (based on Talvenmaa, 2002), with red boxes indicating the focus of this study. The stages with common activities in Finland have been highlighted in blue.

The yarns and fabrics are dyed, rarely fibres or finished clothes (Talvenmaa, 2002). The fabrics can also go through pre-treatment and finishing processes. Textile products are sold to stores or directly to customers. The use and maintenance of textiles includes washing and the use of various treatment products. In the end-of-use phase textiles can be recycled and reused or be directly disposed to landfills or by incineration.

Manufacturing of textiles in Finland has decreased over the years due largely to cheaper manufacturing costs in other countries. Many textiles are imported to Finland from non-European countries, such as China, India and Bangladesh.

In some cases recycled materials are reused as raw materials at various stages, as fabrics, yarns or fibres (Figure 1). However, recycling is as yet insignificant in terms of total amounts of materials, except for some special product categories.

## 2.2 Chemicals used in different life cycle stages of textiles

### 2.2.1 Pre-treatment, dyeing and finishing

Many different chemicals are used in the pre-treatment, dyeing and finishing of textiles (Table 1). They can be used, for instance, to make the fabric soft, shrink-proof and colour fade resistant.

According to Priha and Riipinen (2005), chemicals used in colouring and finishing processes can be divided into three groups:

- basic chemicals (e.g. acids, bases and hydrogen peroxide, that is, bulk industrial chemicals, not to be confused with basic in terms of pH),
- dyes (textile and pigment colours)
- finishing agents (e.g. anti-wrinkle, water proofing and fire proofing).

Basic chemicals account for the largest proportion by volume of all used chemicals.

According to Talvenmaa (2002), the dyeing and finishing processes of textile industry consume 0.5-0.9 kg chemicals per one kilogramme of fibres, depending e.g. on the degree of dilution of the chemicals used. Also the fibre material impacts the choice of the chemicals. Natural fibres (e.g. cellulose, wool and cotton) need more chemical treatment than synthetic fibres. Synthetic fibres need more antistatic treatment than other materials (KemI, 2009a). Wool has a lower tendency to ignite and consequently does not need the use of flame retardants. Also environmental and health considerations increasingly play a role. For instance, recently the use of enzymes has increased in replacing the most hazardous chemicals in the treatment of textiles, e.g. in stonewashing.

Chemicals used during the textile finishing are rinsed out using water and detergents (KemI, 2009a), to the extent they are not recycled in the process. The chemicals released can either be broken down quickly or sorbed to sewage sludge mainly in waste water treatment plants, or reach the environment in treatment plant effluents, depending on the chemical and the treatment process. Thus environmental impacts of chemicals used in textile manufacturing depend on the country or region of the process location.

According to Talvenmaa (2002), releases of hazardous substances to the environment from the manufacture of textiles have in Finland been significantly reduced since the 1970's due to better waste water treatment and other emission abatement technologies as well as new recovery methods of chemicals. Some chemicals are,

**Table 1.** Important chemicals or chemical classes used in different stages of textile and clothing manufacturing (cf. list of abbreviations). Chemicals with particular toxicity are shown in bold.

| Process step | Chemicals or chemical groups used | Purpose/product specifics |
|---|---|---|
| Fiber production | **Pesticides**, soda, detergents | Remove wool impurities |
| | **Pesticides**, fertilizers (and irrigation water) | Cotton |
| | **Heavy metals**, sulphides | Viscose |
| | **Heavy metals**, acetaldehyde, 1,4-dioxane | Polyester |
| | nitrile, acrylate, acetate, amide, sulphate, chloride, pyridine | Acrylic |
| Yarn manufacturing | **mineral**/vegetable oil; emulsifiers, **anti-mould agents** | Spinning oil |
| Spinning and weaving | starches | sizing agents |
| Sizing | starch based agents, alcohol, acrylate | |
| Knitting | **mineral oils (including PAHs)**, waxes | lubricating/emulsifying |
| Wet-processing pre-treatment and dyeing or printing | | |
| -washing | synthetic tensides; **organic solvents, NPE/NPEOs** | detergents in washing |
| -scouring | caustic liquor, acidic liquor | remove wax, grease, base |
| -desizeing | Enzymes, alcohol, carboxy methyl cellulose, **DDT, PCP** | remove starch sizes |
| -bleaching | hydrogen peroxide, chlorite, perborite, hydroxide | |
| -mercerizing | NaOH | |
| -dyeing or printing | **azo dyes** and other organic compounds | |
| | acids, bases, salts (Fe, Cu, Al, Sn), carriers (also organic) | e.g., attach dyes to fibre |
| | **solvents, formaldehyde, NPEOs** | auxiliary substances |
| Wet-processing, finishing | | |
| -patterning | acid, base | |
| -stiffening | starch, PVA, resins, esters, starch, **chlorides, CMC products** | |
| -softening | oil, paraffin, wax, alkane, fatty acids, silicones, PE, enzymes | |
| -stonewashing, antipill. | enzymes | |
| -stabilizing | **formaldehyde, triazones, carbamates**, N-alkylol compounds | stabilizing of cellulose fibre |
| -anti-shrink | acids, salts, N-alkanol compounds | |
| -fire-proofing | **heavy metals, halogens, salts, formaldehyde, BFRs, SCCP** | |
| -water repulsion | salts, paraffins, **Cl/F** and Si compounds, pyridines, **isocyanates** | water repellents |
| -oil repulsion | acids, polymers and other oil repellents | |
| -dirt repulsion | oxides, clay minerals, PVC, phosphates, resins, F compounds | |
| -antistatic treatment | polymers, synthetic tensides | |
| -biocide treatment | **phenols (also halogen), metals/Ag, NH4, SCCP, DMF** | anti-mold or –microbial |
| -moth proofing | acids, urea | |
| -microencapsulation | **fragrances**, softeners, **preservatives/biocides**, potential drugs | for durable effect |
| -adding parts | metals including **Cr and Ni** in zippers, buttons etc | |
| Coating | | |
| -anti-pilling, water proof | PVC, PU, pigments, inks, lacquers, Si, **PFCs**, waxes | cotton/PE, polyamide |
| -protective | PVC, PU, lacquer, printing inks | depend on fabric and use |
| -coating | PU | for polyamide and PE |
| Treatment of finished articles | | |
| -wet washing | soap, synthetic tensides | active substances |
| -wet washing | phosphates, zeolites | improve affect of tensides |
| -wet washing | enzymes, silicates, brighteners, **perfumes, metals, anti-mould** | cleaning, brightening etc |
| -wet washing | silicate, phosphonate | fibre protection agents |
| -wet washing | carboxymethyl cellulose, carboxylate glycol | prevention of greying |
| -dry cleaning | **tetrachloroethylene, trichloroethane, CFCs**, hydrocarbons | |
| -bleaching | perborate, percarbonate | bleach stains |
| -dyeing | e.g. azo dyes, pyridine derivatives (disperse) etc pigments | industrial and domestic |
| -maintenance | various | water, stain proof coating |
| Transport and storage | **PCP, methyl bromide, chloropicrin, 1,2-dichloroethane** | added as biocides |
| Recycling | various chemicals, together with physical and bioprocesses | mainly synthetic fibres |
| Disposal | occasionally various also unintended substances | |

however, left in the final products. Release reduction in absolute terms can also be due to reduced production.

Most of the fabrics used by the Finnish textile industry are imported from other countries where the adding of chemicals to the textiles is also usually done (Priha and Riipinen, 2005). The equipment and techniques used in the manufacturing processes influence the releases to the environment. Also the subsequent releases during use, maintenance and waste stages are influenced by the technologies used in adding the chemicals to the articles. Typically, the use of older equipment allows more releases than newer machinery, which usually also require less chemicals (Talvenmaa, 2002).

Textiles have developed to diverse products ranging from simple bulk items, often involving the use of hazardous chemicals, to advanced products and technologies, including 'smart' textiles, also involving chemicals. One example is microencapsulation, described by Nelson (2002): "The move into textiles with new properties and added value has encouraged the industry to use microencapsulation as a means of imparting finishes and properties on textiles which were not possible or cost-effective using other technology. Manufacturers are demonstrating increasing interest in the application of durable fragrances as well as **skin** softeners. Other potential applications include **insect** repellents, dyes, vitamins, **antimicrobials**, phase change materials and specific medical applications, antibiotics, hormones and other drugs."

#### 2.2.1.1
#### Pre-treatment

Pre-treatment of textiles (mostly cotton or cotton mix fabrics or knits) improves the dyeing results and the quality of the final product (Talvenmaa, 2002). Chemical pre-treatment processes include washing and bleaching. Textiles are washed to remove spinning oils, dirt, anti-mould agents and pesticides from the fibres. The substances applied are usually synthetic tensides. Also chlorine based organic solvents have been used, but they are no longer used in Finland.

Nonylphenol ethoxylates (NPEs) have been used as surfactants in the washing process of textiles for scouring fibres (Massey et al., 2008) or in fibre lubrication (Environment Agency, 2008). Traces of NPEs have been found in finished products. In the studies by the Swedish Society for Nature Conservation (SSNC), focusing on NPEs in t-shirts (2008) and towels (2007) purchased from Sweden, it was found that these textiles contained measurable concentrations of NPEs. NPEs are persistent and toxic to aquatic organisms and their degradation products, nonylphenols (NPs), are also endocrine disrupters (Massey et al., 2008). NPs enter the environment through waste water treatment plants (effluents and sludge) or direct discharge.

The most common substances used in bleaching are hydrogen peroxide, hypochlorite, chlorite, as well as sodium perborate added to detergents (Talvenmaa, 2002). Dioxins and other persistent and bioaccumulative toxic chlorinated organic substances can be formed as a residue in chlorine bleaching (KemI, 2009a). According to Talvenmaa (2002), the use of chlorine as a bleaching agent has decreased significantly, although chlorine can still be found in imported textiles. The Finnish textile industry uses only hydrogen peroxide in the bleaching processes (Priha and Riipinen, 2005).

It has been reported (Priha and Riipinen, 2005) that the use of pre-treatment has decreased in the global textile industry. It has also been estimated that the volume of chemicals released to the environment from textile processing has decreased due to the increased implementation and efficiency of waste water treatment systems (Priha and Riipinen, 2005).

### 2.2.1.2
### Dyeing

Dyeing agents and different auxiliary substances are used in textile dyeing processes, to improve the attachment of colour into the fibre. Preservatives are used in dye pastes for printing (KemI, 2009a). Almost all dyes used in textile industry are synthetic organic compounds. According to Talvenmaa (2002), there are more than 8,000 different synthetic dyes and almost 40,000 commercial dye products. The selection of dyes depends on the quality of the fibre and the fabric as well on the desired colour and its properties (Priha and Riipinen, 2005). There are two types of dyes: textile dyes that attach into the fibres, and pigments that are attached into the fabric using a binding agent and applied using a printing method.

Hazardous substances used in dyes include e.g. the heavy metals copper (Cu), nickel (Ni), lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr), zinc (Zn) and arsenic (As) (Talvenmaa, 2002). Cr also used for leather including footwear production. These heavy metals and elements are toxic, many of them in low doses, Cr and As also carcinogenic. Carcinogenic organic dyes, such as those containing benzidine, have not been used in the European textile industry for more than 20 years, but may still be used in some developing countries (Priha and Riipinen, 2005; Talvenmaa, 2002). There are many different azo dyes (colourants with an azo group, i.e. derivatives of diazene) used in the textile industry. The hazardous azo dyes release aryl amines in certain conditions and are classified as carcinogenic. NPEs are used in the pre-treatment process, and for dye levelling in dyeing and printing of fabrics (KemI, 2009a; Environment Agency 2008). Phthalates are used in textile printing. Swedish authorities found that the use of PVC-based printing colours is common (Stockholms stad, 2009), and 12 out of 13 investigated printer shops also used colours containing phthalates. The most commonly used phthalates in textile dyes are butyl benzyl phthalate (BBP) and di-isononyl phthalate (DINP).

Auxiliary agents used in dyeing processes include acids, bases, salts and carriers. The carriers containing aromatic organic compounds are no longer used because of their hazardous properties. According to Talvenmaa (2002), dyeing of finished textile articles such as clothing is rare but has become more common lately, especially in laundries. The most common articles that are coloured include socks, pantyhose and wool knitwear. Natural dyes are used in small scale, mainly in cottage industry. These dyes usually require the use of auxiliaries which improve the attachment of the dye to the fibres. These auxiliaries include iron sulphate, copper sulphate, alum and tin salts, some of which contain heavy metals. The producers of synthetic dyes have started to study natural dyes and to develop alternative auxiliaries.

In a well-managed dyeing process 70-95 % of the dyeing agent attaches to the fibre and the rest is led to waste water treatment (Talvenmaa, 2002). In some developing countries the attachment rate of the dye into the fibre may be only 50 % or less. The environmental impact of dyeing chemicals depends on the amount and attachment rate of the dye, on the efficiency of the waste water treatment processes and on the type of hazardous substances used in the dyeing process. If natural colouring is carried outdoors and the effluent is not led to waste water treatment, dyes including heavy metals and other toxicants can be released directly to the environment.

### 2.2.1.3
### Finishing including chemical preservation

The purpose of textile finishing is to improve the properties, maintenance and use comfort of the product, and also to achieve the desired appearance of the articles (Talvenmaa, 2002). The finishing of textiles can be divided into chemical and mechanical processes. Moreover, they are divided in wet (liquid-based) and dry processes.

The most commonly used chemical treatments of textiles, many of which can be combined, include the following (Priha and Riipinen, 2005):

- stability and anti-wrinkle treatment
- water and moisture proof and repellent treatments
- stain proof treatment
- fire proof treatment
- antistatic treatment
- softening treatment
- antimicrobial, anti-mould, pest and moth proof treatments
- stonewashing

Cellulose based fibres usually need chemical resin treatment for the stability of measures and also for anti-wrinkle treatment of the finished textile article. These chemicals may release formaldehyde, and have partly been replaced by urea based substances in industrialized countries (Priha and Riipinen, 2005; Talvenmaa, 2002). Finland was the first country in Europe to restrict formaldehyde concentrations in textiles in the 1980's (3.1.3). Also formaldehyde concentrations in finishing agents were reduced. However, there have been set-backs in formaldehyde use especially due to import from countries outside Europe (Talvenmaa, personal communication 19.4.2011).

Water repellent treatment is used to lower the aspiration and permeability of water to the textile (Talvenmaa, 2002). This will provide protection from light rain. Water proof treatment requires covering with a water proof layer. The chemicals used in water repellent treatment include paraffins (also persistent and toxic short-chained chlorinated paraffins, SCCPs), and compounds based on chromium stearyl chloride, resins, silicone and fluorine (e.g. fluorine carbonate). Resins and fluorine compounds are used in stain proof treatment, which is often carried out at simultaneously with water proof treatment. Also alternative chemicals based on waxes have been used.

Perfluorinated compounds (PFCs) have been commonly used as water, oil and stain proof coating in textiles, for instance in all-weather clothing, footwear, carpets, upholstery, tents and bed linen (KemI, 2009a, b; Massey et al., 2008). PFCs are highly persistent, bioaccumulative and toxic. They can thus be released from textiles treated with PFC containing coating over prolonged periods (Massey et al., 2008). Also indirect adverse ecological effects can occur. The PFCs used include perfluorooctane sulphonates (PFOS) and fluorotelomers. Since the EU restriction of PFOS for this purpose because of their persistence and environmental hazards, they have been replaced by other fluorinated chemicals, such as perfluorobutane sulphonate (PFBS) and fluorotelomer alcohols (FTOH). PFOS is, however, still used for textile coatings in other countries, China being a major importer of fluorine-containing textile finishing agents.

Fire resistance of furnishing textiles is required by law in vehicles, public buildings and certain working clothes (Talvenmaa, 2002). Different salts (e.g. nitrogen and phosphorous containing) can be used as fire proof agents, but they are washed off the textiles. Permanent fire proof can be achieved by chemicals that attach to the fibres or by a binding agent. Chemical fire proof treatment is used for natural fibres and mix materials, not for clothing textiles (Talvenmaa, 2002).

Most of the substances used for fire proof treatment are hazardous, containing chlorine, bromine, formaldehyde, phosphorus and nitrogen (Priha and Riipinen, 2005; Talvenmaa, 2002). Brominated flame retardants, such as polybrominated biphenyls (PBB) and diphenylethers (PBDE) and hexabromocyclododecane (HBCD), have been added to e.g. curtains, carpets, mattresses and upholstery. These compounds are persistent, some of them bioaccumulative, and toxic, causing chronic effects at low doses; they may also form other toxic reaction products such as brominated dioxins. SCCPs have also been used as flame retardants in textiles (HELCOM, 2010). According to Priha and Riipinen (2005), in Finland the permanent fire proof treatment of cellulose based textiles is usually done using tetra-cis(hydroxymethyl)phosphonium salt.

The substances used for the antistatic treatment of textiles (usually synthetic fibres) are mostly synthetic tensides (Talvenmaa, 2002). Stonewashing can be done chemically using hypochlorite, which is hazardous to the environment. Phthalates can be found as softeners in textiles made of PVC plastic (e.g. shower curtains, raincoats and tents) and also in plastic coatings of textiles. Coatings are used to make the fabric water-proof or to make patterns e.g. in t-shirts (KemI, 2009a). The PVC plastics can also contain Pb, Cd or toxic organotin compounds used as stabilizers. The endocrine active compound octylphenol has been used as emulsifier in textile finishing agents for water, dust and light resistant cover of the fabric (Environment Agency, 2008). These finishing agents are mainly styrene-butadiene copolymers that cover the textile with a thin film.

Natural fibres are more often deteriorated by micro-organisms or insects than synthetic fibres. Textiles can be treated with biocides for internal or external effect (Milieu and DTC, 2006). Antibacterial agents such as silver (Ag) and triclosan, a chlorinated bisphenol (Orhan et al., 2007) used mainly in soaps (Sutton et al., 2008), are added to textiles, such as sports clothing, socks, stockings and footwear, to prevent odour. Marketing of such materials and practices has increased, along with new outdoor lifestyles and other aesthetic and hygienic perceptions. Home textiles, such as bed linen and towels, can be treated with biocides, and mattresses and carpets against mites. The use of antibacterial agents can for instance result in the disappearance of useful bacteria and the development of more resistant strains (KemI, 2009a; UNEP, 2011a).

Anti-mould agents and preservatives are used mainly for cellulose based fibres, such as cotton (Talvenmaa, 2002). Outdoor textiles made of natural fibres such as tent materials, fabrics in deck chairs and textile coverings used in buildings can be treated with anti-mould agents to prevent fungal growth (Milieu and DTC, 2006). Indoor textiles (curtains, fabric wall coverings and furniture upholstery) can be treated against mould in humid conditions.

Anti-mould agents and preservatives contain many hazardous substances, such as Hg, Zn and Cu compounds, as well as phenols and chlorinated phenols, even PCBs (Talvenmaa, 2002). The latter contain chlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) as impurities or can cause their formation in thermal reactions. SCCPs have also been used based on their anti-fungal properties (HELCOM, 2010). These substances can be found especially in imported textiles. High levels of dimethylfumarate (DMF) were reported to have been found in several jeans brands in Sweden in 2009. The use of DMF as an anti-mould agent has been restricted in EU. According to Priha and Riipinen (2005), pentachlorophenol (PCP) laurate is no longer used as an anti-mould agent in textiles. However, in all countries these restrictions do not apply (see below).

Anti-moth finishing is applied to wool fibres (usually industrially produced) used for instance in carpeting. This is done by using among others aromatic sulphonamide compounds, fluorine compounds and pyrethroids such as permethrin (Talvenmaa, 2002; Priha and Riipinen, 2005). Naphthalene is no longer used for this purpose. The treatment can be done either during spinning of the yarn or as a surface finishing of the final product (Milieu and DTC, 2006).

Chemicals can also be added to textiles to protect the material e.g. from mould during storage and transportation in damp conditions, especially for long voyages such as by ship from Asia to EU (Milieu and DTC, 2006). PCP has been used in some Asian countries. Biocides are used both for intermediate products, such as yarns and fabrics, and for finished textile products. The chemicals can be directly applied to the textile or contained in separate bags with the packaging (KemI, 2009a). Containers can also be sprayed with chemicals to protect the cargo from biological degradation or as a phytosanitary requirement (especially to prevent the spreading of plant pathogens) of the importing country. According to Milieu and DTC (2006), the treatment of the container should be labelled. However, this does not apply if the articles in the container are treated before loading. Moreover, even when labelling is done it may be inaccurate, insufficient and unclear. Chemicals that have been used for the treatment of textiles include the halogenated compounds methyl bromide, chloropicrin and 1,2-dichloroethane.

Non-woven textiles are increasingly used in hygiene, medicine, filters, geotextiles and other applications, also to replace polyurethane. Nonwovens are not woven or knitted and need to be reinforced by other means. One means is chemical bonding by binders such as latex emulsion or solution polymers to join the fibers. A more expensive route uses binder fibers or powders that soften and melt to hold other non-melting fibers together (Wikipedia: Nonwoven fabrics, 2011).

The environmental impacts of textile finishing depend on the chemicals used, their hazardous properties and their use amounts and patterns, including the locations of application, and on subsequent treatment. The chemicals are often released primarily to air and water (Talvenmaa, 2002). Some may also be transmitted by direct contact dermally and through ingestion (also by non-human animals). Releases can take place at various stages, also from textile wastes.

## 2.2.2 Use and maintenance

Residual chemicals (e.g. PFCs) used in the manufacture of textiles may remain in the finished articles and be released to the environment during use and maintenance stages. According to KemI (2009), functional chemicals may not be tightly bound to the textile. These chemicals can evaporate, wear or be washed out of the material over time. In addition, chemicals are carried and released in particles of textiles as they disintegrate.

Released chemicals can be captured for treatment from waste waters, solutes and other streams generated in textile maintenance, especially in cleaning operations, in principle similarly as from manufacturing processes. Some chemicals (e.g. NPEs) can however not be readily removed from waste water by usual treatment methods (KemI, 2009a). Thus they end up in the aquatic environment. Even those chemicals removed from waste water to sewage sludge may be subsequently released to the environment in uncontrolled fashion, especially from sludge application in soil if they are not broken down.

Maintenance of textiles includes washing or other forms of cleaning, mainly dry cleaning with solvents, and other means of maintenance. According to Talvenmaa (2002), approximately 2/3 of the releases of hazardous substances to the environment during the life cycle of textiles come from the washing and other maintenance of textile products, not from the production processes.

### 2.2.2.1 Washing and dry cleaning

Textile washing agents contain many different active substances to remove a variety of stains and other impurities from textiles. Washing agents are divided into soap based and synthetic detergents, the active substances being soap and tensides (Talvenmaa, 2002). Phosphates and zeolites are used to soften the water and to improve the effect of tensides. Phosphates that cause eutrophication of waters have often been replaced by zeolites. Zeolites, however, need additives including complexants such as ethylene diamine tetraacetic acid (EDTA) and nitrilotriacetic acid (NTA), phosphonates and polycarboxylates. The environmental impact of these chemicals is not clear, although their use as small amounts has been considered harmless.

Sodium perborate and percarbonate are used to bleach stains. Other substances commonly found in detergents include enzymes, silicates, optical brighteners, whiteners and perfumes; some of these are added separately. Detergents may also contain fibre protection agents (magnesium silicate and phosphonate) and greying prevention agents (carboxymethyl cellulose, polycarboxylate and polyalkylene glycol). Bleaching agents release boron which is hazardous to water systems (Talvenmaa, 2002). Fibre protection agents and greying prevention agents contain substances which degrade slowly in the environment.

Dry cleaning is used for materials that are sensitive to wet cleaning, e.g. wool fibres (Talvenmaa, 2002). Dry cleaners use organic solvents, which do not swell the fibres, instead of water in the washing process. The most common solvents used as detergents are tetrachloroethylene and trichloroethane. According to Talvenmaa (2002), the use of dry cleaners has diminished to only few per mils (‰) of textiles cleaned in Finland. However, in some categories such as industrial, office and public space textiles the share is greater. In many other countries even in the EU the share of dry cleaning is also greater.

Solvents used in dry cleaners are hazardous to the environment. Tetrachloroethylene and tricloroethane can be emitted to air and pollute soil and groundwater if released from the dry cleaners. The use of trichloroethane is however very limited in Finland. According to Talvenmaa (2002), dry cleaners in Finland have generally improved their recovery of solvents and started to substitute hazardous substances and methods with less hazardous alternatives. For instance, chlorofluorocarbons (CFC) and aliphatic hydrocarbons have been used as detergents in the past, but the use of CFCs has been banned and aliphatic hydrocarbons are no longer used in Finland.

Most of the releases of chemicals in the use-phase of textiles thus come from washing. Environmental impacts of washing depend on the type and amount of the washing agent as well as on the washing conditions, such as temperature. Also the contents of hazardous substances in textiles and the waste water treatment processes have an effect.

#### 2.2.2.2
#### Other maintenance

Other processes of maintenance of textiles that are relevant in connection with chemicals include adding water or stain-proof coating (impregnation agents) to shoes and other outdoor textile articles, and colouring textiles and treating them with antibacterial agents. Also softeners, dye-fixing agents, finishing agents and binders are used.

Some chemicals used in the treatment of textiles (e.g. for water proofing) are washed away in the process and need to be added to the material regularly (Talvenmaa, 2002). Impregnation agents are sold to the customers, e.g. in sprays for the treatment of footwear.

Textiles can be coloured at home using washing machines. The chemicals used in the dyes end up in the waste water. Also antibacterial agents, such as silver, can be used in washing machines e.g. to remove odour from sports clothing.

### 2.2.3
### Recycling, reuse and disposal

Depending on the articles, their ingredients and the conditions they are subjected to, a large fraction of these ingredients can be present in textiles throughout their life cycle. Recycling and reuse of textiles reverse and postpone this flux of chemicals to end-of-use phases. The chemicals released along the life cycle can enter various waste streams, or be emitted to the environment.

According to Talvenmaa (2002), more than two thirds of the waste textiles generated annually in Finland (all in all approximately 70,000 t) came from households, amounting to circa 50 000 t/yr (10 kg per capita). Textiles represent 1-5 % of all waste coming from households. In addition, considerable amounts of textile wastes are generated in enterprises, offices and public spaces and buildings. As these waste batches are generally larger than those from households and the responsibility for their treatment is more centralized, the treatment of these streams can be more efficiently organized. The same applies to wastes from textile and clothing industry that represent 0.5 % of all industrial waste, and are subject to environmental regulation even to higher degree.

The amount of textile wastes and their share of total waste amounts vary in time and regionally. According to recent data (Talvenmaa, personal communication), their share of all household wastes increased from 2 to 15 % during 2002 to 2010 in the city of Tampere while it was continuously only 3 % in rural Northern Finland. This suggests that ever more clothes are being purchased and more easily discarded in affluent communities, and that this trend has rapidly accelerated. Fashion-induced consumption habits are evidently a key cause of this as such increase in actual needs is impossible. On the other hand, industrial textile waste generation has dropped as practically all production has been transferred to other countries.

Textiles can be recycled after selling at flea markets for use as clothes, or after donation to charity at collection points organised in Finland mainly by various NGOs. For example, the Finnish NGO the Martha Organization arranges collection of used textiles and shoes (Uudenmaan Martat ry, 2010), as does the international NGO Emmaus. The Nordic UFF (Utvecklingsbistånd från Folk till Folk) and the Finnish Mission Development Aid run a network of containers for clean used clothes and shoes. The articles received are sold or donated to be used in Finland or developing countries. Some are reused by industry for making new products such as industrial towels or carpets used under parquet floor, or weft of rags. This may provide more direct and efficient recycling.

The processing of textiles into recycled material can be done mechanically, by melting or chemically (Talvenmaa, 2002). In the mechanical method, textiles are shredded into fibres which are spun into threads, used in fibre fabrics or used as filling materials, for instance in mattresses and blankets. Recycled wool is used to make tweed type threads, fireproof blankets and oil absorbing carpets. According to Talvenmaa (2002), a high proportion of waste textiles collected is processed mechanically into recycled material.

The melting method can be applied only to synthetic fibres. In the process, the fibre material is melted and used as a raw material for plastic products. Also the chemical method can be applied only to synthetic fibres. In the process, the textiles are transformed back to the original material by using various chemicals. This is not a very common method due to the expensive equipment.

The final disposal of textiles is usually to landfills either directly or after incineration. In waste incineration plants most of the chemicals in the textile wastes can be broken down to (relatively) harmless residues, and the released energy can additionally be recovered. Also the *de novo* formation of harmful substances such as PCDD/Fs can be efficiently prevented and controlled, given a high level of incineration technology.

In contrast, many chemicals that can be released from textiles during manufacture and use are present also in textile wastes disposed, and can be released to the environment if the emission control technology (especially landfill leachate and gas treatment) is insufficient. These chemicals undergo biochemical transformation in mixed waste landfills containing organic materials. The requirements of the EU's landfill directives, for instance for pre-treating the organic fraction, increasingly influence the conduct of textile waste disposal also in Finland.

Municipal sewage sludge that contains much of the chemicals released from textiles in households (and in industrial facilities draining to municipal sewage networks) are recycled to cultivation areas, including agricultural and municipal green areas, also landfill covers. The sludge is usually processed by aerobic composting or anaerobic fermentation whereby methane and other gases are retrieved. At all stages, some emissions of textile chemicals occur to the environment.

Recycling of textiles in Finland comprises, besides flea markets and collection of clothes, the mechanical recycling of textile materials and the incineration of waste textiles (Talvenmaa, 2002). Also the melting method has been tested, but there are enough waste plastics to be reused as material, which reduces the feasibility of textile waste recycling by melting. Mix materials of textiles are also a problem in the process. Usually the obstacles of textile recycling in Finland are rather economical than technical. The small proportion of textile waste affects recycling and reuse rates.

2.3

## Chemicals used by the textile industry in Finland

2.3.1

### Structure of Finnish textile and clothing industry

Finnish textile and clothing industry has gone through a structural change since the beginning of 1990's. Domestic manufacture of textiles and wearing apparel has largely disappeared and these operations have been outsourced. Several companies have ended their own production and have focused on product design and marketing. The Federation of Finnish Textiles and Clothing Industries have approximately 140 members (Figure 2). In addition, there are 30-40 small and medium-sized enterprises operating outside the federation (Salonen, 2008).

Most textiles were imported to Finland from the EU while only 44% of the imported clothing was from EU in 2007. Clothing products are mainly manufactured outside Finland. The basic, bulk products are manufactured in China or in the Far East but the most fashionable products are manufactured in Eastern Europe or in other neighbouring areas in order to enable fast reaction to changes in the demand and markets (Salonen, 2008; Engblom, 2010a).

2.3.2

### Survey among Finnish chemical importers and manufacturers

#### 2.3.2.1 Data gathering

Information on the use of hazardous chemicals in the Finnish textile and clothing industry was collected from the KETU Product Register of Chemicals in Finland (3.1.4), and through a survey sent to chemical importers and manufacturers. The search from KETU database was focused on chemicals classified to be used in the manufacturing of clothing and in textile finishing. In the category of textile finishing, there were a total of 300 (in August 2010) chemical products in the register. In the category of manufacturing of clothing, there were only 12 chemical products. The KETU register contains explanations on the purpose of use for each product.

A survey on the use of chemicals was sent to importers and manufacturers of these products to identify the life cycle stage in which the chemicals were used. The importers and manufacturers were also asked to estimate the amount of chemicals left in the product after textile treatment.

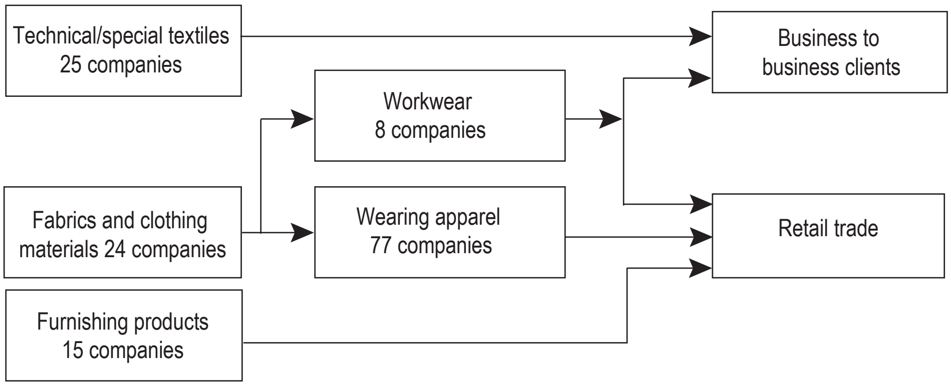


Figure 2. Structure, size and functional relationships of the Finnish textile and wearing apparel cluster (Salonen, 2008).

The survey was sent to 11 companies, out of which 8 (82%) answered. Three importers could not be included in the survey as they did not have representatives in Finland. However, product information for two of these companies was searched from the Internet. The scope and the response rate of the survey can be considered good.

2.3.2.2
**Key results**

Five products of four companies found in the KETU register were not relevant for this study. Part of the chemical products (approximately 50) was intended for home treatment of finished textiles. The rest of the products, such as dyes, finishing agents and auxiliary substances, were designed for textile manufacturing companies. No information on whether the products were used for home textiles or industrial textiles was available.

According to information from the industry, the implementation of the REACH Regulation has reduced the amount of hazardous chemicals in textile and clothing industry. In this study, chemicals in the KETU register were analyzed to identify which of them are classified as hazardous to the environment.

A summary of chemicals in the Finnish textile and clothing industry and in domestic use (Table 2) reveals that most products containing hazardous chemicals are used in dyeing and printing.

The firms were asked to estimate the chemical residues in their products. Only a few firms responded, as that the amounts remaining in the products are highly dependent on the user of the chemicals. In general, auxiliary substances, such as softeners, can be assumed to stay in the product. Also dyestuff is chemically bound to the fabric or fibre and intended to stay in it during the use. These chemicals are quite expensive and it can be assumed that these chemicals are used according to the recommendations.

2.3.3
## Priority substances in the Finnish textile sector

Based on the above survey and on other sources, priority chemicals and their uses with regard to environmental and human health hazards from chemicals in textiles were identified (Table 3).

The priority chemicals include substances defined internationally within the Water Framework Directive (both at EU level and nationally) and the HELCOM Baltic Sea Action Plan, and nationally. The prioritization methods and grounds vary between proposals made in different contexts and bodies.

**Table 2.** Summary of chemicals used in the Finnish textile and clothing industry.

| Process step | Number of products | Number of chemicals | Number of chemicals classified as hazardous to the environment[1] | Share of the number of chemicals classified as hazardous to the environment of all chemicals |
|---|---|---|---|---|
| Not available | 13 | 20 | 1 | 5 % |
| Equipment cleaning | 2 | 4 | - | 0 % |
| Wet-processing (pre-treatment) | 15 | 27 | 2 | 7 % |
| Wet-processing (dyeing/printing) | 170 | 164 | 14 | 9 % |
| Wet-processing (finishing) | 20 | 30 | 6 | 20 % |
| Finished articles - Bleaching | 1 | 3 | - | 0 |
| Finished articles - Home dyeing | 26 | 13 | - | 0 |
| Total | 247 | 220 | 22 | 10 % |

[1]Based on information in material safety data sheets and Annex 3.1 in CLP regulation; note that these do not cover all hazardous properties. The sales of part of the products in KETU register were ceased by the time of the study, and therefore the number of products is less than 300.

Substance flow analyses (SFA) for certain chemicals were also utilized from the COHIBA project (Control of hazardous substances in the Baltic Sea region, 2009-2012; http://www.cohibaproject.net/home/en_GB/home/). The project will identify sources, emissions and pathways to environment and inputs to the Baltic of 11 hazardous substances in eight Baltic Sea countries and assess cost-efficient measures to reduce these substances. The project collects data on production, use volumes and discharges, emissions and losses of the substances, as a basis for substance flow analyses. The SFAs will be developed also for Finland for prioritized chemicals, for example NP/NPE, OP/OPE, pentaBDE, decaBDE, HBCDD, TBT and PFOS that involve textile use within or outside the EU. The preliminary results indicate that the washing of imported textiles (cf. 3.2.3) is a very important emission source for NP/NPE and OP/OPE.

Information on use amounts of these chemicals and especially their presence in imported textiles and other articles is incomplete. Nevertheless, it may be noted that the use of DEHP is still significant (about 150 tons/year) in the textile sector in Finland.

2.4

## Life cycle assessments of textiles

2.4.1

### General and methodological considerations

Life cycle assessment (LCA) is the study of the environmental impacts caused by a certain product, process, region or society (ISO 14040 series; JRC, 2010). It attempts to integrate all relevant environmental impacts without temporal or spatial limitations in order to identify trade-offs between environmental problems, regions or human generations. Therefore the system boundaries are broader than in other parts of this study which focuses on current emissions of hazardous substances occurring in Finland as a result of the Finnish use.

The aim of this chapter is to outline some of the environmental impacts which originate outside Finnish boundaries. One major component of this is the potential toxic load which is imported embodied in products. Another component is the toxic stress caused in ecosystems abroad by the production of the raw materials later imported to Finland. Contrary to the conventions of life cycle assessment, the focus is

**Table 3.** The usage of priority substances, defined in the EU's Water Framework Directive and the HELCOM's Baltic Sea Action Plan, in Finnish textile sector or potentially occurring in imported textile articles (Finnish Ministry of the Environment, 2005; HELCOM, 2009; Mehtonen et al., 2010).

| Priority substance | Usage in textile sector | Amount used in Finnish textile sector, t/year | Present in imported textiles | Emission stages and compartments receiving emissions |
|---|---|---|---|---|
| DEHP | Plasticizer in carpets and textiles made of flexible PVC (e.g. coated fabrics) | 150 (2008; may include other plastics) | Yes | During washing; to waste water<br>During use; via volatilization to air<br>Waste deposits; to leachate and air |
| BBP | Plasticizer in carpets and textiles made of flexible PVC | used in 2008; amount confidential | Yes | During use; via volatilization to air<br>During washing; to waste water<br>Waste deposits; to water and air |
| NP / NPE | Wool scouring, fibre lubricating, dye levelling (clothes, towels) | No identified used since 2002 | Yes; emission potential high | During washing in factory and households; to waste water |
| OP / OPE | Coatings of textiles | Not used | Possible | During washing in factory and households; to waste water |
| 1,2-dichloro-ethane | Protection of cargo (during storage and transport | Minor in 2008; confidential | Possible | During use and waste stage; to air |
| Dichloro-methane | Glue used in manufacture of textiles | Significant 2006; confidential | Possible | During use; to air and waste water<br>Waste stage; to air and waste water |
| SCCP | Water-proof clothes, industrial protection clothes | Not in use | Possible | During washing; to waste water<br>Waste deposits; to waste water |
| pentaBDE | Flame retardant in special carpets, protection clothes, bedding with flexible PU | Not in use | Possible | During washing; to waste water<br>During use; via volatilization to air<br>Wastes; to leachate and air |
| decaBDE | Flame retardant in curtains, upholstery fabrics & carpets | Not in use | Possible | During washing; to waste water<br>Waste deposits; to waste water<br>Waste incineration plants; to air |
| HBCD | Flame retardant in textiles | Not used | Yes | During washing; to waste water<br>Waste deposits; to waste water |
| Endosulfan | Cotton textiles containing endosulfan residues | Not used | Possible | During washing in factories and households; to waste water |
| TBT, TBTO | Preservative in pillows, canvas, clothes, flooring, wallpapers etc | Not used | Possible | During washing; to waste water<br>Waste deposits; to waste water |
| Tetrachloro-ethylene | Cleaning agent in dry cleaning | Significant 2006; confidential | No | During washing; to waste water |
| 1,4-dichloro-benzene | Biocide use in finishing of textiles (e.g. army clothes) | used in 2008; confidential | Possible | During washing; to waste water<br>Waste deposits; to waste water |
| Bronopol | Wetting in manufacture of clothes | used in 2009; confidential | Possible | During use in factory; to waste water |
| PFOS | Impregnation of textiles such as clothes | Not used anymore | Yes | During washing; to waste water<br>Waste deposits; to waste water |

only on ecotoxicological impacts, the impact of textiles on biodiversity, human health, resource depletion, eutrophication and climate change are ignored in this connection.

In general LCA has four analytical stages: goal and scope definition, inventory collection, impact assessment and interpretation. In many ways, the first stage is the most important, the goal and scope define what is studied, what alternatives are compared and how. After the goal and scope is well defined, the comparison of different alternatives can be done on a common basis, often defined as the functional unit (JRC, 2010). For textiles as for many consumer articles, there usually is less sense in comparing materials as such than the uses of the textiles, e.g. "five years of jeans use for one person" (Dahllöf, 2003) instead of "kg of cotton" vs. "kg of polypropene". If the use stage properties (washing, durability) of materials are similar, comparisons can be done on a covered area basis, e.g. "$m^2$ of textile, woven to a shirt".

It should be stressed that also such comparisons are highly simplifying and their utility depends on the context and the analysis (cf. goal and scope definition), especially regarding the uses, impacts and choices considered along with material flows. The seeming precision in quantification also easily misleads to trust the analyses more than is warranted, and may even restrict alternative perspectives and interpretations. For some purposes comparisons of materials may be suited particularly if coupled with other considerations such as risks and benefits (see Chapter 2.5).

After the functional unit and the goal and scope of the analysis are well defined, life cycle inventory proceeds to identify (a) all products that are embodied in the article (e.g., jeans from market), (b) all products that have contact with it (e.g., detergents used to wash jeans) and (c) services for the process (e.g., washing and drying jeans). These processes are then chosen as the new 'central' processes and the steps (a) to (c) are repeated until the system includes a certain percentage of all environmental impacts. This is the cut-off criterion, defined in goal-setting and scoping stage.

However, it cannot be standardized or harmonized (Hauschild et al., 2008) what "all" impacts include and how many they are. Such cut-offs are thus rather arbitrary. Their relative significance is even more equivocal; are for instance toxic effects prioritized (and what kinds and to what target populations), or are also impacts of textile production cycles on natural resources or beneficial effects of chemicals (e.g. of fireproofing, also to the environment) weighed in. A cut-off criterion thus implies a false certainty and calls for flexible deliberation in assessment (see 2.5).

The inventory may end up with a multitude of unit processes, emissions and other entities, depending on framing and goals also in terms of the level of detail. It should be noted that environmental impacts are not caused only by emissions, but also e.g. land use. It is moreover difficult to compare for example atrazine emissions from fibre production outside the EU with dioxin emissions from EU textiles. In the impact assessment stage, emissions are nevertheless transformed into environmental impacts, commonly using factors which estimate the marginal change in environmental impact from marginal change in emissions. The ReCiPe2008 model for instance includes characterization factors for over 5 000 emissions and 18 environmental impact categories, including human, terrestrial, freshwater and marine toxicity, particulate matter formation and ionizing radiation.

### 2.4.2
## Initial comparisons of the impacts of cotton, viscose and fleece

As an example, LCA results for cotton, viscose and fleece are presented (Figure 3, left). Fleece is included in this comparison although it is not a raw material like the other two but a structure; it does however represent a form of synthetic polymer (polyethylene terephthalate) that has chemical properties and adverse impacts that significantly differ from those of the others. Cotton. although a natural material, seems nevertheless worst in several impact categories, including toxicity from chemicals used in product life-cycle stages compared with those of 1,4-dichlorobenzene. This is largely due to production-stage use of pesticides.

The impacts were also normalized to whole Europe by dividing with the average emissions of a European citizen (Figure 3, right). The main environmental impacts of these fibres then seem to be aquatic ecotoxicity, eutrophication and natural land transformation, cotton being worst in all these impact categories except the last. Fleece is the best option considering all categories, although it has higher fossil depletion than viscose.

This initial assessment provides some justification for a focus on ecotoxic impacts. The comparisons however invite many questions, instead of giving clear-cut answers. Essential questions relate to

- assumptions and uncertainties that underlie the estimates and may easily cause order-of-magnitude changes in them;
- framing in terms of space, time and impacts (such as ecological risks of non-decomposable fleece, or toxicity of bioaccumulating chemicals instead of direct toxicity as benchmark);
- weighing of categories and associated value judgments; and
- fundamental comparability of entities that typically limits quantitative rankings by PLCA.

Thus, this analysis largely serves as an example of the need for such multi-dimensional considerations.

In particular, trade-offs between alternative products, processes and other choices are difficult as they are influenced not only by impacts in physical or even economic terms, but also by hard-quantified socio-political, legal and other factors (see following chapters).

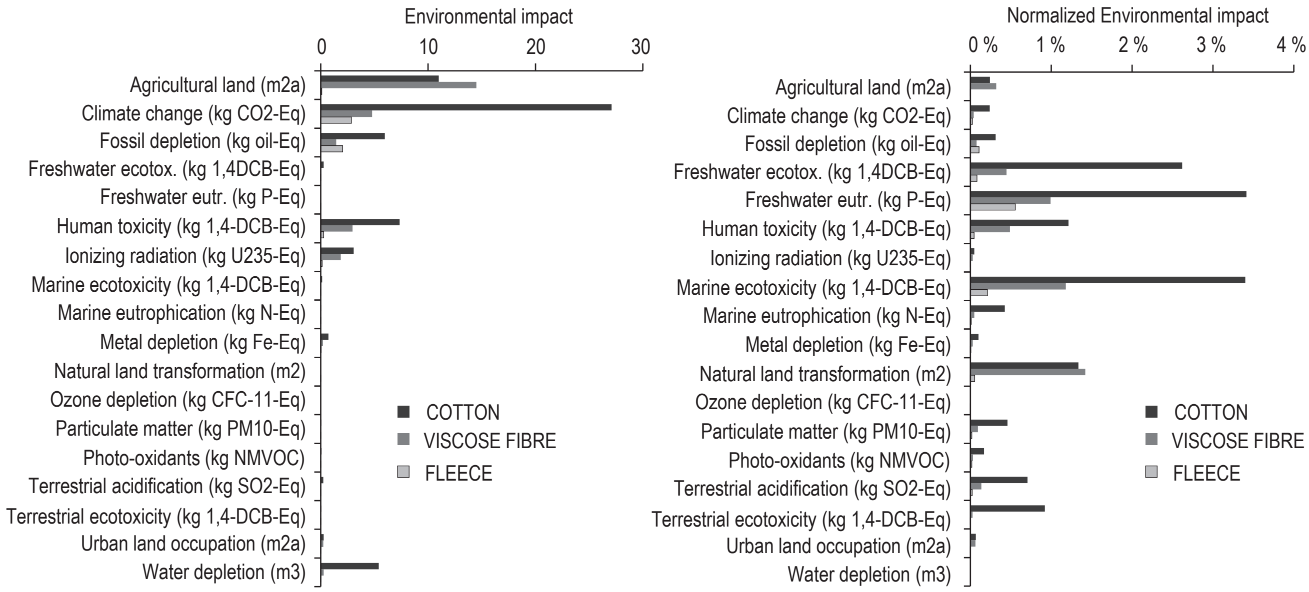


Figure 3. Comparisons of the environmental impacts or pressures of cotton, viscose and polyethylene terephthalate fleece cloth. Left: absolute estimates; right: estimates normalized to average European citizen, accounting for the impacts or pressures of whole Europe. Inventory data from Ecoinvent (2010), impact assessments including normalization according to ReCiPe (Goedkoop et al., 2009).

### 2.4.3

### Imports, stocks and emissions of chemicals embodied in products

In a substance flow analysis in Stockholm, textiles were identified as an important stock of antimony (an element of intermediate environmental toxicity), AP/APEO, brominated flame retardants, antibacterial substances and polyfluorinated compounds (Månsson, 2009). For AP/APEO, textiles were identified as the main emission source.

Månsson (2009) estimated that although the concentrations of AP/APEO in textiles at 500 ppm were well below the 0.1% reporting limit of REACH, some 7 t/a was emitted in the Stockholm region. Using these concentrations and emission factors, the 140 000 t of textiles imported to Finland in 2005 could include 70 t of AP/APEO and leach 6 tons of them annually. By comparison, 10 t/a of NP and 220 t/a of NPE were used in Finland in the same year, indicating that imported textiles are a main source of this group of hazardous substances also to the Finnish environment.

Estimates were made for DEHP and PBDEs by Jonsson et al. (2008), resulting in influxes of 400 and 19 t/a, and emissions of 30 and 0.8 t/a, for DEHP and PBDE respectively. These estimates included only diffuse emissions from articles, so the actual emissions might be even higher.

In the case of Finland, DEHP is imported in PVC and other plastic products, including building materials and packaging, as well as in cosmetics and textiles. Assuming a worst-case-scenario where all imported articles including 940 000 t/a (2005) of plastic products besides textiles contain DEHP at half the REACH reporting level, 460 t/a of DEHP would be imported with products. This is more than half of the reported production and imports of DEHP as such in Finland during that period (760 t/a; KETU-register/Jukka Mehtonen 19.10.2010). The contribution of textiles and other articles to influxes and emissions may thus be significant also for these hazardous substances.

According to Månsson (2009), the stocks of DEHP, PBDE and AP/APEO are accumulating in the technosphere, although they are among the most persistent chemicals. This means that future emissions are likely to be higher than currently even if no new additions would be made. For DEHP, previous usage might contribute to most of the current emissions (Jonsson et al., 2008).

### 2.4.4

### Toxic emissions from textile production outside Finland

In priority product and material assessment of the UNEP, agricultural production and especially cotton production has been identified as a major cause of ecotoxicological effects (UNEP, 2010). These emissions occur far from textile users, in the production of raw materials. Therefore these impacts are sometimes ignored even in otherwise comprehensive LCAs (Nielsen and Nielsen, 2009).

The magnitude of toxic emissions in cotton production is outlined by a simplified case study of cotton cultivation and textile processing in China and NP emissions from use in Sweden. For this illustrative case, secondary data was used for the emissions. Pesticide emissions and electricity production technology were obtained from the Ecoinvent (2010) database. Swedish NP emission factors were used for textiles (Månsson, 2009). The emissions were characterized using the USETOX chemical fate and transport model (Hauschild et al., 2008), recommended by SETAC (Society for Environmental Toxicologists and Chemists).

Based on the results, most of the ecotoxic stress is caused by pesticide emissions in the raw material production stage (Figure 4). Nonylphenol emissions were approximately 10% of the total toxic stress. Therefore a priority in reducing the global

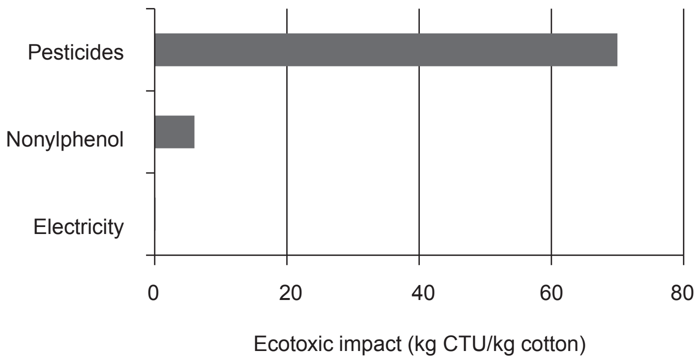


Figure 4. Comparison of the ecotoxic impact of nonylphenol, pesticides and coal power electricity in the life cycle of nonylphenol treated textiles. Ecotoxic impact is reported in comparative toxic units (CTU) with the USETOX methodology, taking into account transportation, persistence, bioavailability and toxicity.

chemical emissions associated with textiles would be the reduction of pesticide use in cotton cultivation. Some studies recommend using organic cotton instead of conventionally sourced (Kalliala and Nousiainen, 1999; RMIT, 2001). This however results in a trade-off problem: organic cotton production requires more land than conventional cotton production. Unless the overall demand for cotton decreases, this increases competition for land which has been identified as a much higher threat to biodiversity than ecotoxic emissions (UNEP, 2010). Assessing such trade-offs in more depth and for added management relevance would require not only the quantification of impacts caused by both production systems but also analyses of the particular grounds for focusing on seemingly smaller toxic stress, such as risk reduction opportunities (which may be better in Finland and other consumer areas).

The analyses above indicate that a major part of the toxic emissions in textile life cycle occur outside Finnish borders in the agricultural production of fibres. The amount of textiles imported to Finland is approximately 26 kg/capita/year. Thus a priority in the minimization of toxic impacts would be to reduce the imports of textiles, especially conventionally grown cotton, with high usage of pesticides; cotton also has a high water footprint and exerts other pressures on natural resources, although being renewable resource in itself. Such processes and measures should be prioritized which (a) increase the durability and use-life of textiles (including fashion-induced and other behaviour), (b) recycle waste textiles and (c) replace cotton with other fibres.

2.5
## Synthesizing characterization of risks and impacts

2.5.1
### Risks at different life-cycle stages

As shown above, risks and impacts from chemicals in textile articles are caused along many life-cycle stages and along many processes and operations. It was also explained that the present report focuses on the stages after production of fibres. The life-cycles and processes vary according to the case, such as the article, its uses, the chemicals, and the risks in question that involve various categories. Risks to consumers may be dominated by the use stage, the 'properly environmental' risks to other targets by other stages.

It is difficult to distinguish the risks of different life-cycle stages from each other, as they have overlaps and feedbacks. It may for instance be argued that demand management and design stages, situated largely previous to production but influenced by consumer perceptions of risks, are crucial for prevention because they can reduce risks from all subsequent stages. Overall, it cannot be much generalized what stages and specific processes are the most important ones, especially for non-differentiated 'risks'.

Even those risks that are smaller by some measure such as material flows and toxic effects can warrant priority measures. Priorities depend on many management and policy considerations, notably the qualities and distribution (targets) of the risks and on the risk reduction opportunities. It may thus be more strongly demanded and acceptable, more straightforward and more feasible to reduce some risks than others, partly regardless of the magnitude of the risk. Some differences in reducibility of risks can be influenced (cf. chapters below), others are more permanent.

It seems evident that, for many chemicals, washing and cleaning during the use stage and final disposal during the post-use waste stage cause particularly significant risks to the environment,. Human health risks are additionally caused by exposures during use.

As to chemical groups, persistent and bioaccumulative substances in textiles are particularly important as their risks span over many life-cycle stages and food-chain levels. The same is true of their parent or daughter substances (reaction products). These include halogenated substances and bioaccumulative elements (heavy metals).

In terms of impacts, as was suggested by the life-cycle analyses, environmental risks at all stages are associated with many different pressures, including emissions as well as impacts on renewable and non-renewable resources, land, biodiversity and so forth. Impacts also extend to the social sphere, in Finland and elsewhere such as in producing countries; and these impacts interact with physical environmental impacts.

Changes will occur in the profile of risks along life-cycle stages as textile markets evolve. Bulk production essentially shapes the chemicals used and their risks. Increased recycling and prolonged use age may reduce the material flows but also retain toxics in the system. New materials including synthetics and combinations likewise influence the use chemicals. Ecological considerations are likely to become more pronounced, but their precise contents and implications for instance for the risks of chemicals are not clear.

### 2.5.2 Exposures and vulnerabilities

Exposure shapes the risks from chemicals in textiles: the dose makes the poison. Exposure scenarios generally depend on the chemical and its occurrence in textiles or other materials after release, its bioavailability in the environmental matrices as well as on the vulnerability (proximity and behaviour) of the organisms exposed. These scenarios need to be specified to assess risks more realistically. However, for many chemicals in textiles, assessment is based crudely on limited concentration and property data and transport and fate models with little specification and detail.

Exposure of consumers to chemicals in textiles naturally takes place through skin. This route can be important for contact allergens and skin-permeable substances. Of other exposure routes, inhalation is important for dust-laden and volatile chemicals. Occasionally chemicals in liquid streams may enter drinking water systems.

Non-human animals are exposed to textile chemicals mainly in waste water recipients: at treatment plants (activated sludge microbes) and waste disposal sites and in watercourses below these. Exposures to persistent chemicals take place in many more compartments, also food in the case of PBTs that can also be transferred to embryos and lactating young (Table 4).

The above discussion has mainly addressed continuous exposures. Chemicals in textiles may also cause sudden exposures and risks, even more catastrophic than pulsed emissions to sewers. Such exposures include accidental releases in fires, both in storages and in end use localities.

Exposures are determined by the level and the duration of exposure. In addition, the timing can be important for effects that have specific time windows. The internal exposures in terms of critical tissue doses are modified by toxicokinetics depend on the substance and the biological target system. In addition to parent compounds, exposure to metabolites may need to be accounted for.

Animals can also be exposed to textile parts and matrices that can be physically harmful in both aquatic and terrestrial environments, especially in the case of synthetic textiles, although also offering some use e.g. as nest materials.

2.5.3
## Biological effects

Textiles and their chemical exert a variety of toxic, otherwise harmful and beneficial or neutral effects on biological systems, including humans and non-human organisms (Table 4). These effects can arise in all stages of the life-cycles of the textiles and of the associated chemicals.

According to standard risk assessment, the biological effects of chemicals in textiles depend, besides exposures, on their toxicity and on other properties influencing effects. This is described by dose-response functions, approximated in basic-level assessment by some measure of (highest) toxicity after a (lowest) exposure.

Dose-response assessment involves many choices, such as the type of endpoint or intermediate effect which may not be clearly adverse, and the species. For instance, when using 1,4-DCB as a yardstick (see above), depending on assumptions and extrapolations, toxicities may vary by orders of magnitude. Rough classes of (very) high or low toxicity are then distinguished.

To account for qualitative differences in endpoints, CMR substances are often singled out (cf. above) mainly with a view of human health. These classifications are not clear-cut, e.g. for the relevance of tumours across species. On neurotoxicity or endocrine effects apart from reproductive toxicity there is still less consensus, but EU criteria are emerging for potential endocrine disrupting substances (EDS) according to type and strength of hormonal activity.

Responses are not homogeneous for any chemical exposure, but vary among systems exposed. The susceptibility of those exposed thus needs to be factored in. Often this is done simply by picking a worst-case LOAEL or NOAEL, possibly with additional uncertainty factor. In other cases however inter-individual variation in sensitivity may be explicitly accounted for (see below).

Toxic effects are usually estimated based on tests on laboratory animals, though for health risks human evidence has more direct relevance. Also ecotoxicological effects are usually assessed from laboratory data on standard species. Risks to wildlife tend to be greater. Free-living animals including humans are also exposed to complex mixtures of chemicals and stressors. This in some respects emphasises, in others deemphasizes the risks specifically from textile chemicals.

For some substances such as nanomaterials in textiles, risks can be hardly be assessed at all, as their behaviour and modes of action are not known and even measurement and testing methods are still very scanty. Also the effects of some new chemicals, fibres from GM plants and novel mixtures of materials can be known only very incompletely. Unanticipated risks are thus possible.

Specific toxic risks from textiles are caused by PBTs; CMR dyes; endocrine disrupting polymer additives such as APs and DEHP; biocides e.g. against fungi. For many of these, both humans and other organisms are at risk. Also some reactive chemicals can cause risks, for instance acutely to health and to the ozone layer, depending on their specific fate properties and modes of action.

As shown above, biological impacts of chemicals in textiles are not restricted to toxic effects; there may be disproportional attention is given to these. A major category of risks is related to physical safety, for instance suffocation, fires, and accidents due to unpractical clothing and textile surfaces. Such risks are often determined by the main fibres, but in some cases chemicals do play a role.

### 2.5.4 Socio-economic risks and impacts

Socio-economic risks are highly important for risk management in contexts such as those encountered with textiles and related consumer health and safety. These risks, both perceived and 'real' (often not clearly distinguishable in the socio-economic area), are also highly varied, including the following overlapping categories (Table 4):

- risks of economic losses, both from adverse effects of textiles and their chemical ingredients on environment, health and safety and from loss of benefits (see below)
- specifically, socio-economic risks from pressures on natural resources and land
- risks of unemployment in textile industries and in broader work economy
- political risks to markets and trade, due e.g. to consumer fears and boycotts
- risks of losing trust between actors and other risks to social cohesion.

Socio-economic risks are directed to many groups of stakeholders such as consumers, administrations, policy-makers and enterprises, both textile producing and retailing and down-stream user industries. These have conflicting as well as common interests at stake.

Socio-economic risks are intimately linked with risks in biophysical terms in complex ways. Socio-economic realities evidently play a key role in causing and shaping risks, such as when market forces and mechanisms contribute to consumerist behaviour, material selection, and prompt and relocate production in cheap-labour regions with low technological, occupational and environmental standards. On the other hand, risks of toxic effects, often based on fears, justified or not, may trigger significant social reactions some of which are sudden, unexpected and chaotic.

### 2.5.5 Beneficial impacts of chemicals in textiles, and their relations with risks

Textiles in clothing and many other goods, such as furnishing, are basic and necessary commodities, compared to many other goods that may be considered more as gadgets. Textiles play a key role in protecting humans and their living environments and increasingly also in making life more efficient and comfortable. Some benefits are crucial for human health, welfare and safety. Some textile articles can even be used to combat environmental pollution (e.g. in recycled rags).

However, there is also luxury and otherwise excessive use of textiles, and of associated chemicals. Excessive use occurs in many forms: as low use-life (rapid discarding); as use of materials that entail (also indirectly, e.g. in fibre production) excessive use of chemicals; as unnecessary inclusion of chemicals such as dyes and perfumes in textiles that in themselves are necessary; as low quality bulk textiles that easily leach even their necessary chemical ingredients; as excessive or unnecessarily harmful (dry) cleaning. The dividing lines between necessary and luxury use are not clear and hard to define objectively. For instance, luxury use is often based on deep-seated cultural habits that may be claimed to serve a beneficial social and even welfare function.

The relationships between risks and benefits are complex and vary from case to case. In many cases there are **trade-offs** between risks and benefits. However, several risks can also be reduced or avoided simultaneously, or risks can be avoided while benefits are secured and even increased, thus providing win-win options. Risks may also modify benefits, and *vice versa*. In particular, the relationships between the relative risks and benefits of presently used and alternative chemicals are important in governance and need to be evaluated (cf. following chapters).

The beneficiaries of textile chemicals include the various stakeholder groups to which the value added and impacts of textiles and their chemicals are directed (see above). In addition to such present human groups, future generations are important beneficiaries of textiles. These groups can benefit from textiles as such or through more sustainable, qualitatively changed and also reduced use and production and use. Thus, benefits may accrue also from reduced risks.

### 2.5.6
### Temporal, geographical and population distributions of risks and impacts

As shown above, in the **time dimension** risks to the environment from chemicals in textiles may span over prolonged periods especially in the case of PBTs that accumulate in food-webs and may become sufficiently concentrated in living tissues to impair their normal functions. These substances can cause exposure over several generations; they also cause typically chronic effects, in some cases inter-generational (e.g., through gene damage). Risks from PBTs thus can peak still after phase-out due to lagged exposures and effects. Even the textile fibres themselves may depending on conditions be preserved over centuries, and can thus have certain adverse impacts on the environment and on humans. Also such other ecological risks may persist for long.

The timing of risks depends not only on the fate of the chemicals now used, but also on the development of textiles and of the use of chemicals in them. This development has both technological and social elements (see above). Recycling and 'eco-fashion' may increase; so can indiscriminate use of chemicals in bulk textiles. New (and substitute) chemicals are introduced, with some ups and downs in risks, and different risk profiles.

In addition to duration, the frequency and timing of exposures and risks is important. Sensitive time windows include early developmental stages. As mentioned above, sudden risks are caused by accidental releases. Likewise, the susceptibility to exposures can be suddenly increased by other stresses due e.g. to nutrition, illness, and disasters.

**In the spatial dimension,** risks are directed according to the chemical, the textile and the use setting to specific environmental compartments. These include water courses (sediments for substances of low water solubility), and soil or waste matrices. In homes of consumers textile chemicals are concentrated in the fabrics, in dust (emphasizing risks to children) and in indoor air.

Geographically, chemical releases and risks from textiles in Finland include those from imported articles. In many other countries and regions the standard of chemical use in textiles is poorer. POPs in textiles have global (or circumpolar) distribution through long-range transport, but also formaldehyde and other such hazardous chemicals pose risks. Even particles of textile polymers can be distributed widely over the life cycle. Likewise, socio-economic risks as well as impacts on natural resources are transported, also to producing regions. Thus, the spatial distribution of risks is a multi-dimensional problem that involves the interaction of jurisdictions and control systems.

The distribution of risks among populations and generally among receptor organisms is a key characteristic of risks in policy. High-risk species evidently include humans as users, handlers and producers of textiles in direct contact with them. However, the higher sensitivity of some vulnerable non-human species may endanger them too.

Children are easily exposed to chemicals (e.g., through skin and accidental ingestion) and sensitive; they are not small adults. Because of the importance of the early developmental stages, both children directly exposed and those exposed through placenta and milk are at risk. Therefore women in reproductive age constitute a high-risk group also as mediators of risks.

Other high-risk groups include producers especially in countries where occupational hygiene and safety is sub-standard (often including woman and child workers).

### 2.5.7 Uncertainties of risks and impacts

There are uncertainties concerning risks and impacts at many levels:

- risks as fundamentally probabilistic entities (functions of the probability and consequence of adverse events or processes)
- uncertainty of framing and model boundaries; extrapolation and generalization
- other model uncertainties, including assumptions of risk phenomena
- data uncertainty; distributions and ranges of risks and risk factors
- genuine stochasticity (beyond the standard probabilistic notion)
- high-level uncertainty, e.g. of decision rules, and ambiguity.

Uncertainties pertain not only to measurements e.g. of chemical concentrations or fluxes, or to physical simulation models, and that they surround both risks and risk management strategies and measures. Uncertainties are emphasized by increasingly complex systems in nature and society, e.g. in global trade and ecology.

Analysis of uncertainties can help not only to reduce them but to guide policy and decision making. For instance, by focusing on the greatest or most decision-relevant uncertainties and reducing them, other variables of less importance can be omitted. This can provide an essential way out of the complexity encountered with many risk issues, and help to focus on essentials, instead of trying to assess all specific details as is often done on a deterministic (and linear) approach. For instance, considerations of uncertainty are an essential though often non-explicated part of monitoring, surveillance, decision-making and quality control in management.

In essence, uncertainty analyses reduce the risk of relying too heavily on data, models or expert judgment in general. This applies not only to the quantitative entities but also to qualitative aspects and to the uncertainties in framing (e.g., in model boundaries); and it applies to risks, or benefits, as well as to risk reduction or governance opportunities. Attention to uncertainties can thus help simplify assessment and management to an appropriate degree – not too little or too much, and accounting for the case, the context and the purpose.

At a still more general level, conceptualization and analysis of uncertainties and ambiguities, including value judgments, can also be a key part of the dialogue and deliberation processes that are essential in reframing and refining risks and related issues.

2.5.8

## Synthesizing appraisal of risks and impacts

From the point of view of regulatory risk management and governance in particular, the risks from chemicals in textiles or associated with them can be framed and characterized in a structured manner by examining the linkages of these risks with other topical areas (Figure 5). It can be seen that the risks are closely related to and partly overlap other areas of governance, notably nanomaterials and pharmaceuticals among risk-causing agents, waste management among environmental media, consumer safety among protection targets, and housing among sectors or compartments.

A synthesizing characterization and semi-quantitative evaluation of the risks and impacts associated with key classes of chemicals and textiles and their causative factors and implications (Table 4) suggests that, despite restrictions in the use and subsequent risks of several harmful chemicals in textiles, a variety is still in use around the world and endanger human (consumer) health as well as (or even primarily) the environment especially after the use stage.

Chemicals become associated with textiles in an extensive chain of processes, from production to waste management. It may also be noted that some risks from chemicals textiles have only recently been identified, most are insufficiently known, and therefore there is the possibility of unforeseen risks as new substances are introduced either in the textiles themselves or in their life-cycles.

The synthetic characterization highlights the role of the persistent and bioaccumulative toxic chemicals. Some of them are simultaneously risky because of their adverse properties in other categories, for example as endocrine disrupters or modulators, and as allergens or other sensitizers. Even some of the toxic heavy metals, although inorganic and not organic compounds (except for organometal derivatives such as Methyl-Hg), can be included in PBT substances as inherently persistent and also bioaccumulative substances.

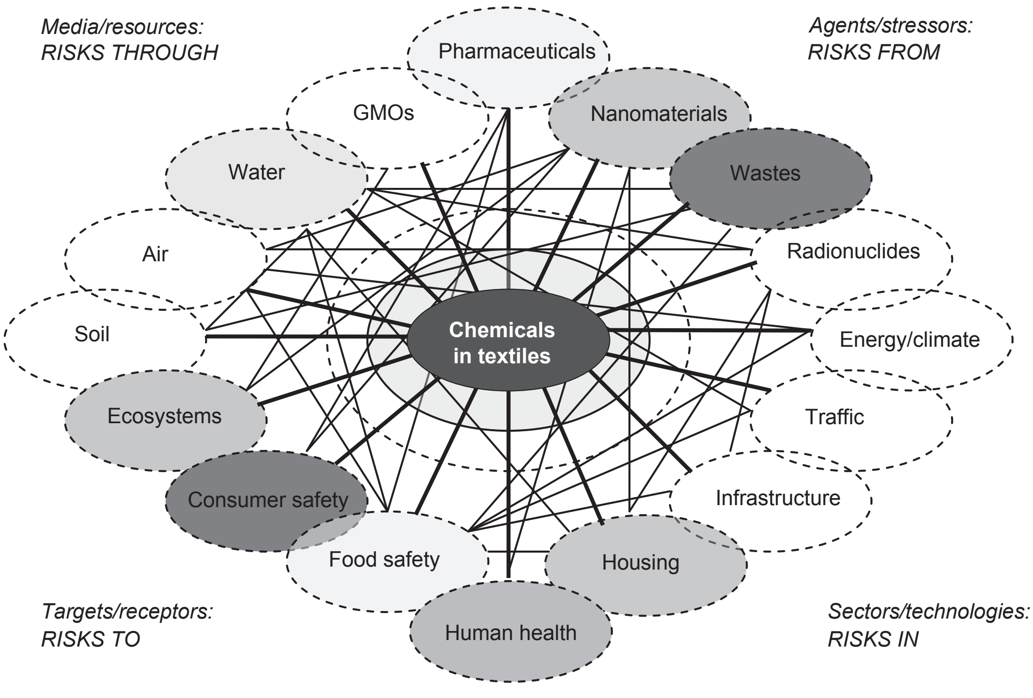


Figure 5. Conceptual and functional linkages between risks from chemicals in textiles and other topical areas, grouped as agents, media, targets and sectors. Those of most importance to textiles in chemicals have been highlighted. Note the multitude of links with other areas

**Table 4.** Semi-quantitative appraisals of environmental risks from key chemical classes in textiles, emphasizing chemicals reported in Finland or commonly present in imported textiles, broader impacts, and social and management aspects. +/++/+++ = rather/relatively/very significant.

| Chemical (class) | Uses | Exposures | Ecological risks | Human health risks | Benefits | Risk distribution | Uncer-tainties | Management implications |
|---|---|---|---|---|---|---|---|---|
| **Persistent organic pollutants** | | | | | | | | |
| PBDEs, HBCD | ++ | diet, inhal. (dust) etc | +++ | ++ | (fire) safety | prolonged, long-range | ++ | restrictions |
| SCCPs | ++ | diet, inhal. (dust) etc | +++ | ++ | technical | prolonged, long-range | + | restrictions |
| TBT compounds | + | diet | +(+) (reprod) | + | technical | medium-range | ++ | restrictions (targeted) |
| PFOS etc PFCs | ++ outside EU | diet, inhal. | ++(+)? | + (also indirect) | technical (cooling etc) | long-range, lagged (O3) | ++ | more global control |
| PeCP | ++ outside EU | diet | + (also PCDD/Fs) | + (also PCDD/Fs) | technical (preservat) | med.-range; precursor | + | restrictions, import |
| PBBs, PCBs | + outside EU | diet | +(+), PCB reduced | +(+), PCB reduced | none (PCBs substituted) | long-range / young | ++ (+ for PCBs) | phased out; dioxin links |
| Triclosan | ++ | diet, dermal | +(+), aq. bacteria | +(+) cancer, hormonal? | aesth (odor) | chronic also indirect | +(+) | more global control |
| **Toxic chlorinated aliphatic industrial chemicals** | | | | | | | | |
| 1,2-DCE, DCM | ++ | +, inhal. | - | + | technical | immediate | + | reduce use |
| TCEe, | | | | | | | | |
| TeCEe | + (dry cleaning) | +, inhal. | - | + (worker); cancer? | tech./safety (non-flamm) | immediate | + | reduce use (cleaning) |
| 1,4-DCB | ++ | +, inhal. | + | + | tech/preserv | intermediate | + | |
| **Endocrine modulating industrial chemicals (in addition to some of the POPs above)** | | | | | | | | |
| DEHP / phthalates | ++ | inhal., diet | ++ | +(+), reprod | technical | infants and embryos | ++ | substitution |
| NP/NPEOs, AP/APEOs | ++ | inhal., diet | ++ (textile share?) | +(+), reprod | tech., also aesth (dye) | infants and embryos | ++ | substitution |
| **Carcinogenic organic compounds** | | | | | | | | |
| Azo dyes (some) | ++ outside EU | dermal, diet, inhal. | (-) | ++ (cancer) | limited (aesthetic) | chronic | ++ | global con-trol, substit. |
| **Sensitizing organic compounds** | | | | | | | | |
| Formalde-hyde | +++ | inhal. | - | +++ (also workers) | tech. + saf., aesthetic | immediate | + (expo) | further reduction |
| Isocyanates | + +/water-proofing | inhal. | (-) | ++ acute, also chronic | technical | immediate | + | further reduction |
| **Biocides (other than those above; including pesticides, herbicides and other Plant Protection Products)** | | | | | | | | |
| DMF | ++, non-EU furnit. | contact + volatil. | + | ++, skin burns, rash | technical (preservat.) | acute and allergic | + | reduced in EU |
| Aldicarb, parathion | +++ (fibre product) | +++, cotton agr. | +++ | +++, | pest control | cultivation areas | + (++ for far risks) | biol/integrat. pest control |
| **Toxic heavy metals and elements** | | | | | | | | |
| Cd, Hg, Pb, As | ++ | inhal., via dust | + | + (fraction of total intake) | tech., aesth. (dyes) | prolonged, chronic | + (++ for expo) | more global control |
| Cr, Ni | ++ | direct contact | - | ++, allergies (cancer/ Cr) | tech., aesth. (dyes) | prolonged, chronic | + (++ for expo) | improved implement. |
| Nano-elements | + (in-creasing) | ? (unknown) | ? – also indirect | ? – also indirect | tech./environ benefits | unknown | +++ | regulations to be given |
| **Other textile constituents and textile treatment chemicals** | | | | | | | | |
| Perchlorate | ++ | diet, inhal. | + | +, thyroid | technical | acute mainly | + | improved implement. |
| PVC | +++ | indirect | + (also physical) | + (reaction products) | technical | indirect | + | to be considered |

# 3 Current management of chemicals in textiles

## 3.1 Legislative requirements for chemicals

### 3.1.1 General

Legally based control of chemicals and of articles including textiles remains a central area of risk management and in regulatory governance. Some legal provisions and requirements have been laid down at the EU level and variously implemented in and complemented by Member States also in the area of chemicals, textiles and related fields (Table 5).

However, regulatory control interacts more strongly with other approaches including economic and information-based steering, as well as voluntary systems and participatory multi-actor governance whereby both enterprises and civil society organizations have acquired greater roles (UNEP, 2011a; cf. 4). Also the latter forms can be partly legally based or involve mechanisms of 'soft law'.

A fundamental idea of regulation in the EU, implemented by Member States, is the control of the internal market. The EU is a political entity based largely on economic ideas. It can thus also suffer from limitations of this emphasis such as the weaker position of environmental and social values. In any case, interaction with the market economy including incentives and disincentives of enterprises is central in the legally based and publicly implemented governance. A key question then is how this interaction and integration of steering takes place and succeeds in managing risks.

### 3.1.2 REACH regulation

**General**

REACH is an EU wide chemicals regulation ((EC) No 1907/2006) on the Registration, Evaluation, Authorisation and Restriction of Chemicals. It contains several procedures where substances in articles can be controlled. The most severe procedure is restriction where normally the placing on the market of a substance in some product types is prohibited in the EU (CEC, 2009a). Also in the authorisation procedure substances which are included in the Candidate list of Substances of Very High Concern (SVHCs) may have legal obligations concerning substances in articles.

These obligations relate to communication of safety information of a substance from the suppliers of articles to the customers (industrial or professional users and distributors) or to consumers (ECHA, 2008, 2009). Moreover, in the registration procedure those substances used in the EU to produce articles have to be registered. Registration does not apply to articles imported to EU.

However, REACH is not specifically created to account for chemicals in articles. One limitation regards mixtures of chemicals, notably in complex products that contain a multitude of chemicals. For these, also other means of governance than the single-substance focused REACH are needed. Also the function of the globalized trade poises difficulties for the application of REACH procedures to articles (Assmuth et al., 2010b).

**Restrictions**
Based on REACH and other regulations including specific regulations for other chemicals such as biocides, restrictions of prioritized chemicals can be made. Annex XVII of REACH contains restrictions on the manufacture, placing on the market and use of certain dangerous substances, preparations and articles. Several of these concern textiles (CEC, 2010b; Table 6). However, the criteria and cut-off values for the chemicals in articles to be restricted are still emerging.

**Authorisation of Substances of Very High Concern**
The first step in the authorisation process is that Member States' Competent Authorities or the European Chemicals Agency (ECHA) propose substances to be identified as Substances of Very High Concern and to be included in the Candidate List. The SVHCs include substances that are:

- Carcinogenic, Mutagenic or toxic to Reproduction (CMR, category 1 and 2),
- Persistent, Bioaccumulative and Toxic (PBT), or
- Very Persistent and Very Bioaccumulative (vPvB) when there is proof for similar concern.

**Table 5**. Key EU legislation concerning chemicals in textiles and related products and materials.

| Legislation | Directive / regulation | Aim of the legislation and restricted substances |
|---|---|---|
| **Product safety** | | |
| General Product Safety Directive | 2001/95/EC | Safety of articles (including textiles) placed on the market, notifications of dangerous articles by the RAPEX system |
| Toy regulations | 2009/48/EC | New Directive on the safety of toys replaces the old Directive 88/378/EEC, based also on proposal 2008/01/25 |
| Cosmetics regulations | (EC) No 1223/2009 | Simplification of the Cosmetics Directive - Directive 76/768/EEC recasting based also on 2008/01/31 |
| Emergency Decision | 2009/251/EC | Restriction of dimethylfumarate (DMF) in consumer products (e.g. leather furniture and footwear) |
| **Waste legislation** | | |
| Waste framework directive | 2008/98/EC (to be implemented in national legislation by end-2010) | Reducing production of waste and promoting the reuse and recycling of waste; waste hierarchy applies in order: prevention, reuse, recycle, other recovery (e.g. using as energy) and finally disposal to landfills |
| **Chemicals legislation** | | |
| REACH | (EC) No 1907/2006, and 2009 and 2010 | Restrictions on certain substances in textiles (Annex XVII), candidate list of substance of very high concern (SVHC) |
| Biocidal Products Directive | 98/8/EC (Biocides Regulation under negotiation and updating) | Regulating placing of biocidal products on the market (e.g. fibre preservatives of textiles and disinfectants used in detergents) |
| Water Framework Directive | 2000/60/EC | Reducing the pollution of ground and surface waters by reducing releases of certain priority hazardous substances (e.g. nonylphenol) |
| Regulation on detergents | (EC) No 648/2004 | Protecting the environment and human health by harmonising rules on e.g. biodegradability of surfactants and labelling of detergents |
| POPs regulations | (EC) No 850/2004 | Protecting health and the environment from POPs subject to the Stockholm Convention and the UNECE CLRTAP POPs Protocol (including new substances added, e.g. PFOS) |

The Candidate list which is regularly updated included 46 substances in December 2010. According to KemI (2009), at least 4,4-diaminodiphenyl methane, dibutyl phthalate (DBP), di(2-ethylhexyl) phthalate (DEHP), hexabromocyclododecane (HBCD), bis(tributyltin)oxide (TBTO) and benzyl butyl phthalate (BBP) have been used in textile production. The second step in the authorisation process is to select some of these candidate substances to be subject for authorisation.

After a substance is included in the Candidate list there is a **requirement for communication** of information on the substance in articles. The suppliers of articles have a responsibility to provide relevant safety information about the substance to their customer, if the articles contain SVHCs at concentrations of over 0.1 % (w/w). The

Table 6. Restrictions related to textiles among the chemicals listed in REACH Annex XVII (regulation (EC) No 552/2009 and 276/2010, CEC, 2009).

| No. | Substance | Restriction | | Exemptions |
|---|---|---|---|---|
| | | **Use** | **Marketing** | |
| 4 | Tris (2,3 dibromopropyl) phosphate | Not to be used in textile articles intended for contact with skin, such as garments, undergarments and linen | Articles not to be placed on market | |
| 6 | Asbestos fibres | Not to be used in articles including protective textiles | Articles not to be placed on market | articles in use by 2005 permitted until waste |
| 7 | Tris(aziridinyl) phosphinoxide | Not to be used in textile articles intended for contact with skin | Articles not be placed on market | |
| 8 | Polybrominated biphenyls (PBB) | Not to be used in textile articles intended for contact with skin | Articles not to be placed on market | |
| 18 | Mercury compounds | Not to be used in impregnation of heavy-duty textiles and yarn for them | | |
| 20 | Tri-substituted organotin compounds | Not be used after 1 July 2010 in articles where concentration (w/w) is >0.1 % | Articles not on market after date | Articles in use before date |
| 20 | Dibutyltin (DBT) compounds | Not to be used after 1 Jan 2012 in articles to general public where the concentration (w/w) is >0.1 % of tin | Articles not on market after date | Articles in use before date; PVC-coated outdoor fabrics by 2015 |
| 20 | Dioctyltin (DOT) compounds | As or DBT; includes textile and footwear in contact with skin; nappies | Articles not on market after date | Articles in use before date can be marketed |
| 22 | Pentachlorophenol | Not to be used in conc. (w/w) > 0,1 % | Not to be marketed, either | |
| 23 | Cadmium | Not to be used in certain PVC articles (apparel/clothing; impregnated/coated fabrics; imitation leather) | Not to be marketed, either | |
| 43 | Azo dyes in Append. 8 releasing at >30 ppm listed aromatic amines | Not be used in textile and leather articles in contact with skin or oral cavity, including toys, yarn and fabrics | Articles not on market | Unless conform to requirements |
| 43 | Azo dyes in Append. 9 | Not to be used in conc. (w/w) >0.1 % if intended for colouring textile or leather | Not to be placed on market | |
| 44 | PentaBDE | Not to be used in conc. (w/w) > 0,1 % | Articles not on market if contain >0.1 % (w/w) | Articles in use before 15 Aug 2004 |
| 45 | OctaBDE | As with pentaBDE | As with pentaBDE | As for pentaBDE |
| 46 | Nonylphenol and nonylphenol ethoxylates | Not to be used in conc. (w/w) > 0,1 % for cleaning and textiles and leather processing (with exceptions) | As with octaBDE | Processing without waste water release and special treat. systems |
| 51 | DEHP, DBP and BBP (phthalates) | Not to be used in conc. (w/w) > 0,1 % of plasticizer in toys and childcare articles | As with pentaBDE | |
| 52 | DINP, DNIP, DNOP | As with DEHP, DBP and BBP | As with pentaBDE | |
| 53 | Perfluorinated sulfonates (PFOS) | | Not to be placed on market in >1 μg/m$^2$ of coated | Articles in use before 27 Jun 2008 |

available information must also be provided upon request and within 45 days. The requirement also applies to packaging materials and articles produced or imported before the substance has been included in the list. The threshold 0.1 % is applied to the whole article (ECHA, 2009).

**Registration**

In the registration process of REACH, substances which are used in the EU to produce articles have to be registered. However, registration does not apply to articles imported to EU. In the registration dossier, EU manufacturer or importer of a substance has to provide information on its safe use during the whole life cycle. One deficiency in the process is that chemical safety assessment (CSA) does not always contain exposure assessment of a substance, since this is only required for substances which are produced more than 10 tons per year and which are classified as toxic or is assessed to be PBT or vPvB.

In addition, EU producers or importers of articles have to notify ECHA if their article contains a substance on the Candidate List (ECHA, 2009). This obligation applies if the substance is present in those articles in quantities totalling over one tonne per producer or importer per year and if the substance is present in those articles above a concentration of 0.1% (w/w).

It is as yet difficult at this stage to assess how much information on substances in articles will be received from registration dossiers after the first deadline of 30.11.2010 on registration of phase-in substances. It is also too early to evaluate the notification system in REACH is, as the obligation to provide data for substances in articles will enter into force on 1 June 2011.

### 3.1.3 Regulation on detergents

EU Regulation (EC) No 648/2004 on detergents came into force in 2005. According to the Regulation, the surfactants used in detergent have to meet the criteria for ultimate aerobic biodegradation. Derogations may be granted to detergents used only in specific industrial or institutional applications. The surfactants used in these detergents must meet the criteria for primary biodegradation (anaerobic biodegradation of surfactants and the biodegradation of other organic main substances than surfactants).

The labelling requirements include e.g. the content of the detergent, dosage into and the number of use times, and the information about the company placing the product on the market. Also cosmetics legislation applies to detergents (SYKE, 2009). In detergents sold to consumers, the presence of most common fragrance allergens in concentrations above 0.01 % (w/w) and the presence of all preservatives must be labelled in the product by their INCI-names. There will be additional labelling requirements for detergents considered as biocides, e.g. disinfectants (SYKE, 2010).

According to the Regulation, the Commission has to evaluate the use of phosphates in detergents and their gradual phase out or restricted use for certain applications. In 2010, the Commission made a proposal to restrict the content of phosphates and other phosphorus compounds in household laundry detergents to less than 0.5 % from 2013. In Finland, the use of phosphate-free detergents has increased due to voluntary initiatives and recommendations to consumers.

### 3.1.4 Other regulations concerning chemicals in textiles

Finland has limit values for the concentration of formaldehyde in manufactured and marketed clothing (Decree 210/1988). The values vary between article groups: textiles for children under two years of age, textiles in contact with the skin, and other clothing and home textiles. Implementation of the Decree has however been hampered (Talvenmaa, personal communication 19.4.2011).

Companies which are placing a chemical (substance or mixture) on the market or for use have to make declarations about their chemical (Valvira, 2009). The declaration has to be made on chemicals classified as hazardous. The register is based on the Decree (553/2008) by the Finnish Ministry of Social Affairs and Health concerning providing information about chemicals, and is maintained by the Finnish Safety and Chemicals Agency (Tukes). The register is used by national authorities. There is a public version of the register available at https://www.ketu.fi

The Biocidal Products Directive (98/8/EC) is relevant for some biocides used in or for textiles (SYKE, 2010). This directive is presently under revision, to be amended as a Biocides Regulation by 2013.

The RAPEX procedures for consumer and business to business products constitute an important management mechanism for chemicals in textiles. These are treated in more detail below (3.2.2).

There are additionally several regulations or sets of regulations that, more or less directly, concern chemicals in textiles, especially in the environmental protection sector both even elsewhere. This reflects the cross-sector nature of chemicals in articles, and the complexity and partial disconnectedness of related pieces of legislation. These include regulations on construction materials and toys, and waste regulations. Some of these are discussed below.

## 3.2 Surveillance by authorities and responsibilities of enterprises

### 3.2.1 Textiles on the market

The Finnish Safety and Chemicals Agency (Tukes) conducts surveillance of consumer articles, including textiles, on the market. The aim of the surveillance is to make sure that the articles fulfil the requirements of legislation and do not pose a risk to the health of the consumer (Tukes, 2010). According to the General Product Safety Directive (GPSD) implemented by the Act on safety of consumer products and services (75/2004), the main responsibility for the safety of the article is on the producer, importer or supplier of the article. The market surveillance is conducted preventively and reactively, including e.g. spot checks, notifications and surveillance projects. Spot checks include analysing articles purchased from stores. Notifications on dangerous articles include those made by consumers, companies and other authorities (e.g. RAPEX). Surveys are used to find out the compliance with legislation by article groups (Tukes, 2010 and e-mail replies to inquiries).

The tested articles are chosen based on known risks of the articles or group of articles to the consumers, need for information about the risks, or change in legislation. Focus areas of surveillance vary, currently being on toys and childcare articles.

If the article is found not to comply with legislation, the marketing of the article is prevented, the article is withdrawn from the market or the article is collected back from the consumers. The authorities can prohibit the sale or production of the article, as well as the export. The article can be ordered to be destroyed or the company can repair or replace the article with safer one.

Municipalities have focused on surveillance of services, but also conduct surveillance of certain articles manufactured locally (including cosmetics, toys and candle products). The surveillance is usually done by health officer as a part of environmental health care (including also food safety and health protection). The authorities can visit the companies manufacturing, selling or storing articles, in order to check the compliance with legislation (Kuluttajavirasto, 2007; Tukes, 2010).

The competent authorities of the Regulation on detergents and the REACH Regulation are SYKE and Valvira. Tukes also conducts surveillance of certain chemicals restricted by REACH Annex XVII (benzene, nickel, azo dyes and phthalates).

The scope of RAPEX notification procedure was widened 1.1.2010 to cover also risk to the environment and business to business products by AMS Regulation (EC) No 765/2008.

### 3.2.2
### Notifications of dangerous articles through the RAPEX procedure

The Rapid Alert System for non-food consumer products (RAPEX) is an EU wide information exchange channel to alert consumers and authorities responsible for enforcing GPSD legislation on dangerous articles, including textiles (CEC, 2010b). RAPEX, which is based on the GPSD, concerns articles posing a serious risk to the health and safety of consumers.

Tukes is obligated to make notifications of dangerous articles to the system based on the legislation on notification of dangerous articles (1197/2009). When an article is found to pose a serious risk to consumers and is restricted in the market, Tukes will notify the Commission about the dangerous article. The authority conducting the restriction is obligated to notify Tukes. Tukes will send notifications coming from other EU countries to the corresponding authorities, who will inform Tukes on the actions they will conduct based on the notification (Tukes, 2010).

Clothing, textiles and fashion items represented 23 % of all 395 RAPEX notifications in 2009, whereas in 2008 the proportion was 9 % (CEC, 2010a). While this may partly reflect fluctuation in the share of different product categories, it does suggest an increasing importance of textiles. Chemical risks reported in the RAPEX include e.g. azo dyes in clothing and dimethylfumarate (DMF) in inner coating of shoes.

### 3.2.3
### Textiles imported from outside the EU

The customs conducts surveillance of consumer products, including textiles, coming outside the EU area. The surveillance is based on the product safety legislation (75/2004) and the food legislation (23/2006). The customs also conducts surveillance of certain articles based on the Annex XVII of the REACH Regulation. These include e.g. cadmium in certain plastics and paint, migration of nickel from articles in contact with the skin, certain azo dyes in textile and leather articles in contact with the skin and certain phthalates in toys and childcare articles. The selection of these articles is based on legislation given on the basis of the product safety legislation. The tested articles and chemicals are mainly those regulated by national and/or EU legislation.

The selection of tested articles and chemicals is based on risk evaluation. The customs uses their own data gathered over the years and the RAPEX information exchange system to identify the most problematic article groups and chemicals. Previous history of the company affects to the decision, also if the company is new in the sector. The sample selection is based on annual surveillance plan of the analysed articles and chemicals. The surveillance plans of Tukes are taken into account when making the surveillance plan of the customs. There are certain focus areas in the surveillance of consumer articles, for instance toys and childcare products.

If the customs finds articles not complying with legislation, the importer has to destroy the imported batch, apply for a licence to export the batch from the country or change the article to comply with legislation (e.g., on labelling). The authorities can also write a notice to the importer, if the limit value of the chemical has only been slightly exceeded. In case of articles coming inside the EU area, the company can voluntarily withdraw the article from the market or the authorities can order the article to be withdrawn from the market and the consumers.

In 2009, the Finnish customs laboratory tested a total of 692 textile samples, including e.g. clothing for children less than two years of age, clothing in contact with the skin, bed linen and outdoor clothing for children (Customs, 2010 and email replies to inquiries). The division of article groups is based on the national formaldehyde regulation. The surveillance has been focused on the first two groups. The tests included analyses on concentrations of formaldehyde and azo dyes, as well as release of nickel from metal parts in contact with the skin. In addition tests included physical danger (strings) of children's clothing and measurement of cadmium from textile packaging.

Of the samples analyzed, 12 % did not conform to regulations. Significant concentrations of formaldehyde were found in children's outdoor clothing. Prohibited azo dyes were found on 33 imported batches of scarves, most of them from India. High migration of nickel was found from metal press buttons of romper suits for babies. The laboratory also tested 109 samples for DMF, including textiles, footwear and bags of drying substances in furniture, finding no DMF. By comparison, in UK at least 3 500 consumers reported complaints of skin rashes due to DMF use in Chinese leather furniture, prompting the EU to emergency action in 2009 (Pro-Med, 2009).

## 3.3 Official environmental labelling systems

The aim of environmental labelling is to guide the consumers and professional buyers in their product choices by helping them to identify more environmentally friendly textiles, as well as to encourage the textile manufacturers to provide more environmentally friendly products. The label can be used to show that the articles are among the most environmental friendly articles in the group and that they fulfil the criteria required by the label.

The number of eco-labelled articles has increased over the years and there are currently many different textiles assigned an environmental label (SFS, 2010a, b). Criteria behind them may vary significantly and they are not always so clear to the consumers (Talvenmaa, 2002). The Nordic eco-label, the EU eco-label and the Öko-Tex standard 100 are examples of environmental labelling that are supervised by third party.

The official eco-labels, environmental labels or other such as consumer health focused labels are complemented by voluntary labelling and other information steering by the industry (cf. 3.4).

### 3.3.1 Nordic eco-label "the Swan"

The Nordic Eco-label was introduced by the Nordic Council of Ministers in 1989. The criteria for eco-label are set so that only a maximum of 20-30 % of the articles in the group can fulfil those (SFS, 2010a). Criteria for labelling are evaluated for the whole life-cycle of the product and several factors are included, e.g. harmful chemicals, hazardous effluents and waste. The companies can apply for a temporary right to use the label. The criteria need to be revised approximately between three to five years due to the changes in raw materials, production methods and legislation.

There were approximately 70 product groups with the Nordic eco-label in August 2010, including e.g. textile and leather products, furniture and floor coverings (SFS, 2010a). There are also criteria for textile detergents and stain removers, as well as washing machines and dry cleaners. Criteria for textiles are based on the corresponding EU eco-label criteria.

Furniture textiles are not allowed to contain halogenated flame retardants, certain azo dyes or chromium. There are also limit values for formaldehyde (see 3.1.4, 3.3.2). Floor coverings include products with textile fibres and foam. There are limit values for the content of biocides in fibres and restrictions for the use of certain auxiliary chemicals, such as alkylphenol ethoxylates (APEO).

### 3.3.2 EU eco-label "the Flower"

The EU Eco-label certification scheme was established in 1992. Criteria are set so that 5-30 % of the products in the product group can only be granted the eco-label. The criteria, usually valid for three years, are based on the whole life-cycle of the product. The environmental standards of the criteria include banning products containing substances, preparations or mixtures classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic to reproduction (CMR). The label will also not be awarded to products containing substances of very high concern (SVHCs) of the REACH regulation. The general requirements include substitution of hazardous by safer substances or by alternative materials or design if technically possible (SFS, 2010b; CEC, 2009b).

In August 2010 there were 26 product groups with several hundred products licensed to use the label, including textile products, footwear, textile coverings and mattresses. There are also criteria for laundry detergents. Textile products include clothing and accessories, interior textiles (mats and rugs included, wall and wall to wall floor coverings excluded), as well as fibres, yarn and fabric.

The criteria for textile products restrict the use of e.g. biocides in transportation, APEOs, chlorine agents for bleaching, certain azo dyes, flame retardants and fabric finishes. There are also limit values for formaldehyde and volatile organic compound (VOC) concentrations. The criteria for footwear restrict the use of hazardous azo dyes, APEOs and (PFOS), phthalates and biocides.

The criteria for textile coverings (e.g. carpets) include restrictions on the use of e.g. formaldehyde, flame retardants, phthalates and heavy metals. There are also limit values on VOCs released from products. In the criteria of mattresses, there are limit values for e.g. heavy metals, formaldehyde and VOC concentrations. (SFS, 2010b; CEC, 2009b) The EU eco-label requirements are generally wider compared to the Öko-Tex standard 100 requirements (Talvenmaa, 2002).

### 3.3.3 Öko-Tex standard 100

The Öko-Tex (Oeko-Tex) standard 100 environmental certification came into force in 1992. It was developed by German and Austrian textile research companies (Forschungsinstitut Hohenstein and Österreichische Textilforschungsinstitut). Currently many independent European research institutes have the right to analyse textiles according to the standard and to approve the certificate to use the label. The right to use the label will be awarded for maximum of one year.

There are currently more than 80,000 issued certificates and millions of textile articles with the label. Öko-Tex standard is besides an environmental label, also a product safety label (Oeko-Tex, 2010; Talvenmaa, 2002). Öko-Tex standard 1000 is for the environmental requirements of production processes.

In the Öko-Tex standard 100, textiles are divided into four categories:

- Textiles and textile toys for babies and small children (0-3 years), representing 36 % of all certificates
- Textiles in direct contact with the skin (e.g. underwear, shirts and bed linen), 57 %
- Textiles with no direct contact with the skin (e.g. jackets, coats and interlining materials), 2 %
- Furnishing materials for decorative purposes (e.g. curtains, table linen, floor and wall coverings), 5 %

Textiles awarded with the label may not contain hazardous substances above certain limit values set in the certificate. For example, limit value for extractable lead is 0.2-1.0 mg $kg^{-1}$ (ppm), for certain phthalates 0.1 weight-% (1000 ppm) and for PFOS is 1.0 µg $m^{-2}$. The use of certain flame retardants (e.g. penta- and octaBDE) is prohibited. The limit values may vary according to product categories (Oeko-Tex, 2010; Talvenmaa, 2002).

### 3.3.4 Other eco-labels

Bra Miljöval (Good Environmental Choice) is a label, featuring peregrine falcon, by the Swedish Society for Nature Conservation (SSNC). The label was started in 1988 and currently covers 12 product groups, including textiles. The criteria for textiles are divided into two levels, level B "Approved manufacture" and level A "Approved fibre and approved manufacture". The level B criteria include e.g. limit values for formaldehyde emissions and prohibit the use of e.g. optical brighteners, plastic coatings, flame retardants, and halogen compounds for finishing treatments. Compliance with the criteria is inspected by random sampling (SSNC, 2010a, b; Talvenmaa, 2002).

GuT (Gemeinschaft umweltfreundlicher Teppichboden) is a label for the manufacturers of textile floor coverings and it is coordinated by several European organisations. Environmental aspects are assessed during whole life-cycle of the carpet, from manufacture to installation, use and disposal. Banned substances in products include e.g. certain azo dyes, heavy metals used to dye the pile material, halogenated flame retardants (e.g. pentaBDE) and pesticides (e.g. TBT). There are also limit values for VOC emissions, certain pesticides, and total heavy metal content. Product testing is done by accredited testing institutes (Pro-dis, 2010).

Organic labels include e.g. Global Organic Textile Standard and Soil Association Organic Standard. The Global Organic Textile Standard (GOTS) was introduced in 2006. It is a textile processing standard for organic fibres. The aim is to ensure the organic status of textiles from harvesting to manufacturing and labelling. The processing criteria include e.g. prohibition on certain heavy metals, formaldehyde, certain azo dyes, chlorine bleaching, and printing methods using phthalates and PVC. Compliance with the criteria is checked with on-site auditing and residue testing (GOTS, 2010).

The Soil Association Organic Standards include textile standards for the manufacturing and finishing of textiles (e.g., clothes). The standards are based on the version 2.0 of GOTS. The Soil Association also has extra requirements on some areas of textile production. The criteria prohibits the use of e.g. APEO, formaldehyde, fungicides and biocides, certain heavy metals, fluorocarbons and certain azo dyes in the production and colouring of textiles. There are also limit values for residues found in products, e.g. formaldehyde and certain heavy metals (Soil Association, 2010).

## 3.4 Voluntary actions by enterprises

### 3.4.1 General

Industry has taken some voluntary initiatives which are often driven by the fact that consumers are becoming more aware about chemical risks and environmental impact of textiles. For example, voluntary environmental labelling is used by many companies, mainly through the so-called Restricted Substance List (RSL) programs (UNEP, 2011a, and below). Some textile and garment companies have restricted the use of certain chemicals in textiles or set limit values for the concentration of the chemicals in preparations or final articles. Some companies have voluntarily replaced the use of hazardous chemicals with safer alternatives. Information on restricted chemicals or other voluntary initiatives can usually be found on the web pages of the company.

In Finland, the association of textile and clothing industry, Finatex, has addressed risks from chemicals by producing publications and net-based materials especially for forms (Finatex, 2008) as well as by other activities also in a working group on chemicals (Talvenmaa, personal communication 2011).

As consumers have demanded information on ecological and ethical clothing some internet based code systems for clothes, such as for example Made-By, Icebreaker and Respect-Inside, have been created. With the help of a code, which can be found in clothing, information on the supply chain can be found in the Internet. In addition, also according to Finnish clothing companies, organic and eco-products are selected into their collection but these mainly take into account the origin of cotton or the production conditions rather than the chemical content of finished products.

One significant factor impacting the selection of chemicals is the price (Engblom, 2010a). In general, a purchaser should know that low-cost fabrics may contain cheap, possibly restricted, chemicals resulting in low quality. However, EU legislation may be not well known outside Europe. Another reason for the use of hazardous chemicals may be the absence of substituting substances, at least to a cost and with procedures that seem reasonable justifications for changes.

According to the survey presented above (2.3.2), a maximum of about 10% of the number of hazardous chemicals used in textile industry processes are classified as hazardous to the environment. Some of the industry sources also estimated that, since the implementation of the REACH Regulation, the use of hazardous substances in the textile industry has diminished. There is however little information as yet to verify this.

In order to sustain good quality and confidence of consumers and to avoid bad publicity, Finnish textile and clothing companies often carry out their own tests to ensure that the products purchased have the features the supplier has promised. However, physical properties are being tested more often than the chemical content of the products.

### 3.4.2 Lists of restricted substances and limit values suggested by industry

The American Apparel and Footwear Association (AAFA) and the Apparel & Footwear International RSL Management Working Group (AFIRM) have created lists of restricted substances in finished textile, apparel, and footwear products. The list of AAFA includes only those materials, chemicals, and substances that are covered by a regulation or law, excluding regulations relating to the production processes. AFIRM includes companies such as H&M and Nike (AFIRM 2011; AAFA, 2010; Massey et al., 2008).

In addition to lists and other management advice by industry branch associations, some important international companies such as Ikea, have proactively devised lists of chemicals to be reduced, as part of their specific policies and management systems.

In Finland, the retail company Kesko (2008) has created a list of chemicals that are prohibited or restricted in their products. The products include e.g. home textiles, clothing and upholstered furniture that are manufactured for the company. The company is monitoring these restrictions by visiting the manufacturers in China.

The Ecological and Toxicological Association of Dyestuffs Manufacturing Industry (ETAD) has set limit values for the concentration of heavy metals in dyes and colourants (Talvenmaa, 2002).

## 3.5 Other management instruments and systems

### 3.5.1 Consumer safety and health

**Fire safety** with respect to consumer textiles is an important area, because many chemicals including hazardous substances are used in textiles precisely to combat ignition, flames (e.g., BFRs) and combustion. Therefore, if these chemicals are restricted, increased fire hazard may arise. On the other hand, some unnecessary use of chemicals ostensibly for fire safety may be eliminated and substituted by other chemicals, processes or measures without increased hazards.

Fire safety presents an important and high-profile case of risk (and benefit) trade-off with chemicals in textile articles. The trade-off is not simple. Also other chemicals than those added for fire safety can play a role; so do the fabrics (e.g., cotton and especially wool are naturally more fire-resistant than many synthetics); and structural safety measures may be used in addition to or instead of chemicals for fire safety. The perceptions and acceptance by consumers are crucial.

The trade-offs thus involve a multi-criteria, multi-objective decision and policy problem that is influenced also by uncertainties and variable value judgments of stakeholders. It cannot be solved simply by optimization even if the variables could be quantified. This means essentially that the relationships and coordination between regulations and voluntary actions on the environmental and health as well as safety hazards of chemicals and textiles need to be paid attention to, and dealt with in an integrated manner, in deliberations and negotiations on risks between stakeholders.

**Toys** such as dolls often include textiles. Toxic chemicals in them cause particular risks because young children are exposed who often are in intimate contact with the toy, although not as frequently as with their own clothes. While textiles in toys may not be as thoroughly treated with some chemicals as in human clothing, they can be of poor quality, for instance including easily leached and toxic dyes and containing biocides. Because textiles in toys only represent a marginal use, quality control can be weaker.

Coordination of regulations and other risk management procedures and practices for textiles in toys therefore need to be aligned with those for chemicals in toys, as well as with chemicals in general and toys in general. However, the EU regulations for toys are still being developed, based essentially on the new Directive of 2009 (Table 5), and then to be implemented.

**Cosmetics** are consumer products closely related to and even included in textiles (especially in the case of perfumes and other odours included already in textile articles). Moreover, cosmetics include chemicals that have potential environmental significance. The regulatory and other management procedures for cosmetics such as the EU Regulation of 2009 are therefore potentially relevant in the context of textiles (Table 5).

### 3.5.2 Waste management

Of environmental regulations, those for waste management are in many ways relevant for textiles, although they seldom explicitly address textiles. However, general provisions for avoidance, treatment, recycling and disposal evidently play a role for textiles (Häkkinen, 2010).

There is an advanced, indeed complex, hierarchy of regulations for waste management both in the EU and at supra-EU and sub-EU levels. The latter consists mainly of the national implementation mechanisms for EU regulations. In the EU, a Waste Framework Directive (Table 5) is complemented by the more detailed legal provisions of waste regulations, down to specific classes of wastes such as end-of-life-vehicles and so on.

Waste management measures are also developed in industry and elsewhere outside the public sector. These are to considerable degree prompted by regulatory requirements and statutory environmental management systems (such as the EMAS procedure), but increasingly consist of voluntary, proactive and profitable measures by enterprises and other actors pursuing leaner and more efficient systems, also through improved material economy and recycling.

**Pollution prevention** overlaps waste management especially as recycling and waste reductions are emphasized. Waste management regulations are thus extended to regulations on products and resources, the divide between these and wastes being largely a matter of judgment. The principal concrete instrument in the EU has been the IPPC (Integrated Pollution Prevention and Control) Directive that has recently been superseded by the Industrial Emissions Directive. The title of the new directive implies a more narrow focus on emissions specifically from industrial facilities and operations, but also IPPC had such emphasis.

**Construction wastes** constitute a special area of importance for chemicals in furniture and interior textiles (or used in their installation or some other stage of their life-cycle). These amounts of textiles and associated chemicals are large, and the management of the risks they carry can also be organized efficiently in many cases, as the actors involved are; on the other hand, in cases where negligence is common, the risks can be considerable.

These textile chemicals represent a different area of governance because they are principally used industrially, not by individual consumers in private households. Some overlaps are however notable. The national and international regulations in this area play potentially a decisive role in reducing the environmental and other (such as health) risks from these chemicals, especially through improved waste avoidance, separation and recycling, and management requirements, provisions, practices and surveillance.

# 4 Deficiencies and improvements in governance of risks from chemicals in textiles

## 4.1 Governance contexts and institutional conditions for development

Risks associated with chemicals in textiles are managed in a **dynamic and multi-faceted context** where many levels, sectors and actors of governance play a role, and approaches to observed or perceived problems are continuously evolving. Governance also in this field involves not only regulation or management on traditional political or technical notions, but a more complex and varied entity in present-day societies (Assmuth et al., 20010a). This poses new challenges and problems as well as new opportunities and conditions for development.

Among the key drivers shaping the risks and their management contexts the following deserve special mention:

- **Globalization:** the growing importance of international trade in textiles and chemicals as well as in other commodities and services that are closely linked with these products
- **Consumerist** societies and technologies: for profit and also in the name of economic growth, non-sustainable consumption
- **Complexity** and connectedness of technological, economic and social systems, causing systemic risks and needs for integrated solutions
- Increasing **emphasis on non-regulatory governance**, based instead on voluntariness, reflecting consensus-seeking, reversion of burden of proof, broad cooperation and activation of industry, notably in the field of chemical risk management
- Growing role of enterprise and **economic forces** that complement but in many cases also supersede normative and principle-based regulation
- Increasing and changing roles of **information and communication** in governance and in society at large, and the special challenges for them with risks
- **Participation:** the emphasis in modern societies and also the EU governance on the broad and free participation of stakeholders and other actors
- Importance of **trust:** especially in risk management and in relation to the importance of information and communication.

In summary, some traditional ideas of regulatory risk management have given way to more varied and extended concepts. Risk management is no longer a field narrowly conceived as technical operations or regulation by command-and-control approaches. Focusing on these is insufficient and can be counter-productive, as other aspects and areas of governance can be more decisive. On the other hand, it can also be an illusion that voluntary, participatory and information-focused risk management without strong legal basis and regulatory functions would be an efficient solution.

This development has been influenced by the evolution of risks themselves in modern globalized societies to more complex and broadly connected phenomena, transgressing traditional geographical, temporary, thematic and legal boundaries.

The development of risk governance poses multiple challenges to the EU because it is at its core highly legalistic machinery that has needed to struggle to include other elements and approaches to governance. At the same time, the EU is based on the ideas and premises of free market.

The EU governance inherently includes tensions between the national, Member State level and the Community level. In some areas tensions have been resolved, and the interplay of the national and the EU level has matured on the subsidiarity principle. However, in other areas its multi-level governance has been subject to new challenges, also as part of the power play between actors (Assmuth et al., 2010a). Also between Member States, bloc-building and dominance of the strong have been increased, along with the enlargement and diversification of the community and continuous constitutional and economic crises. On the other hand, related to the enlargement of the European community and its market, increasingly the global dimension interferes and need to be accounted for.

The institutional structures of governance can be schematically illustrated by the main dimensions vertical coordination (between levels of governance) and horizontal coordination (between sectors). As an extension of these, the different categories of actors in state, civil society and private organizations need to be discerned, in order to evaluate instruments for risk management.

## 4.2 Actors and processes of governance

### 4.2.1 General considerations

Actors in risk management of chemicals in textiles exist at all levels of governance and in many sectors and groups, both in the public and the private sector and in civil society at large. Risk governance thus takes place in an extended, but patchy, and heterogeneous network of actors.

These networks are subject to dynamic evolution both in the specific actors that naturally change in some cases fast especially in the private sectors and among NGOs, but also in its general configurations and functions. New actors emerge and established ones decline. Their mutual relationships are only partly well-defined.

The civil society actors, including NGOs and labour organizations, interact with both the official and the private sector, sometimes on continuous but often on ad-hoc basis, depending on their agendas. In addition to consumer, environmental and other NGOs (in themselves heterogeneous), the civil society actors include public media and information transfer organizations, foundations, labour and employer organizations (also in trade), and many other organizations and parties.

The processes of interaction are varied and involve regulatory collaboration, formal partnerships across actor groups, information exchange, economic and organizational steering, competition, coercion and even conflicts. Processes from global to regional (national) level are involved, with different time scales and phases.

A development from regulatory to participatory multi-actor governance has been coupled with a move to outsource activities from the public to the private sector or to intermediate entities including partnerships. This privatization significantly affects risk management and governance in all its sub-areas, from planning to surveillance and evaluation. It also introduces needs and possibilities for new types of steering mechanisms.

**Table 7.** Key actors in risk management of chemicals in textiles at different levels and in different sectors of governance, with particular reference to Finland and to possibilities for improved management in the short and intermediate term. Most important actors have been shown in bold.

| **Level** | **Governmental actors in regulatory sectors** | | | | | **Private sector** | | **Civil society** | |
|---|---|---|---|---|---|---|---|---|---|
| | Environ | Health | Safety | Enterprise, Consumers | Trade | Produ-cers | Retailers | Info/net-works | Advocacy (NGO) |
| Global | **UNEP-Chem;** UNEP-Industry | WHO | (ILO) | UNIDO | WTO | ITAA | Int Apparel Feder | Int Chem Secretariat | Consu-mers Inter-national |
| EU | DG-Env (EEA), EP-Env & Consum | **DG-Sanco,** EP-ENV & Consum | DG-Sanco, DG-Enter; ECHA | DG-Enter; **ECHA** | DG-Trade; DG-Int market; **Customs** | Euratex | AEDT | ECC-Net, EU Ecolabel; EESC | **BEUC** (EEB) |
| Regional | Nordic Council of Ministers / Chem G | (NCM) | | (NCM) | | | | Nordic ecolabel (Swan) | |
| National (FI) | **YM** (MoE) Finnish Environ Inst (Syke) | **STM** (Min Health & Welfare), THL (Natl Inst Public Health), KENK (Fi. Chem Board) | **TEM,** (Min Labour & Enter-prise), **Tukes** (Saf Tech Authority Finland) | **TEM** (VM), **Kuluttaja-virasto** (Fi. Consumer Agency); **KTK** (Natl Consumer Res C) | UKM (Min Foreign Trade), **Customs** | **Tekstiili- ja Vaatetusteoll ry Finatex,** Kemianteoll ry (Chem Ind Feder) | Suomen Kaupan L (Feder of Fi. Com-merce), Erikois-kaupan L (Feder of Specialty Trade) | Ympäristö-merkki, Motiva Oy (Fi. Eco-Label), Ymp. Merk. ltk (Fi. Eco-label Board) | **Kuluttaja-liitto** (Finnish Consu-mers Assoc) |
| Provin-cial | **AVI** (Reg State Admin Agency) | | **AVI/ELY** (Fi. Reg C Econ Dev, Transport & Env) | **AVI/ELY,** Kuluttaja-neuvonta (Consumer advice) | | | | | |

4.2.2

## Modes of governance in product policy

The adoption of less hierarchical modes of governance within the field of (product-oriented) environmental policy can be connected firstly to an understanding of the limited direct problem solving capacity of the state within that policy field, and secondly to a more general view that the state should not directly control companies and consumers (Scheer, 2006, 49). The latter position is partly rooted in the libertarianism-inspired thoughts on deregulation and privatization, and partly on more pragmatic views on the steering capacity of the state and the overgrown rule-intensity of modern societies (Kooiman, 2003, 56 and 92; Mayntz, 2006,19-20; Meadowcroft, 1999).

Instead of a hierarchical mode of governance, the aim to encourage co-governance and self-governance has been emphasized within Integrated Product Policy (IPP), notably in the EU. However, it has not meant deregulation within the more traditional environmental policies (Similä, 2007) or withdrawal from hierarchical patterns of governance within the IPP. For example, the RoHS Directive is mainly based on traditional regulatory instruments: bans and restrictions of certain substances (cf. Kooiman, 2003, 11 and 115).

Besides, as Kooiman (2003, 79) points out, "much of what is sold as deregulation or advertised as self-regulation is better seen as forms of re-regulation or altering traditional forms of public control into 'steering at a distance'" (see also Mayntz, 2006, 19). Thus, the IPP can even be seen as an expansion of governmental intervention into a new field and the aim seems rather to be the use of "better" (EC, 2002) or "smart" regulation (EACSR, 2004) than solely to encourage self-regulation of other societal actors.

As the IPP takes the product life cycle as its starting point, the amount of actors that are targeted or involved increases considerably (cf. Kautto 2008, 22-23).

In the consumer area, a characteristic of governance is the reconciliation of conflicting interests through a mixture of negotiation and legal procedures. The latter are prominent because of increasing consumer awareness and complaints and increasing struggles to impose product liability, in the face of global production and markets.

### 4.2.3 Governance of chemicals in textiles

The boundaries and contents of the sectors and actors involved in governance of textiles and their chemicals are not clear-cut, and they are evolving (Table 7).

In the public sector, the administration for consumer affairs has been rapidly developing under several ministries, and the same is true of environmental, health, safety and enterprise both at national and at EU and provincial levels.

The private sector encompasses importers, manufactures, retailers and other enterprises engaged primarily in either chemicals or textiles or both or still other fields, with very different roles, goals, policies and functions. The same is true of the civil society actors that include besides various NGOs also other stakeholders and groups with very different agendas (such as labour organizations). Often actors also have a role in several sectors depending on the circumstances.

The sectors most often represented and engaged in collaboration (or at least information exchange) are those of the environment (environmental protection and management, including natural resources), human health (public and occupational) and safety, especially consumer safety. The health and consumer safety sectors have often been fused; this is the present configuration in both the EU (DG-SANCO representing both areas) and in Finland (Tukes encompassing chemicals control also with respect to environmental risks, along with health and safety aspects of products).

Many of the processes especially in the public sphere are part of official (EU) policy cycles, from conception though implementation to evaluation. Management in industry and enterprises at large is instead part of firm-level or branch-level strategic and operational management, in production, distribution and treatment of textiles and chemicals and in auxiliary such as consulting functions. The public and private domains interact so that for instance the private sector participates already in the policy formulation stage, and takes this into account in its internal development.

As detailed by Kogg and Thidell (2010), steering in product policy is conditioned by information. These authors importantly point out that in addition to the information provided on chemicals in textiles and the requirements put on this, also the absence of information on chemicals is crucial, and should be governed correspondingly. Specifically, it needs to overcome the 'interruption (or other obstacles) in information transfer' regarding the hazardous substances in textiles between the chemical manufacturers on one hand and the 'end-producer' or brand-owner on the other.

Information flows also extend further along the product life-cycle, from producers to waste-stage actors and to consumers and their representatives. However, the key groups of actors and points of intervention include chemical manufacturers putting requirements on down-stream users of chemicals, based in part on REACH, and the brand-owners responsible for the final garments and clothes that likewise can exert some control upstream in the process on textile producers.

4.3
## Observed deficiencies of risk management

4.3.1
### Narrow framing of risks, impacts and management

A general barrier for more efficient risk governance is the narrow framing of risks and impacts and of management. It is often due to legal and administrative divisions that tend to be too rigid and not sufficiently allowing views of over-arching and emerging problems and broader, more influential solutions. Narrow framing also results from concepts that exclude relevant considerations (conceptual limitations often underlie, and result from, legal and other official definitions).

Chemicals in textiles are seen by parties in a way that is conditioned by their frame of reference (Figure 6). This is partly unconscious, but also results from conscious willingness to emphasize one's own frame, typically in administrative sectors for the sake of authority. This is not only detrimental: an actor, in order to have any possibility to act, needs to prioritize its own angle and the interests it is set to work on. Thus, collaboration results after a process where parties are struggling to make their views heard, until some consensus is reached though competition, negotiation, persuasion or coercion, frequently also through some conflicts.

A key restriction in framing is based on differing objectives of various sectors and actors. Industries, trade enterprises, consumer organizations or regulatory bodies view risks associated with chemicals in textiles, and with chemicals or textiles in general, rather differently, largely because of their differing roles in the processes of governance and society at large. These groups are also not homogeneous but include divergent views, for instance among industry (producers and down-stream users having different roles). For some, the risks are mainly about eco-toxicity, for some (perhaps most consumers) about adverse health effects; these risks are rather closely aligned, butt even these frames differ. For yet others, the risks are about something still more different, such as physical safety, consumer trust, and economic accountability.

Risks are viewed variably and narrowly also in other respects. The focus may be on production stage of textiles for both the producers and the regulators of production facilities; whereas for others such as consumers and public health authorities, the use stage is of chief concern. Importantly, the framing of risks is presently narrow also in the sense that only risks and not associated benefits are considered.

The chemicals focused on in textiles have varied, and attention has shifted. For instance, risks from fire retardant chemicals is increasingly emphasized, based in part on POPs regulations. Also REACH and biocides regulations shape the foci of governance. However, other chemicals may get insufficient attention or interest in their management may fade, such as with formaldehyde.

Management is also often conceived and framed narrowly, for instance focusing on restrictions instead of incentives, or technical instead of institutional measures. The object of governance is regularly restricted to chemicals or textiles only without account of the broader areas of product policy, environment and natural resources, safety and health. This is often coupled with a narrow framing of the risks and lacking coupling with associated benefits (such as when considering risks of losing benefits when substituting alternative products or processes).

Another key restriction and problem in framing is that it often tends to be rigid. This is partly separate from scope, and hampers both broad and narrow framing. Even when a broad view is attempted, it is not well linked with focused consideration, and vice versa.

Related to narrow framing, some actors view chemicals in textiles mainly as risks only, in the sense of direct danger, while others such as chemical producers view them as beneficial. The elephant of textile chemicals is thus seen either as a beast or a beauty. This is accompanied by a common view among consumers that all chemicals are inherently bad (usually because of toxicity) which has been often found in studies of citizen concerns (also in comparison with expert concerns), as documented by special Eurobarometer surveys. Meanwhile, these same consumers often have a very vague understanding of what chemicals are used, where, when, how and why, and what their properties, risks and impacts are, and also use chemicals indiscriminately, such as for excessive cleaning, fragrance and other purposes that may be largely due to advertising and other kinds of social persuasion. Others adopt an intermediate view that realizes that they include substances that are in some circumstances and ways risky and others that are beneficial, and that often one and the same chemical is both, even to the same exposed target.

4.3.2
## Legal basis

There are deficiencies in the legal basis for risk management of chemicals in textiles in many areas and at many levels. This holds both for chemicals, for textiles, and more generally. However, it needs to be questioned whether the solution is more legislation. In some cases, solutions may on the contrary involve less legalized governance, as well as better implementation of the legislation that already exists. This need has been clearly noticed also in the EU and much work on streamlining governance and making it simpler, slimmer and smarter has been initiated.

Many deficiencies are notable in the coordination of more or less piecemeal legislation in areas that are not sufficiently closely integrated, such as between chemicals and consumer products, chemicals and wastes, or environmental, health and safety regulation. This is compounded by the complexity of legislation, such as the REACH

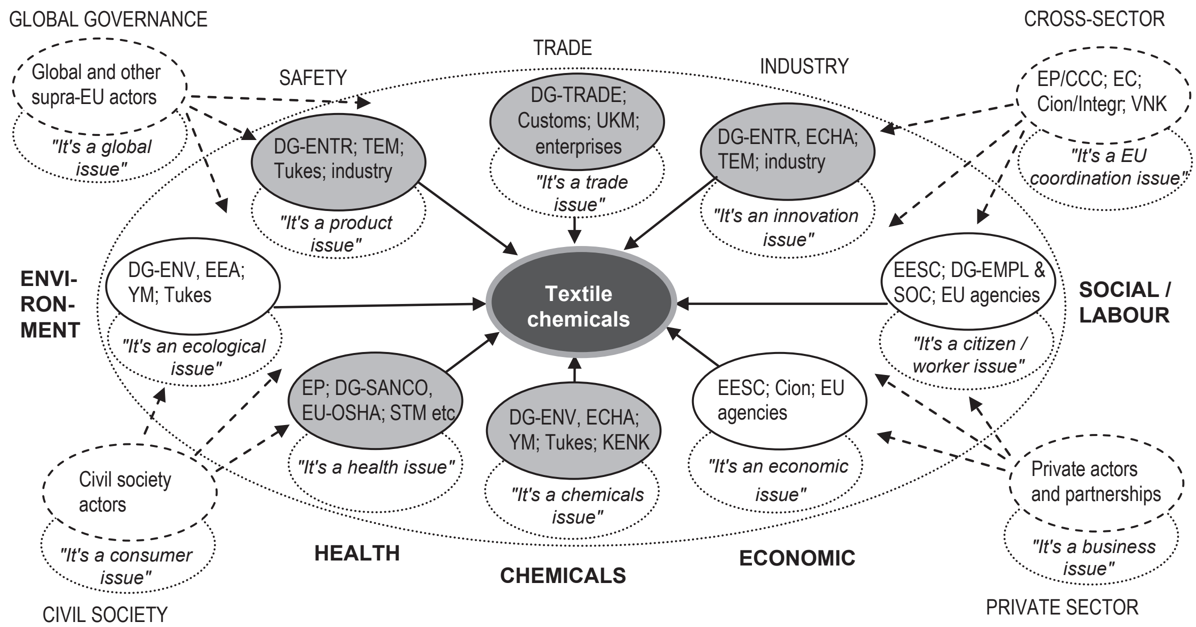


Figure 6. Textile chemicals and 'myopic organizations': Key EU and national organizations and institutions have been linked with such approaches to risks that they are expected to emphasize. Note the involvement of more numerous actors, and that through communication and collaboration organizations can reduce their myopia both in their own focus and with respect to the context.

Regulation and the Biocidal Products Directive which are very large and complicated. While extensive, these regulations and associated guidance are heavily focused on natural scientific and technical aspects at the cost of socio-economic aspects such as risk and benefit considerations.

Legislation as well as other foundations and procedures for product policy are still in many respects in a stage of initial development (see above). Although other areas of consumer safety also for textiles are better established also in terms of legal provisions, broader ecological and resource considerations have more recently become in focus. The same is true of the linkages between legislation in different areas of governance that traditionally have been separated.

The EU legislation is crucial for risk management in Finland, and the deficiencies in community legislation are thus reflected in Finland. In some cases the Finnish legislation is above the average in the EU, but in some areas there are specific deficiencies. However, it is the implementation of the legal basis that matter most.

The deficiencies are due in part of the slow, reactive development of legal provisions in relation to a rapidly changing field of economic and technological activity. Many lags are caused by the complexity of both the object of legislation and the mechanisms enacting and implementing it, especially in areas such as textile chemicals that fall between several sectors and jurisdictions.

4.3.3
### Resources

A common deficiency and a barrier of efficient risk management also of chemicals in textiles is the lack of resources. It can be divided in knowledge, technical, administrative, economic and personnel components. More generally, also resources in the social sphere (e.g., empowerment) can be included. These components overlap, such that for instance the lack of personnel is partly equal with lack of funding, and also involves intellectual resources of knowledge and competence.

Resource lack affects both regulators and the regulated community, and even more severely the civil society. For instance, NGOs therefore often find it difficult to acquire information, participate and have a voice in crucial negotiation processes, compared to the industry (Assmuth and Craye, 2009). Also new partnerships and funding models are therefore sought.

The resources of the official sector are increasingly short due to economic downturns and overall development of the market. Especially in countries with acute economic crises in the public sector this can effectively prevent development of regulatory risk management; but throughout the EU, including Finland, increasing pressures on administrative staff and other resources and requirements for saving are experienced. While administrative and other resources are scanty, also inefficiency in their use is often a problem. In adaptive governance, better utilization of available resources is a key issue. Both incentives and disincentives need to be used.

A typical example is monitoring, for instance of the occurrence and environmental releases of chemicals (see below). In the field of textiles this is as yet rather limited and based on sporadic sampling and analysis, apart from some more continuous quality systems in advanced industries with sufficient capabilities and responsibilities, such as in monitoring for occupational health. On the other hand, monitoring of the upstream stage of chemicals use and of the downstream fluxes in environment is not specific only to textiles, but this monitoring is done also for other purposes. There are deficiencies in linking areas of monitoring in an efficient way that would enable both better focus and coverage, partly because the incentives for saving across areas are not sufficient.

### 4.3.4 Coordination and sharing of responsibilities

As related in earlier chapters and discussed above, a key deficiency in risk management is the non-connectedness and lacking coordination of areas that jointly form the field of risk management of chemicals in textiles. This lack of coordination is partly evident between the thematic or topical areas defined by the objects of regulation, mainly chemicals and textiles. Both of these are linked with other areas such as cosmetics, toys, and other consumer products, and with the consumer safety, health and environmental issues in these fields.

Coordination between sectors defined by the entities or values to be protected (environment, health and safety), is insufficient. The health sector has traditionally been somewhat separate, also based on disciplinary and professional boundaries. There is a strong culture of independent governance in this sector partly because of the understandable requirement to reserve life-and-death decisions to the professionals in that field without undue interference from others.

In the field of chemicals control these boundaries and associated divides and tensions have partly been already alleviated, as can be seen in the established cooperation at practical and detailed level between the environmental and health agencies in the regulatory risk assessment for existing chemicals in the EU and its Member States, including Finland. There is also increased collaboration and coordination between both of these sectors and the consumer safety area.

The lacking coordination is frequently experienced as a problem in all actors groups, including the industry that often feels that there are too many separate and also incompatible requirements put on them from various branches of government (Assmuth and Craye, 2009).

In addition to this horizontal coordination between sectors and their various topical areas, there are deficiencies in the vertical coordination between levels of governance (Assmuth et al., 2010a). This coordination situation varies between the different sectors; on the other hand, the inter-sector coordination varies depending on the level of governance. For instance, there is already improved coordination of consumer safety and health implicit in the DG-Sanco that encompasses both areas (it was born largely from the pressures to better align consumer concerns with other health issues), while the integration and coordination between these areas are not so well developed, at least formally and regarding institutional structures, in all Member States including Finland until now.

### 4.3.5 Availability and management of information

There is a general lack of information on chemicals in textiles. Finnish companies buying fabrics outside the country may not know what chemicals have been used in the production of the fabric and the presence of these chemicals in the finished fabric. There may not be enough information about the release of these chemicals in different life cycle stages of textiles.

On the other hand, additional information does not automatically improve governance of risks. Too much information or information of wrong kinds and in wrong places and times may on the contrary confuse, complicate and impede management. For instance, it may confuse consumers when too much and divergent information is given on chemicals used in textiles and other products used with them. The need for standardized definitions and formats thus arises.

However, also the notion needs to be discarded that information could be non-equivocal, absolutely true, neutral and essentially standardizable and that the question would be only about collecting and delivering it to users. Information involves hidden assumptions and framings, and the process of giving it meaning takes place together with the users in an interactive process.

Management of information thus also includes consideration of and contestation about the relevance and interpretations of these facts and the value judgments involved. As such, information on chemicals in textiles is part of dynamic processes of risk communication, deliberation and negotiation. These processes are presently deficient. For instance, the feed-backs between information from surveillance (see below) and policy and decision making need to be improved in both directions. Also the uncertainties in risks are often not considered.

The REACH requirement for communication of information will probably increase the availability of information and the development of information systems. However, some limitations are caused by specific problems inherent in chemicals in textiles (as in many other articles), such as their long production chains and the inclusion of chemicals in a solid matrix.

In Finland, the KETU-register includes hazardous chemicals used in the production of fabrics and textiles. However, it does not include obligation for companies to register chemicals in finished articles. Although the register is based on national legislation, all the companies are not aware of their obligation to register hazardous chemicals. The companies are responsible for making changes to the register about e.g. when they stop producing or importing certain chemical product. However, this is not always done and consequently the register can contain old information.

There are many eco-labels for textiles, and also informal information systems used by international textile companies, such as H&M and Ikea. The criteria for the labels and how they differ from each other may not be known to customers. Standardization and harmonization have been attempted, but is difficult especially at the global level. Given the existence of various labelling systems, there clearly is a need at least for better information on their relationships including differences.

Information is also needed on the environmental properties and releases of chemicals in textiles, through research and monitoring and testing, as well as on the broader environmental and socio-economic impacts and other aspects of textiles, as shown by the life-cycle analyses above. Some of this information is generic and not limited to only textiles, but some of it needs to be specified for these products and corresponding production and consumption systems and processes.

#### 4.3.6
### Management measures

Imported textiles from countries outside Europe constitute a problem for risk management because they are not as regulated as textiles manufactured in the EU common market. However, also the more advance regulation in the EU has deficiencies and variations, such as between specific risks and Member States. The implementation of the regulations and follow-up also pose problems.

Legislation on chemicals in textiles and the related releases to the environment is thus stricter in Finland compared to countries outside EU. However, imported textiles containing hazardous chemicals may be sold in Finland, without few exemptions (Chapter 3.1.1) (Talvenmaa, 2002).

There are currently 18 restrictions in the REACH Annex XVII concerning textiles. All of these do not prohibit the placing on the market of the treated textile. For example, the restriction on NP and NPEOs states that the substance should not be placed on the market or used for textile processing at concentration of >0.1 %. Thus imported textiles treated with the substance can be placed on the market. According to Environment Agency (2008), NPEs are still produced in the EU, and exported to non-EU countries (e.g. China and India) where they may be used for the treatment of textiles, which are imported to the EU. Likewise, the use of azo dyes has been restricted in the EU but imported textiles containing these dyes may still be sold with few exemptions (see Table 6, 3.1.2).

The Biocidal Products Directive (BPD) only applies to treated textiles when the biocide is released for external effects, for instance from socks and sleeping bags (SYKE 2010). It does not regulate textiles treated with preservatives for which the effect is internal, such as those in carpets. Thus, textiles containing substances that are not authorised under the directive can be imported to EU. The draft for amended Biocides Regulation, which is scheduled to enter into force in 2013, may also apply to these textiles. Nanosilver is under evaluation to be added to the BPD.

In choosing and implementing management measures, trade-offs between different options and also between different objectives, competing or synergistic, are needed. Among the specific trade-offs that present difficult choices, the following can be recommended:

- less washing to reduce waste water emissions, or more to reduce consumer exposure
- less use of efficient flame retardants
- chemical-free textiles that wrinkle more easily and harder, or caving in to consumer habits
- use of cotton degrading the environment in cultivation, or synthetics that are non-degradable.

On the other hand, some risk reduction choices seem easier, as there are no justifiable strong competing objectives. Such choices represent win-win options in risk management.

4.3.7
### Surveillance and monitoring

The aim of the GPSD is to ensure the safety of articles sold on the EU market. It does not consider environmental risks. The content of hazardous chemicals in textile articles is usually controlled by spot checks and notifications through the RAPEX system. It is not possible to check all the articles. Some imported textiles especially do not meet the criteria set by legislation. In 2004, 575 textile samples were analysed and in 2009 the amount was 692. Because a large number of textiles are imported to Finland from countries outside EU, the percentage of tested articles is quite low.

The surveillance of imported articles by the customs is effective and reveals also chemical hazards of articles. There are however deficiencies. The scope of the surveillance is on consumer safety. The chemicals analysed by the customs laboratory from textiles are primarily those presenting health risks (e.g. formaldehyde) to the consumers. Due to lack of resources the customs laboratory has not been able to extent the surveillance to cover all articles and chemicals of the Annex XVII of REACH, only those based on previous legislation.

The companies placing articles on the market are responsible of their safety to the consumers and the environment. However, the companies may not always be aware of their obligations.

The Swedish Chemicals Agency, KemI (2009b), conducted an enforcement and compliance project on chemicals with water- or dirt-repellent function. The 27 inspected companies included suppliers of clothes and shoes, as well as manufacturers and suppliers of chemical products sold to consumers for re-impregnation of textiles and leather. The results of the project revealed large differences in the knowledge level of the clothing and shoe companies relating to chemicals. Many of the companies were unaware of the risks related to highly fluorinated substances. However, a small number of companies were working to reduce the risks from chemicals.

The companies had difficulties in giving detailed replies to questions concerning what impregnation agents were used in their products due to confidentiality issues from the suppliers. The long chains of production and the geographical distance to suppliers were identified as obstacles for the fulfilment of the responsibility of the companies regarding chemicals management. The enforcement process often lacks tools that are required to place demands to the companies.

There are, however, some companies that are prepared to exceed the requirements set by legislation. These include firms that perceive consumer health and safety as well as environmental and natural resources 'green' concerns as especially important. The influence of such firms, both among textile producers and trade firms has been growing. According to KemI, the companies should require openness regarding the chemical composition of articles with the suppliers of the raw materials, in the same way as has been done with the lists of undesired chemicals.

These situations, deficiencies and development needs probably apply very well also to Finland, based on the similarities in the industrial and societal conditions. It may however be that compliance is still more deficient in Finland, in part because of the great differences in resources of the authorities, being an order of magnitude greater in Sweden.

4.4
## Elements of improved risk management and governance

4.4.1
### Improved framing of problems and solutions in multi-actor governance

It has been shown above how and why the risks and impacts associated with chemicals in textiles are multi-dimensional and affect several sectors and actors, in both the Finnish society and others. Also the governance of risks and impacts associated with chemicals in textiles is thus not a simple and straightforward task that could be reduced to a specific governance approach.

The breadth and multi-dimensionality underlines the **need for improved framing of risks, impacts as well as governance** approaches and means. For instance, the risks and benefits associated with chemicals in textiles differ in some respects considerably as seen from the perspectives of environmental management, health care or consumer safety, although there are also similarities between the views of these sectors.

Even within any one perspective such as environmental management, a **multitude of aspects**, some of them conflicting, need to be accounted for, such as (cf. 1.3)

- the relationships and relative importance of toxicological risks and the risks of the depletion of natural resources
- the relationships of environmental risks, benefits and impacts, including those in different life-cycle stages; that is, not only risks directly 'from' textile chemicals but also risks more generally and even indirectly associated with them
- the relationships and relative merits of different management approaches, such as chemicals-focused and other such as textile-focused or generally product focused policies and measures.

Governance takes place also and even increasingly, for better or worse, in the **private sector** and as a joint effort between public, private and other sectors. Especially when considering practical possibilities for management, attention needs to be paid to the contexts of the textile producing and treating industry and other enterprises as well as of consumers, in order to discern efficient or otherwise justified and workable solutions. This attention on the other hand also involves scrutiny of the limitations of enterprises in managing risks, due to their priorities and overall roles.

Both the object and objectives and means of management are **preferably to be framed broadly**, even when specific measures are being considered and applied. In particular, while ecotoxicological and, in the context of consumer safety, human toxicological considerations are given prominence, broader ecological issues (including natural resources) as well as socio-economic issues (including human resources) need to be paid more attention. These include issues associated with other risks and impacts from textiles along their whole life cycle, and with the prerequisites and implications of alternative technological and social solutions.

On the other hand, some arguments may be offered for **emphasizing a narrower field** of governance. It is for instance conceivable that environmental effects and risks of chemicals are more neglected than those on consumer safety and health, because these areas are already better developed and perhaps particularly because there are not as strong incentives for enterprises for reducing and preventing environmental risks based on product liability. After broader framing and assessment, the objects, objectives and approaches of governance may be narrowed down.

It is similarly conceivable that risk management is based on a narrower framing of solutions, for instance through straightforward bans of chemicals found sufficiently certainly to be sufficiently hazardous. In some cases this can be based on generalizations from other substances or on theoretical assessments of their key risk properties such as persistence, without evidence specifically for the substance in question. It may also be argued that as a response to the increased responsibilities of enterprises for environmental management and product policy, a stronger regulatory role is needed and can benefit all players.

**Other avenues than command-and-control** are available in regulatory governance, including such as combine precautionary restrictions with other approaches, and better account for auxiliary risks and problems, including those associated with loss of benefits. Such regulation extends precaution also to risky consequences of risk management, usefully through inter-agency work. The banning approach also is limited in terms of substances and in other respects. Complementary and more integrative management and governance approaches, including consumer-based measures are advisable and promising.

### 4.4.2 Strategic goals, trade-offs and alternative steering mechanisms

Given the multitude of actors with stakes in chemicals and textiles, harmonization of management goals and objectives becomes complicated. Some of the goals are compatible, even synergistic, while some are competing or downright conflicting. Also the frames may conflict: the question of whether and what additional measures are needed, will divide actors and also sectors, depending on the ways they frame the issues to be governed and on their priorities.

Is there for instance a need mainly for additional measures and efforts on environmental risks, in comparison with consumer safety and health risks that are usually in focus among consumers and therefore also enterprises? There are no absolutely right specific answers to such questions, although some general facts and arguments may be considered valid to favour a general emphasis or approach. There is still plenty of room for negotiation and resolution of competing and even conflicting judgments.

A key issue in risk governance thus is the coordination of different goals and objectives of sectors, stakeholders and other actor groups. There are many **trade-offs** involved in this, such as

- between environment and health: to what extent and how should the present largely consumer concern based health-oriented risk management goals be complemented by broader environmental concerns, both those of eco-toxicological effects of chemicals in textiles on non-human organisms but also on other ecological entities and functions
- between environment and safety: how could environmental risks and adverse effects of chemicals in textiles be best balanced with concerns for consumer and general technical safety, notably including trade-offs between fire safety, now largely based on flame retardants
- between environment, health, safety, on one hand, and enterprise and trade, on the other: In this central area of interaction in the EU (due to its emphasis on a harmonized single market) and at supra-EU levels (given the globalized economy), the objectives of those sectors concerned with dangers involved in textile products and their chemicals need to be integrated and balanced with the objectives of the enterprises and affiliated parties.
- between objectives and preferences of textile (and chemical) producing and using regions.
- In all of these and in yet other areas, trade-offs are also needed between *risks and benefits* of chemicals in textiles. It is important to relate these more closely to each other: the loss of benefits implies a risk, as accounted for in standard economic risk analysis. Likewise, it is important to consider the *qualities and distributions* of risks and benefits:
- which groups are primarily affected and receiving benefits, and are these otherwise commensurate;
- how do the risks and benefits vary in space and time, for instance transferring some risks or benefits to future generations or to other such as textile-producing regions (Table 7); and,
- in management contexts, to what extent are the risks unavoidable and the benefits essential or not achievable by other means.

Such questions are essential in deliberations between stakeholders on the framing of risks and governance. In many cases there are conflicts and juxtapositions of goals but also common interests. In longer and broader perspective there may be shared interests not evident in more limited perspective; conflicts may be resolved after initial opposition, as common interests emerge in the long-term. On the other hand, some obstacles to harmonizing interests arise gradually.

It may be argued that what is good for the consumers is in the long term good for industry, as (if) the adverse and beneficial impacts become known and influence the functions of the industry, that is, if appropriate information and steering systems are in place. Likewise, a good economy benefits also (to some extent) the consumer populace, through the wealth and occupations generated.

Behind such generalizations of commonality, qualifications and conflicts reside. The goals and interests in any given sector or group of actors are not homogeneous and clear-cut, but include variable and shifting positions. Thus, low-chemical textiles may become a profitable market for some enterprises, while others lag behind and continue producing textiles with priority pollutants. In this 'race to top or bottom', a key driver will be the perceptions of consumers, enterprises and decision makers and regulators (which are also consumers) regarding what are key goals and values and most significant risks, benefits and impacts. Also this calls for stakeholder dialogues.

In multi-objective and multi-actor governance, such goals need to be harmonized at some stage, either up front in planned manner or when sector policies are fused at a later stage at higher level, often in a rather unplanned and ad-hoc manner. Thus, risk governance needs to facilitate an efficient, suitably broad and balanced treatment of the goals, interests and motivations among different actors. Such fundamental choices are essential to the development of more efficient specific measures, and therefore also more integrated views, discussions and developments are needed between sectors such as environment, health and safety, and between groups of actors.

Meanwhile, the sectors operate within their present remits and possibilities. In some cases this established sharing of mandates works sufficiently. However, such measures cannot in many cases be addressed in isolation from the broader context. A broader view and improved communication and coordination between actors seems beneficial also to help the specific sectors see more clearly both the links between fields and the crucial issues within their own work.

In Finland, the coordination of goals is presently a key issue in the fusion of chemicals control authorities from SYKE, Valvira and Tukes to a new, broader national chemicals control body, a division of Tukes. The interplay and coordination of objectives, policies and measures between the ministries under which the parent organizations reside will also be crucial.

### 4.4.3
### Improved regulations, institutional capabilities and inclusive agencies

**Regulations and legal provisions** evidently need to be specified, developed and coordinated, in order to address observed deficiencies and to address emerging issues also by legal instruments. Yet, it can be questioned how extensive and detailed new legislation is needed or feasible. The key seems rather to be in the institutional and other structures and in the processes of implementation of existing regulations, both for chemicals and textiles and for environment and consumer health and safety as a whole. Thus, effective mixes of old and new and regulatory and non-regulatory including voluntary instruments are a crucial part of improved risk management and governance.

In some respects legal provisions already are more proactive and precautionary, such as for PBT substances and, partly, EDS. Regulations have also increasingly applied other principles such as reversed burden of proof (based on REACH) and right-to-know (labelling). However, these provisions have limitations especially regarding their practical implementation, and such elements are needed also in the regulation of other risks, from other chemicals and agents.

On the other hand, proactive legislation is not problem-free. While addressing some deficits fast and effectively, problems may be caused by provisions that are exaggerated (over-zealous), excessive (bureaucratic), uncoordinated and non-harmonised, non-permanent, inequitable and non-inclusive. Specifically, as part of these challenges, proactive regulation of some risks may cause or increase other, also unanticipated risks, including those of loss of benefits.

Correspondingly, the elements for improved governance in this regard essentially include

- realism in both substantive requirements and in the ambition level of implementation;
- simplification and transparency, and coherence between areas of legislation;
- continuity and predictability;
- equity and fairness, especially with respect to different legal subjects;
- negotiation processes that are able to take into account the views of stakeholders and sectors.

These requirements are compounded by the task of coordination between EU-level and national legislators, placing considerable resource demands on the multi-faceted preparation processes. The compensating reward is that if attention and efforts are expended, the regulatory frameworks can prevent costly and otherwise harmful mistakes and inefficiencies later on. For instance, it is crucial to make the various stakeholders in the consumer chemicals and textiles area feel that their concerns have been addressed for well-functioning implementation (cf. REACH process).

Improved **institutional capabilities** are needed to cope with over-arching, complex, uncertain and thus challenging risks and governance tasks associated with textile chemicals. The capabilities are not limited to government, and do not mean only more resources to institutions. On the contrary, they have to do with fewer resources also in Finland. Thus, the needed improvements in capabilities essentially involve network governance that is able to deliver more with less.

Improved legal and institutional capabilities thus even more require the **inclusion** of a multitude of stakeholders, as part of multi-actor governance. This in turn requires participatory procedures also beyond routine consultation. Simultaneously, all cannot be left to a vague participation blurring responsibilities. As voluntary initiatives increase, also requirements for a strong regulatory role increase for objective and impartial coordination.

## 4.4.4 Coordination and collaboration

### 4.4.4.1 Coordination between sectors

As explained above, chemicals in textiles require the increased participation and improved collaboration of many different sectors. Collaboration in order to be efficient requires sufficient incentives, such as from legal provisions (see above), as well as coordination and planning. In the present connection, we focus on coordination in the horizontal relationships between sectors.

The sectors to be coordinated do not exist only in administrations but also in other societal spheres, such as the private sector (industries and enterprises in different branches) and in civil society (NGOs and other organizations engaged in different thematic sectors). Increasingly, there are coalitions, partnerships and networks tying these together, both at national and other levels. Thus, the coordination problem is not restricted as traditionally to governmental agencies.

A distinct need in developing the coordination is to involve additional key sectors beyond those now commonly represented, i.e. environment, health and (consumer) safety. These additional sectors mainly include enterprise and trade, which have a central position because of the character of textile products and because of the development of the administration for consumer affairs principally under the Ministry for Enterprise and Labour. The former is in some contexts already well-represented in the governance and risk management of chemicals, such as based on REACH.

### 4.4.4.2 Coordination between levels of governance

Finnish actors have in some respects relatively limited possibilities to profoundly influence governance, beyond implementation of EU regulations and reactions to global developments. This applies to both public and private sector, as the latter increasingly is conditioned and even directly owned by supra-national bodies (firms and their shareholders), and as also many NGOs are part of European or global conglomerations and alliances.

This deficit of national-level agency is moreover increasing as a result of globalization, despite some counter-acting strives and developments based for instance on the subsidiarity principle and also unplanned differentiation and bloc-building in the enlarged and hard-homogenized EU. Nevertheless, Finland and Finnish actors do have possibilities to influence the supra-national and even the global level at least indirectly, informally and on ad hoc basis, through opinion-building, active participation and engagement, and strategic alliances. In consumer and environmental matters alliances are typically forged with other Nordic countries, The Netherlands and Germany. Also through a neutral mediator role, Finnish government and other actors can obtain political presence, both in EU governance as well as in global contexts. In addition, formal influence is possible based on European and global mechanisms based on conventions and treaties.

In any case, vertical coordination between the national level, and further the provincial level, and the EU level, and further the global or regional (such as Eurasian) level, become of increasing importance when trying to respond to risks in both regulatory governance and elsewhere. The regulatory coordination at the EU level typically takes place in the Council and its working groups, and in the committees of the European Parliament (for these institutional structures and processes of risk governance specifically in the chemicals area, see Assmuth et al., 2010a, b).

Vertical coordination interacts with horizontal coordination: For instance, the different ministries and the agencies and expert bodies in their sectors all have EU-level and most of them also national-level mandates and roles, even based on legal provisions. Thus, coordination of the national and international level requires simultaneous coordination of these sector agencies.

The unification of the expert and regulatory bodies of three ministries to the reformed Tukes may facilitate this two-dimension al coordination, but additional vertical relationships remain to be factored in, such as that of Syke in collaboration with both EU-level and provincial-level bodies, in the areas of their competence such as some chemicals (POPs), sustainable consumption and production issues, and environmental policy functions.

#### 4.4.4.3
#### Co-governance between actor groups

The roles of actor groups overlap but they also differ, often distinctly. They may have fundamentally different interests. Therefore, coordination between them is not possible in the way it is in the public sector between sectors that are, after all, supposed to work for the common good, averaged by the integrative functions of the state (or other public entity such as the EU). Rather, co-governance of a looser kind may serve to reconcile the different interests and capabilities.

New forms for this are developing within partnerships between authorities, enterprises, CSOs and other actors. Also official boards such as the Chemicals Board, the Waste Management Board, the Consumer Disputes Board, and Eco-labelling Board play an important role in Finland. Panels such as the Product Panel are a more recent type of co-governance bodies that may become important. They have usually an advisory role however and are not directly charged with policy decisions.

As shown above and discussed by Kogg and Thidell (2010) and UNEP (2011a), various kinds of enterprises participate along the product life cycles, from brand-owners of garments to upstream manufacturers of textiles, and from chemical manufacturers to down-stream users including these manufacturers. Thus, risk management requires better steering of the activities of these operators. Simultaneous knock-on effects of REACH and other legal procedures and of industry branch organizations from one side, and those of the chemical manufacturers from the other, can induce improvements but better coordination between these parts of the cycle and also between the respective jurisdictions (countries) is also needed.

4.4.4.4
**Coordination between regulatory and non-regulatory steering**

A key task is the efficient coordination of risk governance through legally based regulatory steering and other including voluntary activities. This was stressed also more generally for chemicals in consumer products and articles by Häkkinen (2010). There are complex relationships between these types of steering that thus complement each other but may also compete.

The key general issue is to what extent governance can be achieved through normative or voluntary measures, and what obligations and procedures are needed to ascertain the efficiency, equity and other desired characteristics of the latter. This depends, for instance, on how broad and compelling the responsibilities and other incentives of enterprises are in reducing risks.

4.4.5
## Efficient use and mobilization of resources

4.4.5.1
**General**

Risk management takes resources - economic, material (also natural) and human resources. On the other hand, risk management also generates or saves resources of some of these kinds; otherwise it would not be very meaningful. Any decrease in risks also through conscious human actions is, particularly on a broad interpretation, accompanied by increases in some benefits.

Emphasis on resources, inputs and outputs of risk management has greatly increased along with the scarcity of resources and the importance of economy, reflected in turbulences and recessions. Assessment of the efficiency, productivity and resource impacts of risk management and governance measures have thus become commonplace, and have indeed taken over some other such as ethical or political considerations of management. For instance, detailed *ex ante* (prospective) assessments and justifications for new governance measures are routinely required both for new legislation both at the EU and the national level.

4.4.5.1
**Administrative resources**

Regulators and industry have better possibilities to cover the resource spending by creating revenues for instance through taxes or obligatory resource reallocation systems (regulators) and through transferring the resource spending to prices for their products and services (enterprises). It may be more important that the elementary governmental functions in risk management, such as official surveillance and information, are sufficiently funded, and that enterprises responsible for most of the functions of whose risks are to be managed separately allocates sufficient resources.

A balance is to be struck between the chemicals-focused and more general monitoring. This is however not a zero-sum game. When broadening the scope, additional resources from other fields that have similar needs may be obtained, and also the priorities and the efficiency of monitoring can be increased over the atomistic, narrowly sectorized approach. In general terms, a balance is needed between the breadth and detail of monitoring, as both of these increase resource needs.

#### 4.4.5.2
**Corporate resources**

Firms also need improved resources for risk management. This is part of the management and economic risk that enterprising involves. It is borne by the revenues of the enterprise, and then by its shareholders and financiers. In some cases these include public bodies. Even in other cases, the economic risk of a big private enterprise (such as Marimekko, Reima, Nanso and Virke in the Finnish textile branch) affects the economy as a whole and it citizens, for instance through price hikes, corporate taxes and employment.

Corporate and the public risks and rewards thus overlap, and are in some respects parallel (Søndergård et al., 2004). In others, the private risk is different. Especially long-term and indirect risks such as those from many chemicals are not born the firms that focus on short-term profits. Compensatory mechanisms for risk-sharing are emerging especially within product liability, but these are inherently limited.

It is in principle in the interest of enterprises to manage risks so that consumer trust and overall societal prerequisites for successful action in the competition are retained. However, competition can both engender responsible risk governance (to the extent it is seen profitable) and limit it, for the firms (especially in poor economies) that are not willing or able to meet environmental, health, safety and other quality criteria in their products and processes. Firms both in more and in less developed regions also need information resources and other preconditions such as efficient institutional and regulatory environments to be able to identify, reduce and avoid risks. The main emphasis of forms also in Finland is moreover on consumer safety and health, not environment.

#### 4.4.5.3
**Civil society resources**

Because of the lack of resources of the NGOs and other CSOs not affiliated with the enterprises, they generally speaking need particular improvements in their resources. This is especially the case in the consumer products area. However, such improvements have already emerging, based on the financing directly from consumers, in addition to more traditional public support.

### 4.4.6
### Meaningful information and open communication

#### 4.4.6.1
**Monitoring, surveillance, assessment and evaluation**

As stressed above, information on risks as well as risk reduction and management opportunities needs to address more explicitly questions of the significance and meaning, paying attention to the user context and the receiving audiences. A consequence of this is a move toward more evaluative and often integrative information. Priorities in information gathering can also be readjusted to complement present orientation such as monitoring of environmental emissions and occurrence.

This does not imply downplaying chemical (or biological and physical) measurements of textile articles or releases from them, but does call for critical analyses of the relevance and uses of such information in relation to other needs. Some information needs for instance in testing individual chemicals can be reduced by focusing on key indicators and by using predictive models (for the purposes where their accuracy is sufficient). Thus can new information needs such as those for management opportunities better facilitated.

Such opportunity-oriented areas of information have the particular strategic value that they can render the collection of information on problems and in 'end-of-pipe' stages gradually less crucial, even though some monitoring is continuously needed to ascertain the performance of management measures. While 'data-less' information is not an option, the value of information in the data can and should be considerably improved, and value-of-information and uncertainty management analyses can considerably aid this.

Also the burden-sharing of the generation of information is crucial in this regard, also in relation to resource needs (see above). The involvement of industry is likely to be increased also as an impact of the REACH regulation which prominently applies the principle of reversed burden of proof whereby chemical manufacturers to some extent jointly with the downstream users bear the responsibility for testing of the chemicals to be offered for the market. This has the potential benefit of utilizing the detailed knowledge of industries of their processes for environmental and consumer friendly product and production design, as part of overall development and operative management. This applies to producers as well as to some traders of textiles.

REACH and related procedures also serve information sharing and consultation among parties (Assmuth et al., 2010b, Häkkinen, 2010). At the same time, the need becomes pronounced to ascertain objective and critical evaluation of the data and initial assessments by industry regarding their products, mainly by authorities and independent parties.

#### 4.4.6.2
#### Communication and deliberation between actors

The many actors in different roles and contexts of risk governance (cf. above) communicate not only on information on risks but also their concerns, valuations, objectives, capabilities and so forth. This communication takes place at many levels and in various forms and channels. Much of it is multi-directional, as communication inherently involves interaction, not only the one-dimensional distribution of information and views.

Risk communication in the area of chemicals and consumer products is highly turbulent as risk information and risk issues are typically hotly contested and debated, and become politicized. This is especially challenging as more numerous actors, both in the public sphere (such as sectors of administration) and in the society at large are (to be) included. These want to influence also the overall process in order to participate. Moreover, the scientific and expert opinions regularly diverge and clear-cut answers regarding either risks or management options are hard to come by.

The active role of media in risk communication especially regarding consumer health and safety risks contributes to often exaggerated and polarized and even chaotic communication around fears (but also successes), liabilities, perceived cover-ups, and the like.

### 4.4.7
### Possible measures to improve risk management

#### 4.4.7.1
#### Previously proposed measures

Based on the above discussion of risk governance, including its contexts and goals and its general means, existing and previously proposed risk management measures can be evaluated or characterized regarding their potential in relation to observed deficiencies and their overall applicability to textiles (Table 8). It is evident that existing proposals form a basis for further development and for implementation. Among constraints, those from resource needs are common.

It can be seen that mainly information focused instruments have been proposed in these sources. This is reflected in the CiP project of SAICM (Kogg and Thidell, 2010;

UNEP, 2011a,b). Regulatory measures have been dealt with in some documents and, what is more important, have been applied in practice. However, their improvement and integration with other instruments have been seldom explicitly analyzed in policy documents. This under-representation of the regulatory perspective is due in part to the complexity of the branch and its risk issues that cross the boundaries of jurisdictions, and also to the inherent importance of consumer-driven and industry-practiced management in this area of economy, with less interference of the public sphere.

#### 4.4.7.2
### New and emerging measures

**General**

Many new steering instruments and measures are evolving in environmental and product policy, even new types of instruments, along with developments in existing instruments (Table 9).

Instruments and measures can be defined along many lines, such as the object or approach of governance (e.g., normative, economic and information steering). The categories of new, emerging and existing measures overlap, and often an instrument combines new and established elements.

Thus, some 'new' measures are adjustments in a traditional approach to management, such as a technical improvement or a new specific regulation, while others are more radically new, such as citizen demand management, novel motivational activities, or broad partnerships and negotiation platforms of stakeholders.

New instruments emerge for many reasons, largely due to overall developments in governance, such as the increased roles of the private sector and civil society actors and of 'soft law' steering. On the other hand, these developments usually are responses to factual problems and opportunities, such as new technological processes developed, new risks identified or new socio-economic needs and settings. Thus, because of the introduction of novel chemical substances in textiles, also novel methods for planning, management and monitoring are being developed, notably based on legislation that tries to catch up with such developments. There is multi-dimensional interaction between legally binding and other steering.

Because of the uncertainties and dynamics in governance contexts and well as in the products and processes to be governed (including both textiles themselves and their uses), it can be difficult to anticipate the emergence of wholly new instruments, also in short or intermediary term.

Within the scope of this work, only a preliminary identification and evaluation of new and emerging measures has been made, in qualitative and semi-quantitative terms (Tables 8 and 9), and largely as a means of identifying potentially important opportunities and associated important factors, including barriers for development and application. In addition, a few emerging areas of different type and of growing importance are discussed by way of example.

Evaluation of the relative merits and disadvantages or risks associated with the measures depends on the perspective, and the weights given to the different evaluation criteria and even their selection are ambiguous. In practice, governance takes place through a multi-frontier approach by multiple actors combining different measures, and these jointly shape the governance.

Many measures, especially new ones, are as yet poorly known and their efficiencies and other qualities cannot be documented based on empirical or experiential knowledge. Uncertainties regarding outcomes limit also evaluations of long-tried measures, partly because their application contexts change and because it is difficult to ascertain to what extent an outcome is the result of a specific measure. Rather than attempting to provide a clear-cut answer to which approaches are 'best', tentative characterizations of them along some key dimensions is made (Table 9). However, in general it can be concluded that the proposed measures (Table 8) comprise only a small part of the overall options, and that there thus is much room for innovation.

New measures can also be divided according to the life-cycle stage(s) they address, from preventive to end-of-pipe measures. In general, preventive measures in the early stage, for instance to alter demand by life-style changes or structural changes in production, have not yet been as commonly employed as those in use and emission and, to some extent, waste stages.

**Nanomaterials management**

Nanomaterials and nanotechnological applications are increasing rapidly also in textiles, for several purposes, both technical and cosmetic. They are used e.g. in stockings and in several coating materials of textiles to add durability and permeability and to facilitate cleaning. Nanosilver in particular is used.

Regulatory and non-regulatory governance of nanomaterials is still very unclear and insufficient, especially regarding environmental and health risks. This is partly due to the continuing lack of analytical methods to measure the occurrence of nanomaterials in various matrices, environmental and other, and to characterize the key properties of the materials. Even basic definitions and distinctions of nanomaterials needed in regulatory and managerial practice are as yet lacking. The definitions of industry cannot be directly applied or checked, in many cases also because of the inaccessibility of proprietary information. Thus, very little empirical and verifiable information on the environmental fate and biological effects of these materials is as yet available. Therefore, the principles and procedures of governance as well as assessment (pending essentially on some level of predictive models) are necessarily as yet undeveloped and inefficient.

Nanomaterials are to some extent covered by the REACH legislation. However, much work is ongoing and has partly only started to address the issue more comprehensively under this legislation. Several official bodies have been set up for nanomaterials in the area of chemicals control and related areas such as waste management, also at EU level. Thus, nanomaterials represent a key development need of the REACH procedures, in the same way as assessment and management also of chemicals in articles.

The developing regulatory governance of nanomaterials draws on the work on these materials in the food safety and pharmaceuticals area which in some respects has proceeded much farther than in the field of environment. As such, nanomaterials highlight the need to cross boundaries and improve coordination between traditionally separate legislative areas and sectors, in the face of profound technological developments.

European governance of nanomaterials is heavily conditioned by the global scene and especially other OECD countries, and by the more liberal approach to the development and application of such materials both in the US and elsewhere, notably China and other key emerging economies. Therefore, harmonized and enforceable rules for nanomaterials are hard to come by. The EU may regulate its own production and influence others by its regulations, through knock-on effects on economies exporting to Europe.

**Eco-design**

The Directive 2005/32/EC on Establishing a Framework for the Setting of Ecodesign Requirements for Energy-using Products (so called EuP Directive) is the first directive requiring the incorporation of life cycle-based environmental considerations into product development process. The EuP directive is a framework directive that defines how to prepare product group-specific implementation measures in further detail, what types of regulations they may include, and how product compliance is demonstrated. Product group specific regulations may be either specific requirements or general ecodesign requirements.

The Directive establishing a framework for the setting of ecodesign requirements for energy related products (2009/125/EC) extended the scope of the EuP Directive to allow for the setting of ecodesign requirements for all energy related products. Besides, the Committee on the Environment, Public Health and Food Safety of the European Parliament proposed to extend the scope of Directive 2005/32/EC to all products. Although this amendment was not adopted, it is required that the COM "shall assess […] the appropriateness of extending the scope of the Directive to non-energy-related products" "not later than 2012".

Thus, it is in principle possible that implementation measures could be given on ecodesign of textiles[1]. However, the Method for the Evaluation of Energy using Products (MEEuP) used in the development of implementation measures has been criticized for restricting the life cycle scope and thus overestimating the significance of the use phase. In particular and importantly from the point of view of this study, it has been claimed that chemical substances and toxicity issues are not properly assessed in the MEEuP process.(Rossem and Dalhammar, 2010).

Furthermore, it needs to be assessed if textile products fulfil the criteria for the development of ecodesign implementation measures[2]. A key problem may be the rapid changes in textile articles, especially clothes, for these regulations to be able to steer their qualities appropriately and efficiently. This is similar in other areas such as electronics, but the definition of a product additionally poses difficulties for application to textiles.

#### 4.4.7.3
#### Evaluation of steering instruments and measures

There are many conceivable criteria for evaluating risk management and governance measures and steering instruments or strategies even more generally. These criteria are at many levels: they can be specific and operational, or include criteria for conformity with general principles, or mix both levels or types of criteria, such as the following:

- effectiveness in terms of objectives (such as environmental protection goals)
- efficiency in terms of objectives (such as environmental protection goals)
- economic efficiency including cost-efficiency
- equity
- transparency
- flexibility
- legitimacy
- implementability
- consistency
- monitorability.

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[1] During the preparation process, consumer groups explicitly required that implementation measures should be prepared for products such as "textiles, furniture and paper-based products" (cf. EurActiv, 2010).

[2] The criteria referred to in paragraph 1 are as follows:
(a) the product shall represent a significant volume of sales and trade, indicatively more than 200 000 units a year within the Community according to the most recently available figures;
(b) the product shall, considering the quantities placed on the market and/or put into service, have a significant environmental impact within the Community, as specified in the Community strategic priorities as set out in Decision No 1600/2002/EC; and
(c) the product shall present significant potential for improvement in terms of its environmental impact without entailing excessive costs, taking into account in particular:
(i) the absence of other relevant Community legislation or failure of market forces to address the issue properly; and
(ii) a wide disparity in the environmental performance of products available on the market with equivalent functionality.

**Table 8.** Earlier proposals of measures to remedy observed deficiencies in the management of risks from chemicals in textiles or other articles (from various sources, cf. Chapter 2 and 3).

| Subject | Observed deficiencies | Measures in place, to be developed | Measures previously proposed | Scope of application |
|---|---|---|---|---|
| **Availability and management of information** | | | | |
| Information flow in the supply chain | Information of chemicals in articles rarely goes through the whole supply chain | Available in e.g. electronics / UNEP CiP project | Development of information systems to cover the whole supply chain | All articles |
| Information to consumers on chemicals in articles | Lack of article labelling requirements; labelling criteria often unknown | Partial (mainly in eco-labelling); labelling the absence of certain chemicals | Development of labelling requirements for chemicals in articles | All articles / certain groups (textiles) |
| | Unawareness among firms of communication requirements | Basic (authorities, industry) | Information campaigns | All articles |
| KETU-register (chemical Safety Data Sheet based) | All companies not aware of their responsibility to register hazardous chemicals | Procedures and administrative resources | Information campaigns to remind companies about their obligations | All articles / certain groups (textiles) |
| | The register does not include obligation to register chemicals in finished articles | Incentives and administrative resources | Inclusion of obligation for firms to register chemicals in articles | All articles / certain groups (textiles) |
| | The register can contain old information | Quality controls | Companies to be reminded to inform Tukes of data changes | All articles / certain groups (textiles) |
| Information about risks | Lack of information on hazard properties, exposures and management | Testing and assessment e.g. under REACH; ongoing research | More focused research and testing; improved assessment including risk-benefit aspects, management opportunities | All articles; also non-toxic ecological risks |
| **Management measures** (regulative and voluntary) | | | | |
| Chemicals and articles covered | Legislation often covers only certain chemicals or article groups, and certain regions | Legislation (RoHS, REACH Annex add-ons); voluntary lists | Inclusion of more chemicals and articles to regulations; global management | All articles / certain groups (textiles) |
| Management goals | Quality criteria are unclear | Chemical/product regulation; voluntary control/substitution | Specification of criteria; coordination of goals | Certain groups of articles |
| Chemicals controlled | Insufficient implementation for control and substitution; insufficient steering of voluntary actions | Legislation (e.g. RoHS, REACH); voluntary lists | More extensive and integrated control systems, e.g. SAICM and UNEP (2010) | Certain groups of articles / chemicals |
| Post-use management | Lacking concern for textile chemicals in waste stages | Recycling procedures | Increased recycling | All articles |
| **Surveillance and responsibilities of actors** | | | | |
| Surveillance of articles | Based on risk assessment (e.g. company data) and the RAPEX system | Requirements and systems on ad hoc basis | Faster and more complete identification of risky articles and removal from market | All articles and priority groups |
| Surveillance of chemicals | Based on existing legislation not focused on articles; health risks mainly addressed | Limited systems for release / environ monitoring | Inclusion of more chemicals and of environmental aspects | All articles |
| Surveillance of activities | Insufficient monitoring of extent and efficiency of measures | Facility-level monitoring mainly | Strategy-level and more global monitoring | All articles |

There are also various established systems of evaluation adopted in the EU policy processes that apply a limited selection of prioritized criteria, typically focused on either objectives or the process. These systems include, especially in the policy monitoring and indicator area, 'SMART' objectives: Specific, Measurable, Achievable, Realistic and Time-dependent, and 'RACER' criteria:

- Relevant (linked to objectives, cf. the above criteria)
- Accepted (by staff, stakeholders and other key groups)
- Credible (also for non-experts; unambiguous)
- Easy to monitor
- Robust (against manipulation; cf. indicator misuse/abuse)

With a complex issue such as chemicals in textiles (and other articles) in a field of governance that is still highly ambiguous and under rapid development, it is not presently feasible to attempt to evaluate measures and strategies in quantitative and economic terms. This is partly due to the lack of data and models to come up with anything more than educated (yet value-laden) guesses, and due to the amount alternative development paths and outcomes. Thus, traditional risk-benefit or risk-cost-benefit analysis falls inevitably short of the mark, and to put effort in it can even be counter-productive in distracting from other, more crucial considerations in risk governance.

Rather, qualitative or semi-quantitative and inherently tentative evaluations, serving as a basis for further analysis, discussion and deliberation, in a reflexive (iterative) manner, is the preferred approach. Such an approach is better able to account also for uncertainties even of fundamental assumptions and allow reframing as part of the process of risk communication and deliberation.

For the present analysis, some of such criteria are more easily derived than others and seem more relevant. For instance, the acceptance of measures is uncertain *ex ante*, while the legal basis, application scope and, to certain extent, monitorability can be more readily derived either theoretically from first principles, or based on some empirical data or practical experience.

Applying some of these criteria, or combinations and further developments of them, potential risk management and governance measures for chemicals in textiles and related areas can be tentatively evaluated, in a qualitative or semi-quantitative manner (Table 9).

This evaluation addresses a selection of measures and approaches that is much broader than those previously instituted or proposed for textile chemicals, as identified in documents (Tables 6 and 8). This extension in the scope of opportunities is partly due to the fact that, in addition to such specific measures, many others in adjacent areas and at more general levels are relevant also for textile chemicals. The extension in opportunities also reflects the fact that both the field of the risks to be governed and the field of their governance are dynamically evolving and extensive, and many opportunities have not yet been identified or paid sufficient attention. This is particularly true of preventive measures including product design, and voluntary and cooperative measures, both with enterprises and consumers.

As emphasized above, evaluation of the pros and cons and relative merits of alternative measures or, in practice, their different combinations is difficult and can be based on empirical facts and objective knowledge only to a limited extent. However, it can be seen that much promise is given by measures in the more recently emerging preventive, voluntary and cooperative categories. These on the other hand introduce additional challenges and needs to couple them with established approaches to management and governance (Table 9).

The role of chemicals in relation to the **overall quality of textiles** needs to be evaluated broadly and in detail. Quality is an alleged focus of the industry, and any attempt to govern the risks of products must account for this. The relationships between chemicals in textiles and their overall quality are complex. Risky use of dangerous chemicals in textiles and in their production can be, and often is, linked with poor overall quality, such as in sweatshops churning out low-quality garments that also are dyed and treated for protection by restricted (but often cheap) chemicals.

On the other hand, for some uses, chemicals (also those causing environmental and health risks) can increase the durability and sustained utility of textiles. Harmful chemicals can thus counteract their accelerated consumption and production and the accelerated use of *other* harmful chemicals. An extreme example is flame retardation which protects not only those wearing a textile (and its environment) but also the textile itself from destruction, thus preventing discarding it unnecessarily. Thus, fireproofing has an important function also for environmental and resource protection, and careful trade-offs are needed between the multiple risks and benefits of alternative chemicals used for that purpose. Likewise, is has been posited that nanomaterials can increase the use life of textiles, thus saving resources and the environment, and balancing risks they may cause.

The amount and turnover (use life) of textiles plays a role in addition to their quality in terms of chemicals contents. There is little information on this; an example is that 430 000 web pages are retrieved by Google using the phrase "product use life" but only 70 pages that additionally include they word "textiles". The possibilities to influence these turnover rates and thus the material flows seem to be primarily dependent on consumers, as it may be less realistic to think that enterprises in free markets would not attempt to maximize consumption of their products. However, also the requirements set on the durability and overall quality of textiles is important, and this involves supply-side measures taken by regulators, industries and enterprises, or both.

**Table 9.** Generalized evaluation of measures for management and governance of risks associated with chemicals in textiles. The measures have been defined loosely along product life-cycle stages, include general and specific measures and are partly overlapping. Note that the evaluation involves uncertainties and depends also on actor perspectives.

| **Measure type** | **Strengths and opportunities** | **Weaknesses and threats** | **Explanations and examples** |
|---|---|---|---|
| Chemical use restriction | can be based on existing regulations; certain and in some cases fast effect | can have unwanted side effects; does not support alternatives; 'crisis option' | Priority PBTs, CMRs, PPPs and EDSs, high-profile sensitizers |
| Chemical use authorisation | based on regulations; can be focused; part of negotiation process | depends on regulatory resources, can be slow; can be limited to single substances, difficult to address mixtures in products | REACH and other procedures |
| Substitution (of chemical/ process) | preventive; risk-benefit balancing; can promote thinking on alternatives | substitutes can be partial solutions; may cause new risks | substitution based on REACH (including risk-benefit assessment) |
| Labelling (chemicals/other) | enables consumers to make their own choice; transparency | understanding and acting on messages; uncertain impact; can cause either low or shock effects | textile/chemical product choice, product care, waste reduction |
| Production control (regulatory/firm) | concreteness, focused | often limited impact | facility control, BAT, worker safety |
| Firm management in general | comprehensiveness, attentive to firm capabilities, dynamic/foresight possible | limited to in-house measures; can have difficulty of critical appraisal | EMAS, co- responsibility |
| Product maintenance control | can reduce main risks from use | depends on consumer or laundry diligence | washing agent choice, technology adjustment |
| Monitoring and surveillance | needed with most options to ascertain impacts; can raise awareness and compliance | reactive | activity, occurrence (textiles/ releases) |
| Product design | proactive, can prevent risks; supportive of innovation | can produce partial or cosmetic improvements; can cause new risks and disadvantages if not | low-chemical; other quality |
| Demand management | can avoid risks from cradle; van integrate low-toxicity with other goals | uncertain (if consumer based); can be hard to coordinate | influence on consumer choice; procurement |
| Economic steering | potentially efficient | hard to focus and allocate; hard to ascertain impact | subsidies/incentives; taxes/ fees |
| Product liability systems | attentive to consumer rights; can promote dialogue on core risk issues | can be adversarial | recall schemes, general liability improvements |
| Negotiation procedures | can be efficient in resolving controversies and interest conflicts | roles of actors may become entangled | interagency panels/boards |
| Recycling | can be linked with and promote environment-friendly behaviour | can recycle also toxic chemicals and cause new risks | collection and reuse capacity building |
| Waste management | takes care of textile products and their chemicals as a whole; certain effect | limited to end-of-pipe solutions (if uncoupled with upstream knock-on effects) | incineration; disposal |

# 5 Conclusions and suggestions

5.1

## The broader importance of chemicals in textiles

Chemicals in textiles are an example of important general issues of environmental policy, including natural resource policy, and product policy. They can therefore illuminate needs and possibilities far beyond the specific area of textiles and chemicals in textiles.

It may be concluded in particular that the risks associated from chemicals in textiles are challenging even among chemicals and products because they have to do with consumer health and simultaneously with deeply seated perceptions and emotions that are associated with clothing. The perception of these risks is also relatively new for many people. Because the textile and clothing industry is an important branch globally and nationally, there are great interests at stake.

Chemicals in textiles as a border-zone issue unite environmental, health and safety concerns and solutions, including the necessary trade-offs and coordination. Specifically, textile chemicals bridge chemicals control and product policy, and are important for comprehensive approaches to these.

In broader governance contexts, textile chemicals exemplify questions of consumption and production styles, such as how many and what kinds of textiles people need and are offered. These questions are related to the functions of consumption beyond mere fulfilment of 'needs'. This is important as many risks associated with chemicals in textiles may be avoided by reducing superfluous consumption of textiles in the first place, especially those with unnecessarily dangerous chemicals, instead of accepting such uses and focusing on ameliorating resultant risks.

5.2.

## Governance and management approaches

Although risk management often proceeds within **frames** that are taken as given, for instance based on specific regulations, framing of problems and solutions is a key issue. It is very different to control specific chemicals in articles or to control products in general (Figure 7 and 8). Often a flexible framing is advisable, allowing a consideration of the broader context while facilitating focused framing to address and highlight specific issues. In practice, different framings are combined when analyzing problems and solutions in different contexts and by different parties. Regardless of the relative merits of a broader or a narrower, or a flexible and rigid, framing of risks and management in each case, attention to framing is needed due to the complexity, connectedness and development of risks and of management.

The governance of risks is increasingly complex due to new actors; specifically, national and EU level actions are insufficient to prevent risks from chemicals applied to textiles in other regions. Some of these complexities also open up new and potentially efficient and fruitful ways to management. It needs to combine established and improved regulatory governance and technical controls with other approaches such as eco-design, industry supply chain management and consumer based strategies, also in novel ways involving new deliberations and partnerships.

In addition to traditional regulatory and corporate risk management, **co-governance** involving also other actors and utilizing cooperation as well as interest conflict resolution is important. It requires new types of activity, for instance to mobilize and steer voluntary measures and to ascertain the efficiency of measures, but also offers new opportunities. The limits and potential of co-governance and other governance approaches, existing and new, need to be ascertained though trial and error, in social learning. Therefore, **adaptive governance** in general is needed (Figure 8). This in turn accentuates the importance of **information**, and therefore of transparency and contextualization.

A key element especially of adaptive co-governance is improved also broader consideration of the **benefits and risks** of textile chemicals, substitute substances and, more generally, alternative courses of action. This is closely related to more inclusive and participatory multi-actor governance where different interests are reconciled. For that, also conflicts need to be explicated and resolved, instead of remaining too narrowly in the trenches of the sectors and actor groups.

In general, **preventive measures** are promising as they influence the whole downstream process. Prevention can also overlap curative measures: for instance, the phase-out and reduction of the risks from PBT substances involves both end-of-the-pipe and preventive measures. Moreover, end-of-the pipe solutions drive upstream measures all the way to product design and selection of substitute chemicals.

As detailed in preceding sections, to manage and govern risks associated with chemicals in textiles, several **approaches need to be combined.** Traditional control instruments and procedures need to be applied, but also developed to answer to new needs. New governance approaches are thus needed and are also emerging or possible (Figure 8). It seems that in some principal dimensions of governance this combination of approaches can be achieved by a three-pronged or three-front strategy:

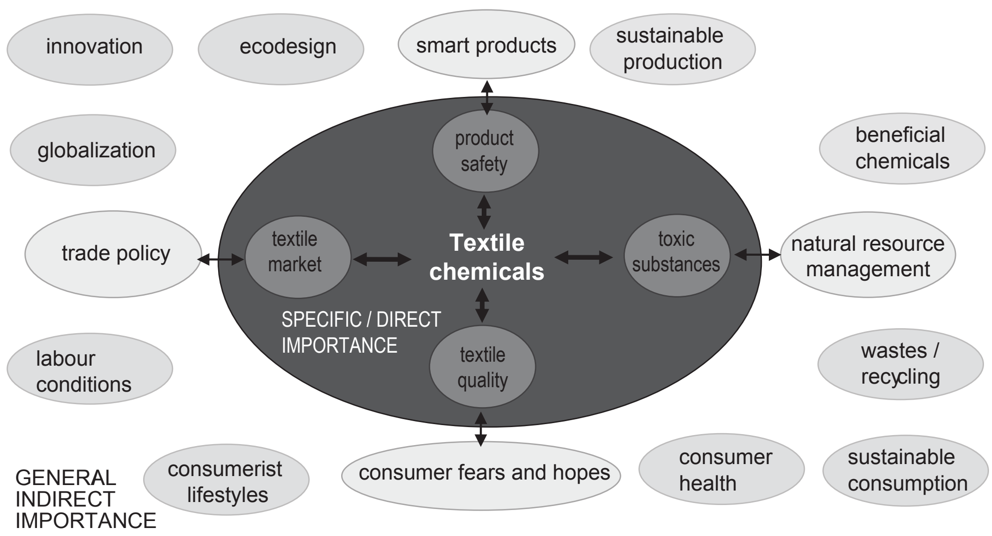


Figure 7. The broader importance of textile chemicals in the universe of policy and practical issues based on direct and indirect links with other key areas.

Multi-pronged approach to the *objects of governance*, through simultaneous use of mutually complementary framings of variable focus:

- chemicals-focused
- products-focused (broader supply-side measures)
- consumption-focused (demand-side measures)

Multi-pronged approach to the *objectives of governance*:

- ecosystem health (ecotoxicological and ecological process emphasis)
- human health and physical safety (safe textiles with regard to both their chemicals ingredients and overall quality)
- healthy and sustainable economy (resource and ecosystem services emphasis)

Multi-pronged approach to the *means of governance:*

- regulatory steering
- economic steering
- information steering

Multi-pronged approach to the *styles of governance:*

- combining incremental and centrally planned, 'bottom-up' and 'top-down' approaches
- adaptive and flexible
- deliberative, based on stakeholder engagement but also clear responsibilities and state.

A **life-cycle perspective** can help identify new or unexpectedly important measures as well as avoid measures that are not crucial, such as when broadening the scope from use stage chemicals to production or to other than toxic impacts. Life-cycle perspectives are also key to combining in efficient ways approaches to risks from the side of brand-owners and other actors in the later stages of the cycles with approaches from the side of the producers and other upstream actors. For this, different levels of actors and actions need to be distinguished.

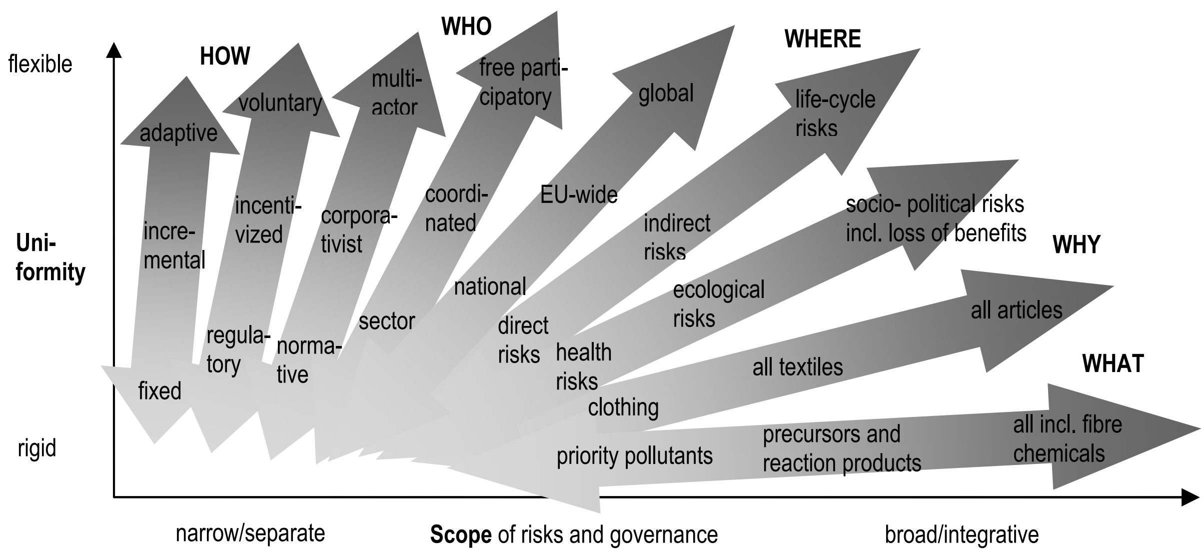


Figure 8. Characterization and possible developments of governance of risks associated with chemicals in textiles along the key dimensions uniformity and scope. Note that the paths may be reversed, divided and combined, and various outlooks and approaches can be balanced according to the context, as there is no single universally best approach but all have pros and cons.

5.3
# Possibilities for nationally based activities

5.3.1
## General

There are many possibilities for improved risk management of chemicals and textiles, as shown above. These possibilities include general and specific and immediate and indirect measures. They can also be identified with regard to the life-cycle of risk management and divided in different types of steering instruments or different time frames. In the following, key areas or directions of activities are summarized with regard to actors, due to the importance of defining responsibilities and enabling collaboration.

Other categories are embedded in this main division. It should be realized that these possibilities are interacting and partly over-lapping, and indeed often require mutual reinforcement and multi-frontier development. Neither are they exhaustive, especially in a longer term perspective on the dynamically evolving field of governance.

While the emphasis is on nationally based activities, these interact closely with supra-national activities. The former are partly based on the latter, such as with the implementation of EU regulations, but also vice versa: national activities influence higher levels of governance.

5.3.2
## Regulatory measures

- Improved **implementation** of regulations already enacted and procedures set up, including the utilization of surveillance to follow-up the efficiency of measures (all authorities and sectors)
- Improved **use of possibilities based on existing legislation**, especially REACH and RAPEX procedures for restriction and substitution of priority pollutants (core responsibility: Tukes, Customs)
- Specifically, **bans on imports** of textile articles containing chemicals banned at the EU level (Tukes, Customs)
- **Enactment of regulations that are in the pipeline**, including planned amendments and revisions of existing regulations, for instance on biocides (Ministries in collaboration with EU-level actors and supported by regulatory expert bodies)
- **Additional regulations** for targeted areas such as prioritized border-zones between products and between jurisdictions, and for emerging areas such as eco-design and integrated product policy (sector ministries, with coordinating ministries and expert agencies)
- Development of **inter-agency collaboration**, including the coordination of national activities at EU and global levels (Tukes, Customs, SYKE, responsible agencies for product labelling)
- **Regulatory risk assessment** and evaluation of alternative management policies and options for textiles and chemicals combining methodologies, also in a broader product safety, environmental and health context and based on life-cycle approaches (Tukes, SYKE, THL)
- **Public information** by authorities, to consumers in general and specific groups, on chemicals in textiles also based on import checks and on related issues such as smart wear and reduction of excessive consumption (Tukes, SYKE, KTK, other official expert bodies)

- **Public procurement** procedures for textiles accounting for chemical risks as part of overall environmental, health and safety considerations to complement technical and economic criteria (all authorities)
- **Mobilization of resources** for the above tasks and activities based on cost-efficiency, including improved cost coverage, revenue-generating and joint financing systems (all authorities).

5.3.3
### Measures by enterprises and co-governance measures

- **Active compliance** with regulatory requirements integrating the requirements, incentives and guidance from different sectors and communicating any incompatibilities or incoherence in these requirements (firms and other actors subject to legal and other regulatory requirements)
- **Transmittal of information among business partners** on chemicals in textiles and on risk management opportunities, especially on exposure reduction, and through further development of net-based and other information sources (industries, industrial associations such as Finatex, and consulting firms; retail trade organizations)
- **Linking risk management along the chain** of chemical manufacturers, downstream users in the textile industry, and end-user garment firms, accounting or regulatory directions and consumer requests (firms engaged in both production and trade, and their associations, involving also foreign and international partners and actors)
- Development of **environment-friendly textile products and processes** especially through industrial design for cleaner production (firms engaged in production and their associations; R&D and educational organizations)
- Development of **consumer information**, especially on maintenance (all actors)
- **Extension of eco-labelling** to chemicals and to new areas of product quality control, including information on physical safety, care, durability, and recyclability (industry and trade associations with Motiva, authorities and international actors).
- Engagement in multi-dimensional risk, benefit and options **analyses** (consultants, researchers and other analysts together with their clients)
- **Multi-stakeholder platforms and procedures for defining problems and solutions in a participatory and balanced manner**, including goal-setting and risk-benefit trade-offs, in textile chemicals and related areas (Chemicals Board and the bodies engaged in eco-labelling)
- **Economic steering** including development of incentive structures for environment-friendly textiles and related products, but also separately so that the public sector lays down the rules and evaluates their impacts (jointly by coordinative actors in the private and the public sector)
- **Joint campaigns fo**r environment-friendly choice and use of textiles, based on best available information of problems and solutions, making use of information provided from researchers and experts, regulators and enterprises, and co-generation of experience.
- Many of these measures imply continuation of ongoing efforts and utilization of existing measures, by industry as well as other actors, but also new forms of management, governance and collaborations are included. In particular, the challenges of risk management of chemicals associated with textiles need to be increasingly tacked at the international levels, and considering the total life-cycle impacts and the risks to the environment in addition to consumer safety.

## REFERENCES


AAFA, American Apparel and Footwear Association. 2010. Restricted Substances List (RSL). http://www.apparelandfootwear.org/Resources/RestrictedSubstances.asp [26.3.2010.]

AFIRM, Apparel & Footwear International RSL Management Working Group. 2011. http://www.afirm-group.com/ [26.1.2011.]

Assmuth, T., Craye, M. 2009. Wrestling with a Medusa - Integrated assessment and management of cumulative risks from multiple stressors according to EU chemicals regulators and stakeholder experts. Deliverable D.4.3.15, NoMiracle Project. JRC Scientific and Technical Reports (submitted) http://nomiracle.jrc.ec.europa.eu/webapp/ViewPublicDeliverables.aspx

Assmuth, T., Hildén, M., Benighaus, C. 2010a. Integrated risk assessment and risk governance as socio-political phenomena: A synthetic view of the challenges. Sci Total Environ. 408: 3943–3953. http://dx.doi.org/10.1016/j.scitotenv.2009.11.034

Assmuth,T., Hildén, M., Craye, M. 2010b. REACH and beyond: Roadblocks and shortcuts en route to integrated risk assessment and management of chemicals. Sci Total Environ. 408: 3954–3963. http://dx.doi.org/10.1016/j.scitotenv.2009.11.034

ATSDR. 1992. Toxicological profile for pyridine. Atlanta, GA: Agency for Toxic Substances and Disease Registry, US Public Health Service. 108 pp. http://www.atsdr.cdc.gov/ToxProfiles/tp52.pdf

ATSDR. 2008. Public health statement - Perchlorates. Atlanta, GA: Agency for Toxic Substances and Disease Registry, US Public Health Service. http://www.atsdr.cdc.gov/ToxProfiles/tp162-c1-b.pdf

CEC. 1998. Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market. OJ L 123, 24.4.1998, 1–63. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998L0008:EN:NOT

CEC. 2009a. COMMISSION REGULATION (EC) No 552/2009 of 22 June 2009 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards Annex XVII. Offic J EU L 164/7, 26.6.2009. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:164:0007:0031:EN:PDF [12.4.2010.]

CEC. 2009b. Environment. 21.12.2009 (updated). Eco-Label. Brussels: Commission of the European Communities, Directorate-General for the Environment. http://ec.europa.eu/environment/ecolabel/index_en.htm [21.12.2009.]

CEC. 2010a. Environment. 25.2.21010 (updated). Waste Framework Directive. Brussels: Commission of the European Communities, Directorate-General for the Environment 2010. http://ec.europa.eu/environment/waste/framework/revision.htm [25.2.2010.]

CEC. 2010b. Consumer Affairs. 18.1.2010 (updated). Rapid Alert System for non-food consumer products. Brussels: Commission of the European Communities, Directorate-General for Health and Consumers http://ec.europa.eu/consumers/safety/rapex/index_en.htm [26.2.2010.]

CEC. 2010c. Keeping European Consumers Safe. 2009 Annual Report on the operation of the Rapid Alert System for non-food consumer products RAPEX. Brussels: Commission of the European Communities, Directorate-General for Health and Consumers 2010.

Customs, Customs Laboratory (Tulli, Tullilaboratorio). 23.3.2010. Kulutustavaravalvonta vuonna 2009 (Supervision of consumer products in 2009, in Finnish). http://www.tulli.fi/fi/yhteystiedot_ja_palaute/tullilaboratorio/toiminta_2009/tiedostot/kulutustavaravalvonta_2009.pdf [4.6.2010]

Dahlöf, L. 2003. Life cycle assessment (LCA) applied in the textile sector: the usefulness, limitations and methodological problems – a literature review. ESA report 2003:9. Chalmers Technical University, Gothenburg, Sweden.

EACSG. Smart Governance. A regulatory governance for Canada. Report to the Government of Canada. Ottawa: External Advisory Committee on Smart Governance Sept 2004. www.smartregulation.gc.ca

ECHA, European Chemicals Agency. 2008. Guidance on requirements for substances in articles. Guidance for the implementation of REACH. May 2008, 118 p. http://guidance.echa.europa.eu/docs/guidance_document/articles_en.pdf

ECHA, European Chemicals Agency. 2009. Requirements for Substances in Articles. Guidance in a Nutshell. ECHA-09-B-13-EN,16.6.2009, 12 p. http://guidance.echa.europa.eu/docs/guidance_document/nutshell_guidance_articles2_en.pdf

Ecoinvent. 2010. Ecoinvent –database 2.2. Available at: http://www.ecoinvent.org

Engblom, O. 2010a. Ari Ilmakunnas Oy. Personal communication 1.6.2010.

Environment Agency, United Kingdom. 2008. Potential environmental risks arising from the use of alkylphenol ethoxylates in textiles. Revised draft of June 2008.

EP and EC. 2004. REGULATION (EC) No 648/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 31 March 2004 on detergents. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:104:0001:0035:EN:PDF [1.7.2010.]

EurActiv 2010 Eco-design requirements for energy-using products (EuP). http://www.euractiv.com/en/energy-efficiency/eco-design-requirements-energy-using-products-eup-linksdossier-188172

Finatex. 2008. Tekstiilialan ympäristölainsäädännön velvoitteet - tekstiili- ja vaatetusteollisuus, tekstiilihuolto (Legal obligations for textile and clothing industry, in Finnish.) 46 p. http://www.finatex.fi/media/Ymparistolakiopas_2008.pdf

Finatex, 2010. Textile and clothing industry statistics 2009. Federation of Finnish Textiles and Clothing Industries. http://www.finatex.fi/index.php?mid=3. [4.6.2010].

Finnish Ministry of the Environment. 2005. Vesiympäristölle haitalliset ja vaaralliset aineet pintavesissä – Ympäristöministeriön työryhmän mietintö (Harmful and Dangerous Substances for Surface Waters - Consultation paper from Finnish Environment Ministry Task Force, in Finnish). Finnish Ministry of the Environment booklet 159. 202 pp.

Goedkoop, M., Heijungs, R., Huijbregts, M., de Schryver, A., Struijs, J., van Zelm, R. 2009. ReCiPe 2008. A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. The Hague: Ministry of Housing, Spatial Planning and the Environment, Netherlands.

GOTS, International Working Group on Global Organic Textile Standard. 2010. General Description. http://www.global-standard.org/the-standard/general-description.html [4.6.2010.]

Grüttner H. Environmental communication in the textile supply chains. www.eco-Forum.de. Danish EPA project on environmental aspects in purchasing textiles for professional purchasers. purchasinghttp://www.slidefinder.net/e/environmental_communication_textile/supply_chains/671767

Hauschild, M.Z., Huijbregts, M., Jolliet, O., Macleod, M., Margni, M., van de Meent, D., Rosenbaum, R.K., McKone, T.E. 2008. Building a model based on scientific consensus for life cycle impact assessment of chemicals: the search for harmony and parsimony. Environ. Sci. Technol. 42: 7032-7037.

HELCOM. 2009. Hazardous substances of specific concern to the Baltic Sea – Final report of the HAZARDOUS project. Baltic Sea Environment Proceedings No. 119. 95 p. Helsinki, Helsinki Commission.

HELCOM. 2010. Indicators and targets for monitoring and evaluation of implementation of the Baltic Sea Action Plan. Helsinki, Helsinki Commission. http://www.helcom.fi/BSAP/ActionPlan/otherDocs/en_GB/indicators/#hazardous [6.8.2010.]

Häkkinen, P. Control of chemicals in articles. Preliminary report. Helsinki: Finnish Environment Institute. The Finnish Environment 14/2010. 42 pp. www.environment.fi/syke/publications

JRC. 2010. General guide for Life Cycle Assessment – detailed guidance. European Commission,
Joint Research Centre, Institute for Environment and Sustainability. http://lct.jrc.ec.europa.eu/assessment

Jonsson, A., Fridén, U., Thuresson, K., Sörme, L. 2008. Substance flow analyses of organic pollutants in Stockholm. Water Air Soil Pollut: Focus 8 (5-6): 433-44.

Kalliala, E.M., Nousiainen, P. 1999. Life cycle assessment. Environmental profile of cotton and polyester-cotton fabrics. AUTEX Res. J. 1 (1):8-20.

Kalliala, E. and Talvenmaa, P. 2000. The Finnish Background Report for the EC Documentation of Best Available Techniques for Wet Processing in Textile Industry. The Finnish Environment 426. Helsinki. Finnish Environment Institute. 33 s.

Kautto, P. 2008. Who holds the reins in Integrated Product Policy? An individual company as a target of regulation and as a policy maker. PhD Thesis, Helsinki School of Economics 2008. Acta Universitatis Oeconomicae Helsingiensis A-339. 125 pp.

KemI, Kemikalieinspektionen (Swedish Chemicals Agency). 2009a. Chemicals in textiles - Practical advice for companies in the sector. Brochure, November 2009. http://www.kemi.se/upload/Trycksaker/Pdf/Broschyrer/Textiles_eng.pdf

KemI, Kemikalieinspektionen (Swedish Chemicals Agency). 2009b. Högfluorade ämnen i kläder, skor och kemiska produkter. PM 4/09. http://www.kemi.se/upload/Trycksaker/Pdf/PM/PM4_09_Hogfluorerade.pdf [in Swedish with an English summary.]

Kesko. 2008. Keskon vuosi 2008, Kesko vastuunkantajana (Kesko bearing responsibilities, in Finnish). http://www.kesko.fi/vuosikertomus2008/FI/03-konserni/04-vastuunkantajana.html [22.3.2010]

Kogg, B., Thidell, Å. 2010. Chemicals in Products. An overview of systems for providing information regarding chemicals in products and of stakeholders' needs for such information. Report of the CiP project, Feb 2010. 85 pp. http://www.chem.unep.ch/unepsaicm/cip/Documents/Kogg_Thidell_CiP%20report_final.pdf

Kooiman, J. Governing as governance. London: Sage 2003.

Kuluttajavirasto. 2007. Tuoteturvallisuusvalvonnan valtakunnallinen valvontaohjelma vuosille 2008-2010. (National control programme for product safety for 2008-2010, in Finnish.) Kuluttajaviraston julkaisusarja 9/2007. http://www.tukes.fi/Tiedostot/Tuoteturva/Kuluttajavirasto/cValvontaohjelma%202008-2010.pdf [13.7.2010]

Massey, R.I., Hutchins, J.G., Becker, M. and Tickner, J. 2008. Toxic Substances in Articles: The Need for Information. Nordic Council of Ministers, Copenhagen. TemaNord 2008: 596. http://www.norden.org/fi/julkaisut/julkaisut/2008-596?set_language=fi

Mayntz, R. From government to governance. Political steering in modern societies. In Scheer, D. and Rubik, F. Governance of Integrated Product Policy. In Search of Sustainable Production and Consumption. Sheffield: Greenleaf Publishing 2006. Pp. 18-25.

Mehtonen, J., Korhonen, J. and Silvo, K. Yhteisötason prioriteettiaineiden päästölähteet ja päästöjen hallintatoimet – Teollisuus- ja kuluttajakemikaalit (Preliminary Assessment of Emissions and Releases of WFD priority substances in Finland – Industrial and consumer chemicals, in Finnish). Draft 8.10.2010. 134 p.

Milieu Ltd. and DTC, Danish Toxicology Centre. 6 October 2006. Study on impacts of possible measures to manage articles or materials treated with biocides – in particular when imported. Final Report for Tasks 2.1 and 2.2. Submitted to European Commission, DG Environment.

Ministry of the Environment, Finland. 2006. Kansallinen vaarallisia kemikaaleja koskeva ohjelma. (National programme on hazardous chemicals, in Finnish). Suomen Ympäristö 49, 100 p. http://www.environment.fi/default.asp?contentid=212022andlan=fi

Månsson, N. 2009. Substance flow analyses of metals and organic compounds in an urban environment – the Stockholm example. PhD Thesis, University of Kalmar, Sweden.

Nielsen, A.M., Nielsen, P.H. 2009. Comparative life cycle assessment of the Elemental t-shirt produced with biotechnology and a conventional t-shirt produced with conventional technology. Novozymes A/S.

Nelson G. 2002. Application of microencapsulation in textiles. Int J Pharmaceutics 242; 1-2: 55-62. http://dx.doi.org/10.1016/S0378-5173(02)00141-2

Oeko-Tex. 2010. Oeko-Tex Standard 100. http://www.oekotex.com/OekoTex100_PUBLIC/index.asp?cls=02 [27.5.2010.]

Oosterhuis, F., Rubik, F. and Scholl, G. Product policy in Europe. New environmental perspectives. London: kluwer 1996.

Orhan M, Kut D, Gunesoglu C. 2007. Use of triclosan as antibacterial agent in textiles. Indian J Fibre Textiles Res. 32: 114-8. http://nopr.niscair.res.in/bitstream/123456789/302/1/FTR%2032(1)%20(2007)%20114-118.pdf

PAN. 2010. Pyridine - Identification, toxicity, use, water pollution potential, ecological toxicity and regulatory information. Pesticides Action Network – Chemicals. http://www.pesticideinfo.org/Docs/ref_toxicity3.html#PANSummaryCancer

Priha, E. and Riipinen, H. 2005. Tekstiili- ja nahkatuotteet. In: Työterveyslaitos. Kemikaalit ja työ, Selvitys työympäristön kemikaaliriskeistä. (Textile and leather products, In: National Institute for Occupational Health, Chemicals and work, in Finnish). Pp. 251-254.

Pro-dis. 19.2.2010 (updated). GUT. http://pro-dis.info/gut.html?andL=0 [2.6.2010.]

Pro-Med. 2009. Dimethyl fumarate toxicity, furniture - UK ex CHINA. Pro-med mail, 31-Mar-2009. http://www.promedmail.org/pls/otn/f?p=2400:1001:53103::NO::F2400_P1001_BACK_PAGE,F2400_P1001_PUB_MAIL_ID:1010,76833 (original source: BBC News 27-Mar-2009)

RMIT. 2001. Aiming for sustainable product development. Textiles. Centre for Design at RMIT, Melbourne, Australia.

Rossem, Chris van & Dalhammar, Carl. 2010. Designing greener electronic products: Building synergies between EU Product Policy Instruments or simply passing the buck? Brussels: European Environment Bureau. http://eeb.org/activities/waste/EEB_buildsynergies010110.pdf

Rubik, F. and Scholl, G. Integrated Product Policy (IPP) in Europe – a development model and some impressions. J Cleaner Prod. 10 (5): 507-15.

Salonen, H., Karinen, J. and Mattila, H. 2008. Tekstiili- ja vaatetusteollisuuden kehittämistarpeiden kartoitus. (Development needs for textile and clothing industry, in Finnish). Helsinki, Tekes. 41 p.

Scheer, D. Environmental governance and integrated product policy. In Scheer, D. and Rubik, F. Governance of Integrated Product Policy. In Search of Sustainable Production and Consumption. Sheffield: Greenleaf Publishing 2006. Pp. 44-68.

SFS-Ympäristömerkintä (Finnish Standards). 2010a. Ympäristömerkki. (Ecolabel, in Finnish). http://www.ymparistomerkki.fi/ymparistomerkki [17.2.2010]

SFS-Ympäristömerkintä (Finnish Standards). 2010b. EU-Kukkamerkki. (EU ecolabel 'the Flower', in Finnish). http://www.ymparistomerkki.fi/eu-kukka/eu-kukkamerkki [17.2.2010]

Similä, J. Regulating industrial pollution. The case of Finland. Helsinki: Forum Iuris 2007.

Soil Association. April 2010. Soil Association Organic Standards, Textiles. http://www.soilassociation.org/LinkClick.aspx?fileticket=jcJ2m%2bT5%2bKY%3dandtabid=353 [4.6.2010.]

SSNC, Swedish Society for Nature Conservation. 2007. Towels with a dirty past. Report. http://www.naturskyddsforeningen.se/upload/Foreningsdokument/Rapporter/engelska/report-towels-with-dirty-past.pdf

SSNC, Swedish Society for Nature Conservation. 2008. T-shirts with a murky past. Report. http://www.naturskyddsforeningen.se/upload/report-t-shirts-with-a-murky-past.pdf [4.8.2010.]

SSNC, Swedish Society for Nature Conservation (Naturskyddsföreningen). 8.3.2010a (updated). Ecolabelling. http://www.naturskyddsforeningen.se/in-english/Ecolabelling/ [27.5.2010.]

SSNC, Swedish Society for Nature Conservation (Naturskyddsföreningen). 2010b. Textiles. http://www2.snf.se/bmv/textiles-index.cfm [28.5.2010.]

Stockholms stad. 19.10.2009 (published). Ftalater vanligt vid textiltryck. http://www.stockholm.se//Nyheter/Klimat--Miljo/Ftalater-vanligt-vid-textiltryck/ [9.8.2010, in Swedish.]

Sutton R, Naidenko O, Chwialkowski N, Houlihan J. 2008. Summary and Recommendations. Pesticide in Soap, Toothpaste and Breast Milk - Is It Kid-Safe? Washington, DC: Environmental Working Group. http://www.ewg.org/reports/triclosan

SYKE, Suomen ympäristökeskus (Finnish Environment Institute). 13.10.2009 (updated). Pesuaineet. (detergents, in Finnish). http://www.ymparisto.fi/default.asp?contentid=167225andlan=fi [5.7.2010]

SYKE, Suomen ympäristökeskus (Finnish Environment Institute). 20.1.2010 (updated). Authorisation of biocides. http://www.environment.fi/default.asp?contentid=349382andlan=EN [17.3.2010.]

Søndergård B, Hansen OE, Holm J. Ecological modernisation and institutional transformations in the Danish textile industry. J Cleaner Prod. 12; 4 (2004): 337-52. http://dx.doi.org/10.1016/S0959-6526(03)00049-0

Talvenmaa, P. 2002. Tekstiilit ja ympäristö. (Textiles and the environment, in Finnish). Tekstiili- ja vaatetusteollisuus ry, Tekstiili- ja Jalkinetoimittajat ry ja Tekstiilikauppiaiden Liitto ry. 2. edition.

Talvenmaa, P. Personal communication 19.4.2011.
The Free dictionary. 5.4.2011. Textile definition. http://encyclopedia2.thefreedictionary.com/textile
Tukes, Turvatekniikan keskus (Safety Technology Authority). 4.1.2010 (updated). Tuoteturvallisuusvalvonta (Product safety control, in Finnish.). http://www.tukes.fi/fi/Kuluttajaturvallisuus/Tuoteturvallisuusvalvonta/ [2.7.2010]
Tukes, Turvatekniikan keskus (Safety Technology Authority). 4.4.2011 (updated). Biosidi- ja kasvinsuojelutietojen ilmoittaminen (Reporting of biocidal and plant protection product data, in Finnish). http://www.tukes.fi/fi/Toimialat/Kemikaalit-biosidit-ja-kasvinsuojeluaineet/Kemikaalitietojen-ilmoittaminen/
UNEP. 2010. Assessing the environmental impacts of production and consumption. Priority products and materials. Wien: United Nations Environment Programme.
UNEP. 2011a. The Chemicals in Products Project: Case Study of the Textiles Sector prepared by United Nations Environment Program DTIE / Chemicals Branch. 48 pp.
UNEP. 2011b. A Synthesis of Findings Under the UNEP-led Project on Information on Chemicals in Products (February 2011). 38 pp. http://www.chem.unep.ch/unepsaicm/cip/Documents/CiP%20Project%20synthesis%20report__Final.pdf
Uudenmaan Martat ry. 2010. Ajankohtaista. http://www.uudenmaanmartat.fi/index.php?sivu=2 [23.3.2010, in Finnish.]
Valvira. 2009. Kemikaali-ilmoitukset. (Chemical registrations, in Finnish). Sosiaali- ja terveysalan lupa- ja valvontavirasto. (Cf. Tukes, 2011) http://www.valvira.fi/kemikaalit/kemikaali-ilmoitukset [11.12.2009]
Wikipedia. Nonwoven fabrics. http://en.wikipedia.org/wiki/Nonwoven_fabric#Bonding [1.2.2011]

## Appendix. Report of a Finnish radio interview with experts on textile chemicals

Leena Partanen/Tullilaboratorio (Finnish Customs Laboratory), Päivi Kousa/Hgin astma- ja allergiayhdistys (Helsinki Asthma and Allegy Society), and Jaakko Mannio/SYKE, in the feature on textile chemicals in Radio Vega programme Smältpunkt, Jan 13th 2011:

- In Finland, textiles can be blocked from the market, stricter than in other areas in the EU
- already awareness of control possibilities can promote risk management in firms
- colors are used ever more, increasing exposure to also harmful chemicals
- azo dyes come mainly from India as the EU banned some due to carcinogenicity; they can give skin rashes, also after lags
- anti-mold substances and insecticides are used due to production and storage in tropical countries
- nickel in metal parts causes allergenic risks; in addition, there are safety risks from metal parts
- 800 textile samples have been tested by the Customs, 13 % of them were found to violate prescriptions
- more is known of food and cosmetics than of textiles
- too little is known of emissions; most of them occur through sewage treatment plants while some chemicals volatilize; EDCs are a potential special problem
- it is hard to know what effects depends on textile chemicals; effects can also accumulate
- formaldehyde allergies are more common in textile industries
- consumers are accustomed to anti-shrink, anti-wrinkle, soft clothes requiring chemicals
- price is no guarantee of low-chemical
- no hysteria is warranted, as we've coped so far; instead, 'common sense' is called for
- if concerned of health risks, it is advisable to wash but avoid remains of detergents in textiles recommendations have been made to wash textiles less often to reduce emissions to the environment; this however conflicts with the recommendation for health
- initial washing of purchased textiles is advisable in case a consumer is worried; new textiles can also be worn first on other textiles
- baby clothes are to be washed
- recycled clothes are safer

## DOCUMENTATION PAGE

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| *Author(s)* | Timo Assmuth, Piia Häkkinen, Jaana Heiskanen, Petrus Kautto, Päivi Lindh, Tuomas Mattila, Jukka Mehtonen and Kristina Saarinen | | |
| *Title of publication* | **Risk management and governance of chemicals in articles. Case study textiles** | | |
| *Publication series and number* | The Finnish Environment 16/2011 | | |
| *Theme of publication* | Environmental Protection | | |
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| *Abstract* | In the context of a project on risk management of chemicals in products and articles, this report analyzes risks associated with chemicals in textiles, and approaches and measures in risk management and governance. The emphasis is on Finnish conditions and environmental risks, but these are put in a global and multi-risk context as it presents key management challenges as well as opportunities. Risks from chemicals in textiles are relatively neglected in comparison to many other risks from chemicals, although textiles and chemicals arouse intense interest.<br>Chemicals associated with textiles throughout their life cycles pose multi-dimensional risks and impacts on ecosystems as well as to human health, well-being and safety. These risks and impacts are shaped by the particular characteristics of these groups of products, such as their heterogeneity and multi-stage treatment and varied exposure patterns, and the properties of chemicals themselves such as those of persistent bio-accumulative chemicals with long-term adverse effects. The risks are also dynamically evolving along with technological and social changes, and many of them are poorly known. In addition to risks, chemicals in textiles provide great and varied benefits, particularly when applied for safety, durability and technical improvements. Key tasks in risk governance therefore include the balancing of risks with benefits and the conciliation of the interests and activities of different actors, involving questions of substitute chemicals, products and processes.<br>Many legally based, voluntary and hybrid management approaches and measures are available. The legally based measures include chemical regulations such as those on REACH and biocides, which have been insufficiently targeted on chemicals in articles; regulations on production processes and wastes; and regulations for product safety. These involve instruments at EU and other levels, and various forms of compliance monitoring and surveillance. Voluntary initiatives by industry are also proliferating, and information steering especially through Eco-labels is an established practice of co-governance involving enterprises, consumers and the public sector. It can yet be concluded that there are importance gaps and deficits in risk management.<br>The keys to better risk governance are broader framings of risks and opportunities and improved implementation of established policy instruments along with the development and application of new ones, in integrated and coherent but open and adaptive approaches. They need to combine regulatory governance with eco-design, supply chain management and consumer based strategies. National and EU actions are insufficient to prevent risks from chemicals applied to textiles in other regions, but these can be influenced by bottom-up strategies. Management of information including multi-actor deliberation on risks, impacts, opportunities and uncertainties is an integral part of this, both in traditional monitoring for instance of chemicals in textiles and emissions and in influencing producer and consumer choices. The report includes general conclusions regarding elements for improved risk management as well as evaluations and recommendations on nationally based activities by different actors. | | |
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| *Tiivistelmä* | Tämä raportti analysoi tekstiilien kemikaaleista aiheutuvia riskejä ja niiden hallintaa, osana hanketta joka koskee yleisemmin tuotteiden kemikaaleja. Kuluttajatuotteiden sisältämät kemikaalit ovat ongelmakenttä, jota tunnetaan yhä huonosti ja jonka ratkaisut ovat vasta kehittymässä, jopa verrattuna moniin muihin kemikaaliongelmiin. Tekstiilit toisaalta ovat merkittävä tuoteryhmä, johon liittyy tärkeitä kysymyksiä myös riskien osalta. Pääpaino analyysissä on Suomen oloissa ja toimissa sekä ympäristöriskeissä, mutta nämä asetetaan globaaliin kontekstiin ja muiden riskien ja vaikutusten yhteyteen, koska se antaa keskeisiä haasteita ja myös mahdollisuuksia hallinnalle.<br>Kemikaalit jotka sisältyvät tai jotka liittyvät tekstiileihin niiden elinkaaren eri vaiheissa aiheuttavat monitahoisia vaikutuksia ja riskejä ekosysteemeille sekä ihmisen terveydelle, hyvinvoinnille ja turvallisuudelle. Riskeihin vaikuttavat tuoteryhmän ominaisuudet kuten sen monimuotoisuus, käsittelyvaiheet, monitahoinen altistuminen käytön aikana ja epäsuorasti, sekä kemikaalien ominaisuudet, kuten pysyvien ja biokertyvien aineiden taipumus aiheuttaa pitkän ajan ympäristö- ja terveysvaikutuksia. Riskit myös muuttuvat teknologisten ja sosiaalisten muutosten myötä, ja monia niistä tunnetaan vasta vähän. Riskien ja haittojen ohella tekstiilien kemikaalit tekstiileissä tuottavat suuria ja monitahoisia hyötyjä, erityisesti kun niitä käytetään turvallisuuden, säilyvyyden ja teknisten ominaisuuksien parantamiseksi. Keskeisiä kysymyksiä ja tehtäviä riskien hallinnassa liittyy siksi riskien ja hyötyjen suhteuttamiseen ja tasapainottamiseen sekä eri tahojen intressien ja toimien yhteensovittamiseen.<br>Monia lakisääteisiä ja vapaaehtoisia lähestymistapoja sekä niiden välimuotoja on kehittynyt ja voidaan hyödyntää riskien hallinnassa. Lakisääteiset keinot sisältävät kemikaalisäätelyä kuten REACH ja biosidisäädökset, joita ei ole vielä riittävästi kohdistettu tuotteisiin; tuotantoprosesseja ja jätteitä koskevat säädökset; ja tuoteturvallisuussäädökset. Nämä sisältävät sekä yleisiä että spesifisiä instrumentteja EU:n ja muilla tasoilla, ja niihin liittyy usein tarkkailua ja valvontaa. Vapaaehtoisia toimia on myös kehittynyt runsaasti yksityisellä sektorilla, ja tieto-ohjauksessa erityisesti ympäristömerkintöjen avulla toimivat yhdessä teollisuus, kauppa, hallinto sekä kuluttajat ja muut kansalaisjärjestöt. Ohjauskeinojen tehosta on huonosti tietoja, mutta ilmeisesti hallinnassa on vielä merkittäviä puutteita, liittyen muun muassa globaalin talouden ja kaupan kehitykseen.<br>Paremman riskienhallinnan avaimia ovat riskien kokonaisvaltaisempi rajaus sekä olemassa olevien keinojen tehokkaampi käyttö samalla kun kehitetään ja sovelletaan uusia lähestymistapoja, integroidusti ja koherentisti mutta avoimesti ja adaptiivisesti. Kansallisen ja EU-tason toimet ovat riittämättömiä hallittaessa muualta johtuvia kemikaalien riskejä mutta niihin voidaan vaikuttaa alhaalta päin. Ratkaisuissa on syytä yhdistää normipohjaiseen säätelyyn ekodesign, tuoteketjujen hallinta ja kuluttajatoiminta. Tiedonhallinta sekä toimijoiden välinen kommunikaatio riskeistä, vaikutuksista ja mahdollisuuksista sekä näihin liittyvistä tavoitteista ja arvoista on olennainen osa tätä lähestymistapaa, sekä perinteisessä tuotteiden ja kemikaalien monitoroinnissa että tarkasteltaessa tuotanto-, kulutus- ja muita valintoja. Raportissa esitetään yleisiä päätelmiä paremman riskienhallinnan edellytyksistä ja elementeistä sekä arvioita ja suosituksia kansalliselta pohjalta rakentuvista keinoista eri toimijoille. |
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| *Sammandrag* | Denna rapport analyserar risker som orsakas av kemikalier i textilier, i samband med ett projekt om kemikalier i produkter och artiklar mera allmänt. Kemikalier i konsumentprodukter utgör ett problemfält som är dåligt känt och vars lösningar är outvecklade även jämfört med många andra kemikalieproblem. Textilier å sin sida utgör en grupp produkter som förknippas med viktiga frågor även beträffande risker. Analysen betonar finska förhållanden och aktiviteter samt risker för miljön men dessa sätts i en global kontext och i samband med andra risker, då dessa innebär väsentliga utmaningar och även möjligheter för riskhantering.<br>Kemikalier som ingår i eller förknippas med textilier i olika skeden av produkternas livscykler orsakar mångfasetterade risker och konsekvenser för både ekosystem samt till människans hälsa, välfärd och säkerhet. Risker påverkas av egenskaperna hos denna produktgrupp såsom dess diversitet, behandlingskeden, exponering både under bruk och indirekt, samt egenskaperna hos kemikalierna såsom benägenheten av persistenta och bioacckumulerbara ämnen att orsaka miljö- och hälsoskador på lång sikt. Risker ändras även med tiden genom teknologiska och samhälleliga förändringar, och många av dem är ännu dåligt kända. Vid sidan av risker och skador skapar kemikalierna i textilier stora och mångsidiga nyttor särskilt då de används för att förbättra säkerhet, hållbarhet och tekniska egenskaper. Centrala frågor och uppgifter inom riskhantering utgörs därför av förhållandena mellan risker och nyttor samt balancering av olika intressen och åtgärder.<br>Många lagstadgade och frivilliga tillvägagångssätt samt mellanformer har utvecklats och kan bättre utnyttjas inom riskhanteringen. De lagstadgade instrumenten inkluderar kemikaliereglering såsom REACH och biocidregelverk, som ännu inte tillräckligt fokuserats på produkter och artiklar; bestämmelser om produktionsanläggningar och avfall; samt produktsäkerhetsbestämmelser. Dessa omfattar både allmänna och specifika instrument på EU- och andra nivåer, samt uppföljning och övervakning. Många frivilliga initiativ har även uppstått inom den privata sektorn, och informationstyrning utförs samfällt av industri och handel, myndigheter samt konsument- och andra medborgarorganisationer. Det finns få uppgifter om effekterna av styrmedel, men uppenbart finns det ännu betydande brister, som hänger ihop med exempelvis utvecklingen av den globala ekonomin och handeln.<br>Nycklarna till effektivare och bättre riskhantering inkluderar en mera övergripande avgränsning av risker samt mera effektivt bruk av befintliga instrument, samtidigt som nya åtgärder utvecklas, på integrerat och koherent sätt men öppet och adaptivt. Åtgärder på nationella och EU-nivå är otillräckliga vid hantering av risker som orsakas av kemikaliebruk i andra regioner, men dessa kan påverkas nerifrån. Lösningar bör företrädesvis kombinera normstryrning med ekodesign, omformning av produktkädjor samt konsumentbaserad verksamhet. Informationshantering jämte kommunikation mellan aktörer om risker, konsekvenser och möjligheter samt om därtill förknippade mål och värderingar utgör en väsentlig del av denna tillvägagångssätt, både inom etablerad uppföljning av produkter och kemikalier och inom produktions-, konsumtions- och andra val. | | | |


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| *Nyckelord* | kemikalier, textilier, produkter, livscykelanalys, miljö, hälsa, riskhantering, policy, innovationer | | | |
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Chemicals and textiles both arouse great interest and emotions. The risks from chemicals in textiles however have been paid little attention, both from the perspective of human health and even more with regard to the environment. The present case study analyzes risks as well as benefits and other impacts from chemicals associated with consumer textiles, as well as management and governance approaches to deal with the multi-faceted problems involved, in the broader context of product and chemicals control and environmental innovation, from national and EU to global levels. The report is written for all those interested in and charged with tasks in this and related fields, including a variety of actors beyond researchers and regulatory or technical experts.

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