Monitoring Action C1

C1 Define starting situation (baseline scenario)

Project acronym:	ECO-TEXNANO
Project full title:	Innovative tool to improve risk assessment and promote the safe use of nanomaterials in the textile finishing industry
Reference number:	LIFE12 ENV/ES/000667
Deliverable:	C1 Define starting situation (baseline scenario)
Version:	Final version
Associated Action:	C1
Action leader:	ITENE

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1. Introduction

Present deliverable is developed in the scope of the monitoring action C1 of the Ecotexnano project. The main goal of action C1 of the Ecotexnano project is to define the starting situation as a reference line to monitor the project implementation progress.

With action C1 a base line scenario data was stablished based on different approaches:

- Results of the preparatory actions
- Results from questionnaires sent in the scope of A2, regarding operative conditions and risk management measures applied in the industry when working with nanomaterials
- Results from questionnaires sent in the scope of action C1 regarding knowledge and use on nanomaterials and knowledge on regulation affecting nanomaterials
- Starting degree of knowledge regarding physicochemical properties and human and environmental impact of nanomaterials related with textile industry, exposure and risk characterization.

Stablished base line scenario data involve key human and environmental impacts of the textile industry, focusing in the main goals of the project which will be monitored throughout the actions C2, C3, C4 and C5, for being able to quantify later:

- The improvement obtained of the knowledge on risk assessment of nanomaterials in finished textiles and to promote their safe use;
- The environmental, health and safety impacts of the use of nanomaterials in substitution of bulk substances at finishing textile industry, so potential risks of these nanomaterials on health and environment;
- The definition of best practice and BAT in the application of nano-based techniques comparing with the conventional finishing chemicals;
- The increase of the professional's knowledge base concerning nanomaterials for the further development of human health and environmental EU policy such as REACH, BREF for textile sector, Regulation of biocidal products and CLP Regulation;
- The improvement of the competitiveness of the EU textile sector, obtaining a higher value product, far from low cost textiles that come from outside the EU;
- The exchange of data and disseminate the project results for potential stakeholders such as competent authorities (i.e ECHA, OECD, etc);
- The increase of consumer's awareness on the human, safety and environmental impacts of the textile sector using nanomaterials.

Potential impacts related to risk assessment and the use of chemicals and substances will be assessed during the monitoring actions C2 and C3, while other environmental impacts and implemented good practice and BAT will be monitored by C4. The action C5 is programmed to monitor the progress achieved in relation with socioeconomic aspects.

2. Methodology

Present deliverable C1 of Ecotexnano project is intended to stablish a base line scenario regarding different knowledge areas related with nanomaterials and their use in the textile industry.

In order to stablish such base line scenario different approaches, apart from the study of all information generated during preparatory actions of the Ecotexnano project, were undertaken:

- Surveys to main stakeholders with different developed questionnaires (Knowledge and use of nanomaterials; risk management measures and operational conditions employed; knowledge on regulation affecting nanomaterials).

- Search on reliable scientific databases about knowledge on physicochemical and (eco) toxicological properties and human and environmental exposure and risk assessment and characterization.

2.1. Analysis of recompiled information from surveys

In order to measure the starting degree of knowledge and implementation about the use of materials and substances at the nanoscale in finishing processes of textiles, as well as health, environment and safety, a compendium of questionnaires was developed and distributed among the main target audience of the project, including industrial companies, trade associations, policy makers and other stakeholders. These questionnaires were created in electronic support and sent by email.

Developed questionnaires are presented below:

- Questionnaire created in the scope of A2 action, Sub Task A.2.1.2 “Collection of relevant information on the operational conditions and the existing risk management measures across nanomaterials life cycle”.

- Questionnaire on the use of nanomaterials in textile industry, created in the scope of C1 action.

- Questionnaire on the knowledge on regulation affecting nanomaterials, created in the scope of C1 action.

Figures 1, 2 and 3 show image from employed tool *Surveymonkey* of the developed and distributed questionnaires. In Tables showed in part 3.2. of the present deliverable different formulated questions are presented.

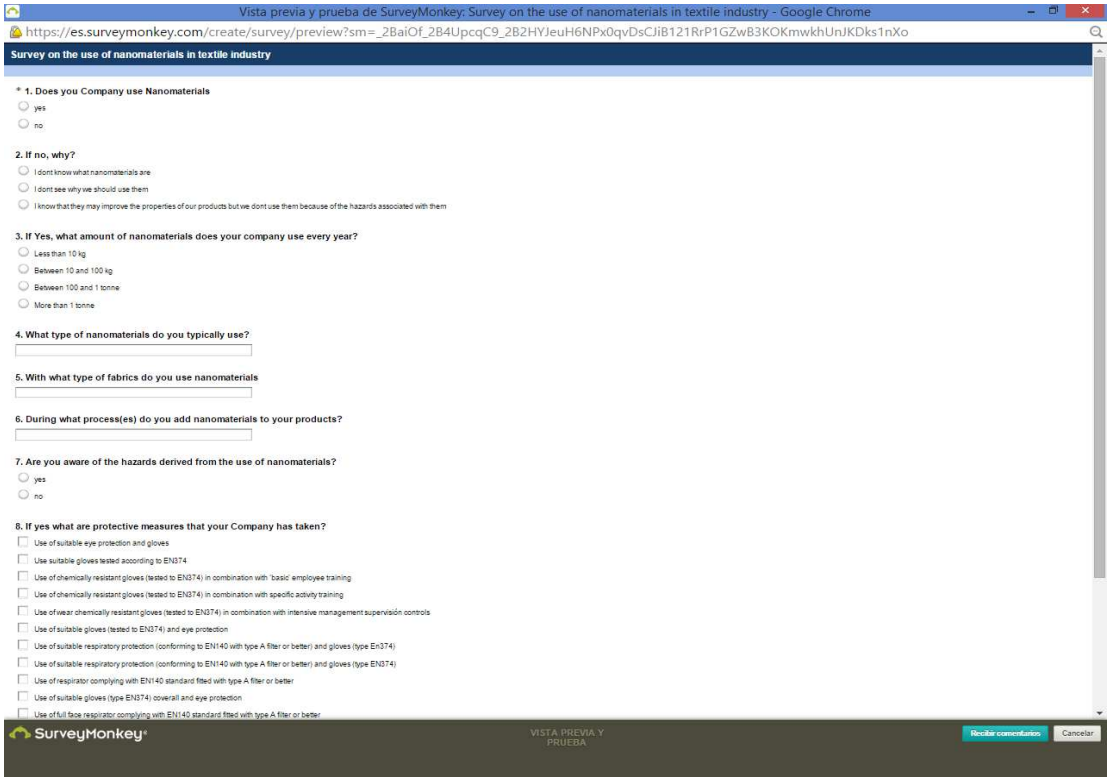

Figure 1. Template of questionnaire "Collection of relevant information on the operational conditions and the existing risk management measures across nanomaterials life cycle" (from A2 action).

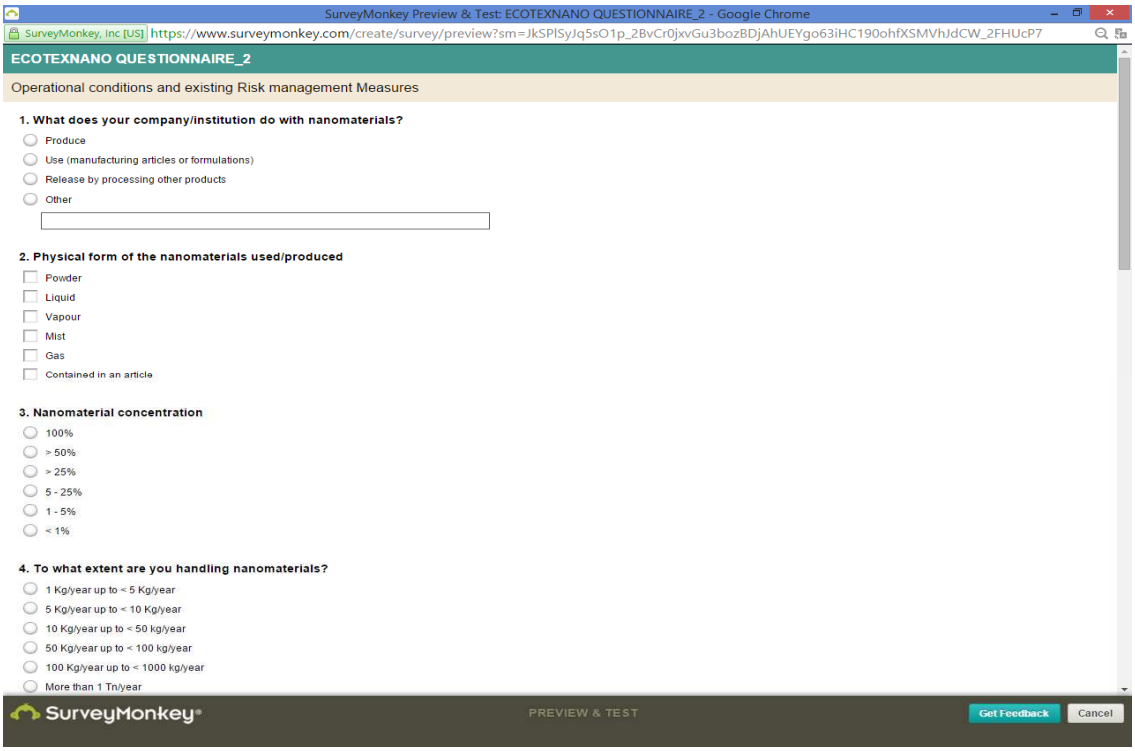

Figure 2. Template of questionnaire "use of nanomaterials in textile industry".

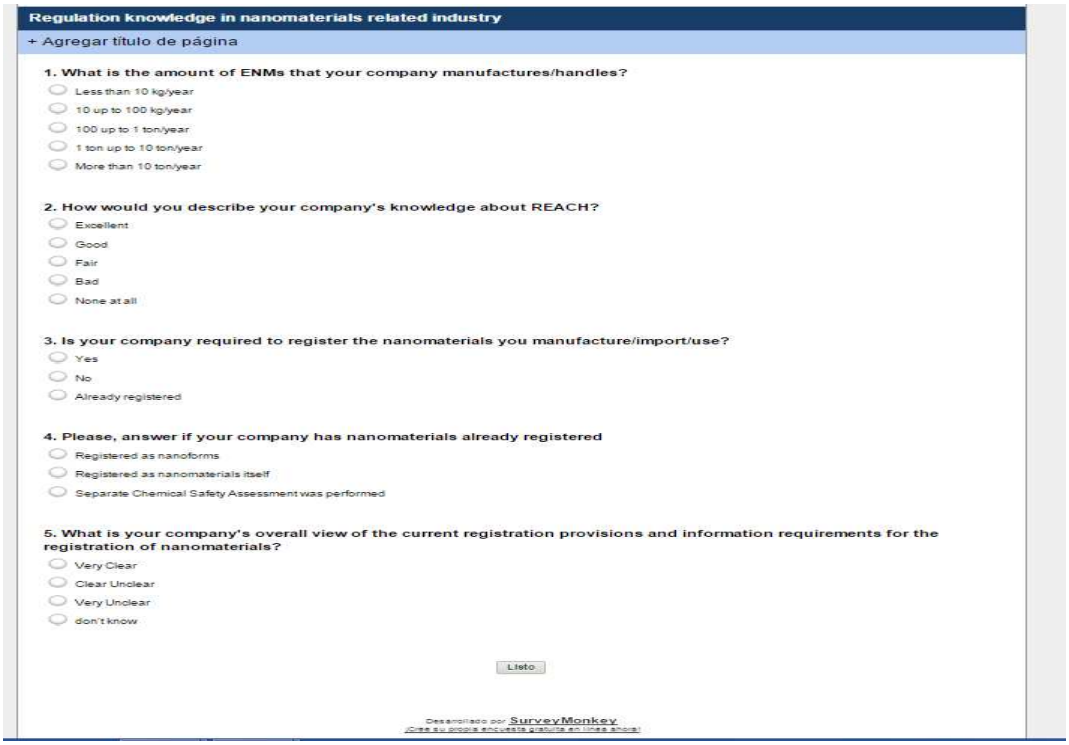

Figure 3. Template of questionnaire "Regulation knowledge in nanomaterials related industry".

2.2. Search on scientific databases

To achieve the objectives of the C1 action, an in depth analysis of existing references from relevant scientific journals, technical publications, related projects, dedicated databases, as well as the new data derived from the project actions was undertaken.

For this task, the platform Web of Science™, from Thomson Routers, was selected in order to monitor advances in knowledge regarding selected nanomaterials as is one of the largest, only true collection of research data, books, journals, proceedings, publications and patents which permit search numerous databases simultaneously via one interface: WEB OF SCIENCE™ CORE COLLECTION, CHINESE SCIENCE CITATION DATABASE, CURRENT CONTENTS CONNECT, DERWENT INNOVATIONS INDEXSM, SCIELO CITATION INDEX or KCI KOREAN JOURNAL DATABASE: insights from research emanating from South Korea. And also an in depth searching on results from main related projects is included.

An in detail explanation of the followed methodology is presented in the deliverable C2 "C2 First Reporting Sheet. Strengthening of the knowledge based on nanomaterials properties and risk assessment". Such strategy for study existing information as base starting point was based on the establishment of different searching "key words" on different interest areas related to nanomaterials and their use in the textile industry, as presented below:

- Physicochemical, toxicological and ecotoxicological properties of nanomaterials: selected key words were:
  - * nano* and textil* and tox*,
  - * nano* and textil* and physico* and chem*,

- * nano* and textil* and ecotox*

- Exposure levels and release potential: selected key words were:
  * nano* and textil* and work* and exposure*,
  * nano* and textil* and release

- Risk ratios when handling nanomaterials (PECs / Exposure): selected key words were:
  * nano* and textil* and risk* and ratio*

And more specifically related with environmental impacts of nanomaterials and textile industry:

- Fate and behaviour in freshwater ecosystems: selected key words were:
  * nano* and textil* and fate and behavior and freshwater

- Fate and behaviour in marine ecosystems: selected key words were:
  * nano* and textil* and fate and behaviour and marine

- Uptake and accumulation of ENMs by whole organisms: selected key words were:
  * nano* and textil* and uptake and accumulation

- Studies on bacteria: selected key words were:
  * nano* and textil* and bacteria

- Studies on freshwater vertebrates (fish): selected key words were:
  * nano* and textil* and fish
-
- Studies on marine organism: selected key words were:
  * nano* and textil* and ecotox* marine*

- Studies regarding toxicity to soil organisms: selected key words were:
  * nano* and textil* and ecotox* and soil*

Studied period of time for the establishment of a base point was fixed from 1993 to 2013, when the Ecotexnano project started, thus covering a period of time of 20 years. Such period of time was considered enough for covering all information references of interest related with nanomaterials properties and risk assessment as mainly is no until the end of the 20th century that research in nanomaterials begun to take importance.

Recompiled data was classified and categorized in order to assess the enhancement of knowledge on the different areas related to the ENMs properties and risk assessment.

3. Analysis of recompiled information and establishment of a base line scenario

3.1. Analysis of information generated during implementation actions

3.1.1. Implementation action A1. State of the art and representative nanomaterials of finished textiles

As it was concluded in deliverable A1 of the Ecotexnano project, nanofinishing can replace traditional finishing agents applied to textile products providing products of higher quality and lower production costs. As a consequence, it is expected that in the next few years nanotechnology will penetrate deeply in the finishing textile sector, and an increasing number of textile companies will invest in the development of processes involving nanotechnology. However, there are still concerns to be taken in consideration before the commercialisation of nanoproducts, such as costs and impacts of uncontrolled release of nanomaterials. Therefore, there is a general need to conduct further investigations to reduce the knowledge gaps in nanomaterials, especially in terms of human health and environmental risks. This will help to understand both the hazards of nanomaterials and potential exposures.

In the state of the art a wide list of nanomaterials have been identified that can provide properties to textiles (e.g. fire resistance, self-cleaning, antibacterial, UV resistance, water repellent, mechanical resistance, etc). However, to date there are only few commercially available nanomaterials with a proven experience to be applied directly to textiles. Many of the nanomaterials sold for the textile sector need to be formulated for an effective performance. One of the major challenges when working with nanoparticles in coating and finishing applications is to obtain a good pre-dispersion of the nanoparticles. These nanoparticles dispersions are often not commercially available or not tailored to textile products. On the other hand, there are nanomaterials that are sold just for research purposes, and not for textile industries.

One of the aims of implementation action A1 was to select four commercially available nanomaterials that provide different selected properties to textiles (antimicrobial, soil release, fire retardant and UV protection) in order to apply in the two pilot scale trials and demonstrate their effectiveness. Different criteria were considered for the selection procedure, such as human health & environmental risks, environmental impacts, performance of nanomaterials, commercial availability, price of nanomaterial, feasibility to be applied in pilot scale trials, level of transferability and availability of data. According these criteria, the four selected nanomaterials were: silver, to provide antibacterial properties; C6 based fluorochemical, to provide soil release properties; clay or silica as a flame retardant (it needs to be formulated during the project as no commercial products are available) and titanium dioxide to provide UV properties.

3.1.2. Implementation action A.2. Information requirements to complete the CSA of NM in the context of REACH and other environmental standards

During A2 action, the different requirements for health and safety assessment under REACH and other environmental regulations affecting nanomaterials were stablished, as reported in deliverable A2. According to that study, nanomaterials neither are nor is it expected to be treated in the future,

differently than any other chemical substance, as the general hazard and risk patterns do not differ from other chemical substances. Nowadays, the European Commission does not consider appropriate to change the rules for when a chemicals safety assessment is required.

At the time of writing, the most common nanomaterials in terms of tonnage and sales have already been registered, such as carbon black and amorphous silica, as they are produced in the high tonnage band. However, the Commission has found that many of the existing registration dossiers for nanomaterials do not explain clearly how specific risks of nanomaterials are addressed, for substances which can occur both in nanomaterial and non-nanomaterial forms. Therefore, it was felt that the regulations need more specific requirements in order to address the properties and risks of these materials. The European Commission is considering to modify some of the technical provisions in the REACH Annexes; a public consultation to that effect closed on 13 September 2013.

The deliverable A2 also identified the gaps in the coverage of nanomaterials under EU environmental legislation and standards, specifying whether the gap is due to nanomaterials not being covered by the objective of the legislation, nanomaterials covered by the objectives but excluded from the scope and nanomaterials being covered but not effectively addressed. The main publications reviewed to complete this document are the following:

- EU Communication "Nanomaterials in REACH": 6th Meeting of the REACH Competent Authorities for the implementation of Regulation (EC) 1907/2006 (REACH)
- Second Regulatory Review on Nanomaterials (COM(2012) 572 final)
- COMMISSION RECOMMENDATION of 18 October 2011 on the definition of nanomaterial
- CLP application to nanomaterials: a specific aspect
- Guidance on Information Requirements and Chemical Safety Assessment : recommendations for NMs
- REACH Implementation Projects on Nanomaterials (RIPoN2 Information requirements and RIPoN3 Chemicals safety assessment)
- Review of Environmental Legislation for the Regulatory Control of Nanomaterials

As key statement, on the basis of the current information launched by the commission, Nanomaterials are regulated by REACH and CLP because they are covered by the definition of a chemical "substance" in REACH. The general obligations in REACH and CLP therefore apply as for any other substance and there are no provisions referring explicitly to nanomaterials.

In the light of current knowledge and opinions of the EU Scientific and Advisory Committees and independent risk assessors, nanomaterials are similar to normal chemicals/substances in that some may be toxic and some may not. Possible risks are related to specific nanomaterials and specific uses. Therefore, nanomaterials require a risk assessment, which should be performed on a case-by-case basis, using pertinent information. Current risk assessment methods are applicable, even if work on particular aspects of risk assessment is still required.

On the other hand, due to the knowledge GAPs on the properties of the rapidly emerging nanomaterials, it is not yet possible to identify any systematic rules for the toxicological characteristics of all nanomaterials.

Regarding the information on the physicochemical, toxicological and ecotoxicological properties are not sufficient to determine the specific properties of nanomaterials, nor to assess how these properties affected their behavior and effects in humans and the environment.

In the near future it is expected the publication of the options to be considered for an adaptation of the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulation when dealing with nanomaterials.

Due to the current lack of knowledge, the CLP Regulation has to be modified as regards thresholds applied as soon as new information on nanomaterials becomes available.

Regarding the environmental regulations, they also cover nanomaterials but different areas should be addressed. In general, threshold values for new pollutants, including nanomaterials whose chemical status can be assessed, should be established. However, there are two challenges with regards to nanomaterials. The first one refers to the difficulty to detect nanomaterials as pollutants by environmental compartments monitoring techniques, due to lack of availability of in situ detection methods for nanomaterials in natural media and technical limitations of currently available methods. And the second challenge refers to the lack of data regarding environmental fate and behaviour of the nanomaterials, which is the needed for the establishment of threshold values for pollutants.

As mentioned in the European Parliament's Resolution of 24 April 2009, there is a need to review waste legislation, emission limit values and environmental quality standards in air and water legislation to adequately address nanomaterials. In general, there is a need to review waste legislation, emission limit values and environmental quality standards in air and water legislation to adequately address nanomaterials. Such regulation revision is being undertaking at the time of writing.

3.1.3. Implementation action A3. Identification of stakeholders and key actors

From A3 implementation action it could be stablished a complete contact list with the target audience to which address the developed questionnaires of the Ecotexnano project, including:

- Suppliers of finishing products
- Chemical companies
- Textil companies
- trade associations,
- policy makers
- and other stakeholders: consumer associations, international organizations, NGO´s

In order to identificate companies and institutions for being surveyed for obtaining an started base scenario, contact list recompilation from Ecotexnano project A3 action was employed as starting point.

3.2. Analysis of recompiled information from surveys

In order to measure the starting degree of knowledge and implementation about the use of materials and substances at the nanoscale in finishing processes of textiles, as well as health, environment and safety, a compendium of questionnaires was distributed among the main target audience of the project, including industrial companies, trade associations, policy makers and other stakeholders.

The three developed questionnaires were created in a electronic support and sent by email. Also telephone call were undertaken in order to improve the company's participation in the survey.

In order to identificate companies and institutions for being surveyed for obtaining an started base scenario, contact list recompilation from Ecotexnano project A3 action was employed as starting point.

But because of the initial low response obtained, contact list was increased. For that, a second in depth searching of partners participating in main projects related with application of nanomaterials in textile industry was undertaken, including chemical companies producing nanomaterials based products intended to be used in textiles. Different platforms were used such as Nanowerk[1], NanoSpain[2] or the project on emerging nanotechnologies[3] European project partners, textile platforms[4] and extension of stakeholders contacts from partners of the project, all of them thematic stakeholders, that is, textile companies that use and incorporate finishing processes based on nanotechnology. Also representative companies such as national and European working with nanoparticles finished based. Most of these companies may be interested in the results to be obtained from the project. Companies of textile finishing included:

• Suppliers of finishing products

• Chemical companies (in general), including producers, importers and suppliers

• Textiles companies (in general)

Finally, a total of **65 completed questionnaires** was accomplished. In the annexed excel file, the recompilation of responses for each question and questionnaire is presented. Also annexed are presented answered questionnaires in a pdf format.

3.2.1. Results from survey regarding the use of nanomaterials in textile industry

This questionnaires was responded by 16 companies. Responses for each formulated question are summarized in Table 1.

Table 1. Responses for survey regarding the use of nanomaterials in textile industry.

Does your Company use Nanomaterials?	
	% of responses
Yes	18.75
No	81.25
If no, why?	
	% of responses
I don't know what nanomaterials are	18.18

[1] http://www.nanowerk.com/
[2] http://www.nanospain.org/
[3] http://www.nanotechproject.org/cpi/products/
[4] http://www.smarttextiles.net

I don't see why we should use them	63.64
I know that they may improve the properties of our products but we don´t use them because of the hazards associated with them	18.18
If Yes, what amount of nanomaterials does your company use every year?	
	% of responses
Less than 10 kg	100.00
Between 10 and 100 kg	0.00
Between 100 and 1 tonne	0.00
More than 1 tonne	0.00
What type of nanomaterials do you typically use?	
	% of responses
Silicon dioxide (SiO2)	0
Titanium dioxide (TiO2)	0
Zinc oxide (ZnO)	0
Aluminium oxide (Al2O3)	0
Diiron trioxide (Fe2O3)	0
Triiron tetraoxide (Fe3O4)	0
Zirconium dioxide (ZrO2)	0
Cerium dioxide (CeO2)	0
Calcium carbonate (CaCO3)	0
Titanium nitride (TiN)	0
Silicon carbide (SiC)	0
Silicon nitride (Si3N4)	0
Gold (Au)	0
Silver (Ag)	33.33
Platinum (Pt)	0
Copper oxide (CuO)	0
Cobalt (Co)	0
Fullerenes	0
Single-wall carbon nanotubes (SWCNT)	0
Multi-wall carbon nanotubes (MWCNT)	0
Carbon black	0
Graphene flakes	0
Graphite	0
Nanodiamonds	0
Nanocellulose	0
Dendrimers	0
Polymer nanoparticles, nanowires, nanorods	0

Nanoclays	0
Quantum dots (CdSe)	0
Nanozeolites	0
Other	66.67
With what type of fabrics do you use nanomaterials	
	% of responses
Plastic	0.00
Natural fibres	0.00
woven	33.33
nonwoven	33.33
other	66.67
During what process (es) do you add nanomaterials to your products?	
	% of responses
Electrospining	50
Coating	50
Other	0
Are you aware of the hazards derived from the use of nanomaterials?	
	% of responses
Yes	71.43
No	28.57
If yes what are protective measures that your Company has taken?	
	% of responses
Use of suitable eye protection and gloves	25
Use suitable gloves tested according to EN374	0
Use of chemically resistant gloves (tested to EN374) in combination with 'basic' employee training	0
Use of chemically resistant gloves (tested to EN374) in combination with specific activity training	0
Use of wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls	25
Use of suitable gloves (tested to EN374) and eye protection	0
Use of suitable respiratory protection (conforming to EN140 with type A filter or better) and gloves (type En374)	50

Use of suitable respiratory protection (conforming to EN140 with type A filter or better) and gloves (type EN374)	0
Use of respirator complying with EN140 standard fitted with type A filter or better	0
Use of suitable gloves (type EN374) coverall and eye protection	0
Use of full face respirator complying with EN140 standard fitted with type A filter or better	0
Use of suitable coveralls to prevent skin exposure	0
Workers wear rubber boots	0
Use of respirator complying with EN 140 filter with type A/P2 filter or better	0
Use of positive pressure air supplied respirator	0
Use of full face respirator complying with EN140 standard with type A/P2 filter or better	0

3.2.2. Results from survey regarding Operational conditions and existing Risk management Measures

This questionnaires was responded by 21 companies. Responses for each formulated question are summarized in Table 2. As formerly mentioned, this questionnaire was created in the scope of action A2 of the project.

Table 2. Responses for survey on the Operational conditions and existing Risk management Measures

1. What does your company/institution do with nanomaterials?	
	% of responses
Produce	19.05
Use (manufacturing articles or formulations)	57.145
Release by processing other products	0
Other	23.81
2. Physical form of the nanomaterials used/produce	
	% of responses
Powder	66.67
Liquid	71.429
Vapour	0
Mist	0
Gas	0
Contained in an article	14.29
3. Nanomaterial concentration	
	% of responses
100%	19.05

> 50%	19.05
> 25%	4.765
5 - 25%	23.81
1 - 5%	23.81
< 1%	9.52
4. To what extent are you handling nanomaterials?	
	% of responses
1 Kg/year up to < 5 Kg/year	52.38
5 Kg/year up to < 10 Kg/year	14.29
10 Kg/year up to < 50 kg/year	4.76
50 Kg/year up to < 100 kg/year	9.52
100 Kg/year up to < 1000 kg/year	9.52
More than 1 Tn/year	4.76
5. Duration of use/exposure	
	% of responses
< 8 h	4.76
< 4 h	33.33
< 1 h	28.57
< 15 minutes	33.33
6. Average numbers of days per week using nanomaterials?	
	% of responses
1	33.33
2	28.57
3	9.52
4	0
5	14.29
6	0
7	4.76
7. Number of employees handling nanomaterials	
	% of responses
<10 employees	90.48
10 up to <50 employees	9.52
50 up to <250 employees	0

250 and more employees	0
8. Technical and organisational conditions and measures	
	% of responses
Basic general ventilation (1-3 air changes per hour)	19.05
Good general ventilation (3-5 air changes per hour)	42.86
Enhanced general ventilation (5-10 air changes per hour)	28.57
Local exhaust ventilation	28.57
Indoor	33.33
Outdoor	0
9. Conditions and measures related to personal protection (PPE used by workers	
	% of responses
Use suitable eye protection and gloves.	66.67
Wear suitable gloves tested to EN374.	23.81
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training.	33.33
Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.	28.57
Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls.	9.52
Wear suitable gloves (tested to EN374) and eye protection.	19.05
Wear suitable respiratory protection (conforming to EN140 with Type A filter or better) and gloves (type EN374) if regular skin contact likely.	33.335
Wear a respirator conforming to EN140 with Type A filter or better.	9.525
Wear suitable gloves (type EN374), coverall and eye protection.	14.29
Wear a full face respirator conforming to EN140 with Type A filter or better.	9.52
Change filter cartridge on respirator daily.	4.76
Use suitable eye protection.	28.57
Wear suitable coveralls to prevent exposure to the skin.	19.05
Wear rubber boots.	19.05

Wear a respirator conforming to EN140 with Type A/P2 filter or better	9.52
Wear positive pressure air supplied respirator if required by safe entry procedures.	4.76
Wear a full face respirator conforming to EN140 with Type A/P2 filter or better.	4.76
10. Environmental protection measures	
	% of responses
All waste water is collected and treated via a WWTP	61.90
Contain and treat vapors from stripping operations	9.52
Dispose of waste or used sacks/containers according to local regulations	80.95
Prevent leaks and prevent soil / water pollution caused by leaks	52.38
Provide a good standard of general ventilation. Natural ventilation is from doors, windows etc. Controlled ventilation means air is supplied or removed by a powered fan	23.81
Other	0

3.2.3. Results from survey regarding Regulation knowledge in nanomaterials related industry

This questionnaires was responded by 28 companies. Responses for each formulated question are summarized in Table 3.

Table 3. Responses for survey on the Regulation knowledge in nanomaterials related industry.

1. What is the amount of ENMs that your company manufactures/handles?	
	% of responses
Less than 10 kg/year	80
10 up to 100 kg/year	10
100 up to 1 ton/year	5
1 ton up to 10 ton/year	0
More than 10 ton/year	5
2. How would you describe your company's knowledge about REACH?	

	% of responses
Excellent	14.29
Good	42.86
Fair	28.57
Bad	10.71
None at all	3.57
3. Is your company required to register the nanomaterials you manufacture/import/use?	
	% of responses
Yes	7.14
No	89.29
Already registered	0
4. Please, answer if your company has nanomaterials already registered	
	% of responses
Registered as nanoforms	0
Registered as nanomaterials itself	14.29
Separate Chemical Safety Assessment was performed	25
5. What is your company's overall view of the current registration provisions and information requirements for nanomaterials?	
	% of responses
	0
Very Clear	14.29
Clear Unclear	21.43
Very Unclear	21.43
don't know	42.86

3.3. Analysis of recompiled information scientific databases

For this task, the platform Web of Science™, from Thomson Routers, was selected in order to monitor advances in knowledge regarding selected nanomaterials as is one of the largest, only true collection of research data, books, journals, proceedings, publications and patents which permit search numerous databases simultaneously via one interface: WEB OF SCIENCE™ CORE COLLECTION, CHINESE SCIENCE

CITATION DATABASE, CURRENT CONTENTS CONNECT, DERWENT INNOVATIONS INDEXSM, SCIELO CITATION INDEX or KCI KOREAN JOURNAL DATABASE: insights from research emanating from South Korea. And also an in depth searching on results from main related projects is included.

An in detail explanation of the followed methodology is presented in the deliverable C2 "C2 First Reporting Sheet. Strengthening of the knowledge based on nanomaterials properties and risk assessment". Such strategy for study existing information as base starting point was based on the establishment of different searching "key words" on different interest areas related to nanomaterials and their use in the textile industry:

- Physicochemical, toxicological and ecotoxicological properties of nanomaterials
- E exposure levels and release potential
- Risk ratios when handling nanomaterials (PECs / Exposure)

And more specifically related with environmental impacts:

- Fate and behaviour in freshwater ecosystems
- Fate and behaviour in marine ecosystems
- Uptake and accumulation of ENMs by whole organisms
- Studies on bacteria
- Studies on freshwater vertebrates (fish)
- Studies on marine organism
- Studies regarding toxicity to soil organisms

Studied period of time for the establishment of a base point was fixed from 1993 to March 2014, when monitoring actions of the Ecotexnano project started, thus covering a period of time of 20 years. Such period of time was considered enough for covering all information references on interest related with nanomaterials properties and risk assessment as mainly is no until the end of the 20th century that research in nanomaterials begun to take importance.

Recompiled data was classified and categorized in order to assess the enhancement of knowledge on different areas related to the ENMs properties and risk assessment.

In the following figures, are represented the number of existing references in the scientific literature for studied key words related with each stablished knowledge area, comparing existing information at each studied period of time from 1993 to 2013, each three years. As can be observed, all areas of knowledge has been improved.

Figures 1 and 2 show results from the study on the enhancement of knowledge on general knowledge areas of nanomaterials in textile applications (figure 4) and of environmental effects of nanomaterials (figure 5) during the last 20 years, from 1993 to 2013.

In figure 4 can be observed as the knowledge on nanomaterials related ith textile applications has increased during the las twenty years, starting the interest in such applications at the beginning of present century. And increasing the most during the last 5 years. A similar behaviour can be observed for environmental impact of nanomaterials related with textile industry knowledge (see figure 5), but with a more accused increment of interest during the last 5 years but with lower number of information references generated.

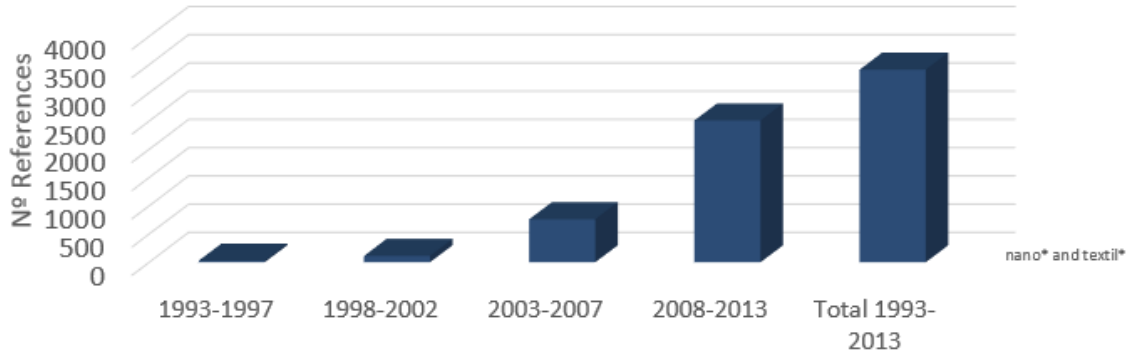

Figure 4. Knowledge evolution on areas related with nanomaterials in textile applications during the last 20 years.

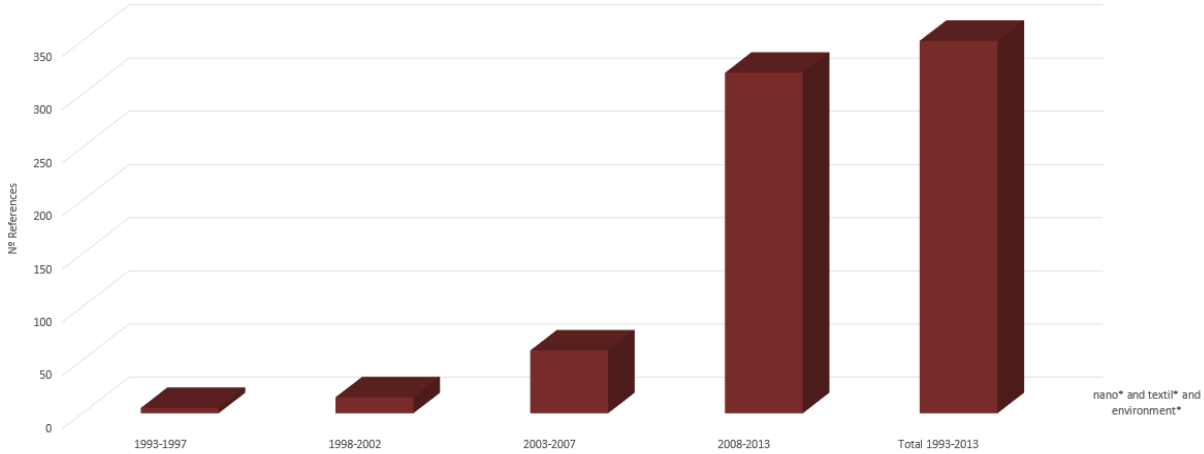

Figure 5. Knowledge evolution on environmental effect of nanomaterials during the last 20 years.

Finally, figures 6 and 7 present the evolution on the knowledge on more specific established areas related to the nanomaterial´s properties and risk assessment, in terms of physicochemical, toxicological, ecotoxicological properties of nanomaterials, fate and behaviour, exposure estimation/characterization and environmental impact assessment, during the last 20 years, from 1993 to 2013.

As can be observed in figure 6, a high increase on knowledge on areas related to the nanomaterials in terms of physicochemical, toxicological, and release properties of nanomaterials has been occurred during the studied period 2008-2013, not the same for ecotoxicity and exposure at work knowledge areas which still needs to be more deeply studied.

Finally, in order to evaluate the advances related specifically with the environmental impacts of nanomaterials on the textile industry, a set of more specific indicators were studied and analysed to quantify the advances in different topics related to behaviour and effects of the nanomaterials in the environment (figure 7). Can be observed in figure 7 that least studied area is the ecotoxicological characterization of the nanomaterials related with textile industry, meanwhile the most studied area regarded their environmental impact is related with their release. And only a low improvement on knowledge is observed, in the area of effects of textile industry related nanomaterials on bacteria. No information is still available for their effect on marine environmental compartment.

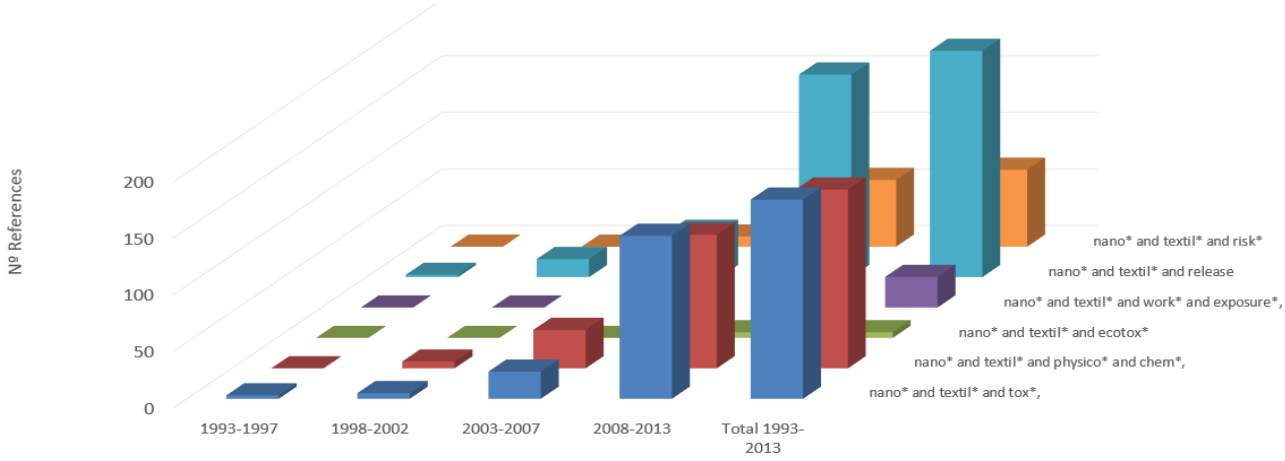

Figure 6. Knowledge evolution on areas related to the nanomaterial´s properties and risk assessment, in terms of physicochemical, toxicological, ecotoxicological properties of nanomaterials.

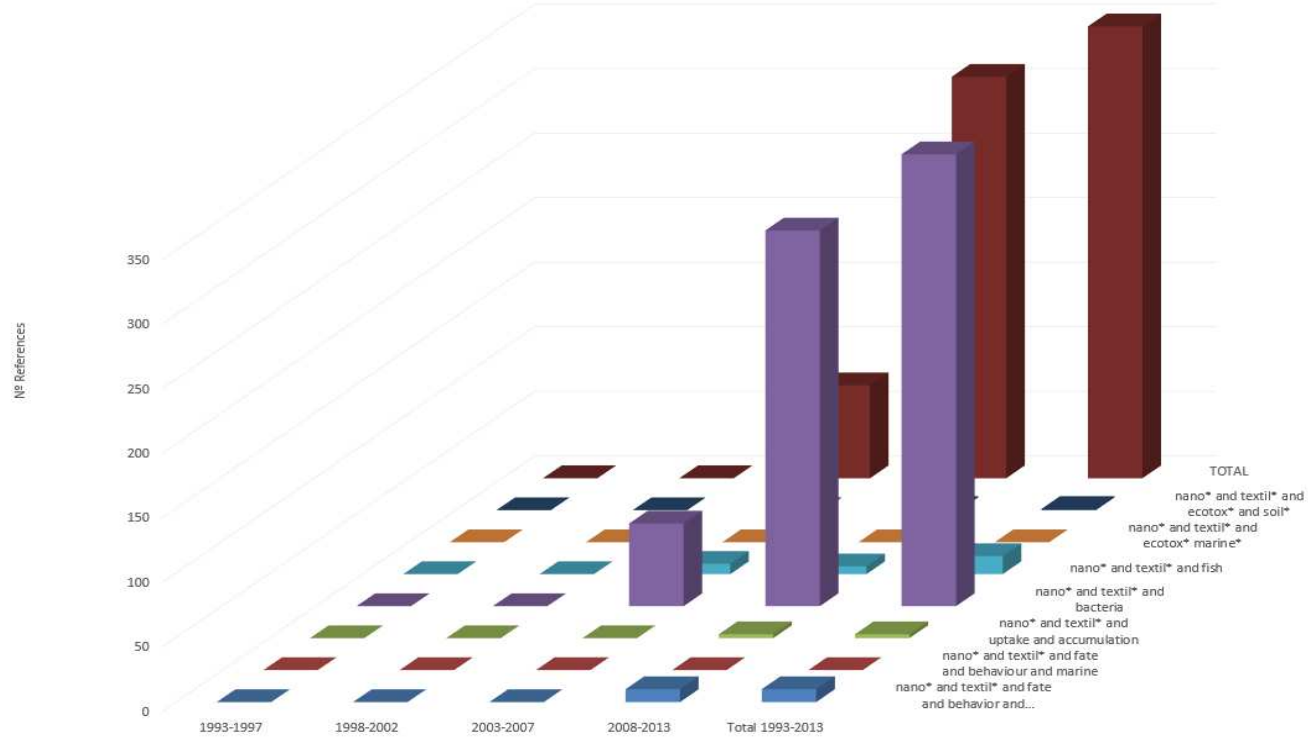

Figure 7. Knowledge evolution on areas related to the nanomaterial´s environmental impact, fate and behaviour.

4. Conclusions

Present deliverable is developed in the scope of the monitoring action C1 of the Ecotexnano project with the main goal of define the starting situation as a reference line to monitor the project implementation progress. The base line scenario data is stablished based on different approaches:

- Results of the preparatory actions
- Results from questionnaires sent in the scope of A2, regarding operative conditions and risk management measures applied in the industry when working with nanomaterials
- Results from questionnaires sent in the scope of action C1 regarding knowledge and use on nanomaterials and knowledge on regulation affecting nanomaterials
- Starting degree of knowledge regarding physicochemical properties and human and environmental impact of nanomaterials related with textile industry, exposure and risk characterization.

As conclusion regarding use of nanomaterials in textile industry, as it was stated in deliverable A1 of the Ecotexnano project, nanofinishing can replace traditional finishing agents applied to textile products providing products of higher quality and lower production costs. As a consequence, it is expected that in the next few years nanotechnology will penetrate deeply in the finishing textile sector, and an increasing number of textile companies will invest in the development of processes involving nanotechnology. But to date, based on information extracted from undertaken questionnaires, only a 20% of surveyed companies related with the textile industry use nanomaterials, and only a 20% still don´t know what a nanomaterial is. And the increase on knowledge on properties of nanomaterials and their possibilities for improving textile products is highly needed as approximately a 20% of surveyed companies are not aware of the improvements nanomaterials can introduce in textile industry and other 20 % are still reticent for using them because the existing lack of knowledge on their hazards.

In the state of the art (presented in deliverable A1) a wide list of nanomaterials have been identified that can provide properties to textiles (e.g. fire resistance, self-cleaning, antibacterial, UV resistance, water repellent, mechanical resistance, etc). However, to date although many chemical companies provide nanomaterials and formulated products based on them, there are only few commercially available nanomaterials with a proven experience to be applied directly to textiles. Many of the nanomaterials sold for the textile sector need still to be formulated for an effective performance. One of the major challenges when working with nanoparticles in coating and finishing applications is to obtain a good pre-dispersion of the nanoparticles. These nanoparticles dispersions are often not commercially available or not tailored to textile products. On the other hand, there are nanomaterials that are sold just for research purposes, and not for textile industries.

As conclusions regarding operative conditions and risk management measures, major part of companies working directly with nanomaterials in textile applications (textile industries) use amounts less than 10 kg for woven and nonwoven applications, in processes such as electrospinning and coating. Silver is one of the most applied nanomaterials with a 30 % of respondents using it, more over as dispersion formulations. The 70% of the companies using nanomaterials are aware of hazards derived from the use of nanomaterials and employ personal protecting equipments such as eye protection and gloves (25%), chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls (25%), and respiratory protection (50%).

When surveying all companies related directly or indirectly with the textile industry, major part of companies are users of nanomaterials and a 20% productors. A 20% are other companies related with nanomaterials covering associations, regulation and standardization official bodies. Most employed

physical form of nanomaterials are powder and liquid, with a concentration on nanomaterial between 50 and 100%. 50% of surveyed companies manipulate 1 Kg/year up to < 5 Kg/year of nanomaterials, most of them from 1 to 2 days a week and with a duration of 15 minutes to 4 hours. 90% of such companies have less than 10 employees working directly with nanomaterials. All companies apply as risk management measures general ventilation, 30% enhanced with 5-10 air changes, but only 30% of them use local exhaust ventilation. Regarding personal protective equipment, all of companies surveyed are equipped with them, most of them eye protection and gloves but only aproximatey 50-60% use respiratory protection. Finally, regarding environmental protection measures, they are in all cases in place. 80 % of surveyed companies dispose waste or used sacks/containers according to local regulations; 62% collect waste water and treated it via a WWTP; 50% prevent leaks and prevent soil / water pollution caused by leaks; 24% provide a good standard of general ventilation but only a 90% contain and treat vapours from stripping operations.

As conclusions regarding legislation regulating nanomaterials it was stated that in the near future it is expected the publication of the options to be considered for an adaptation of the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulation when dealing with nanomaterials. On the other hand, due to the current lack of knowledge on physicochemical, (eco)toxicological, exposure levels and environmental behaviour, the CLP Regulation has to be modified as regards thresholds applied as soon as new information on nanomaterials becomes available. Regarding the environmental regulations, they also cover nanomaterials but different areas should be addressed. In general, there is a need to review waste legislation, emission limit values and environmental quality standards in air and water legislation to adequately address nanomaterials. Such regulation revision is being undertaking at the time of writing.

When companies related with nanomaterials in textile industry where asked about regulation affecting nanomaterials approximately 40 % have a good knowledge on REACH regulation but the other 40 % have a fair to not at all knowledge on REACH. Regarding other regulations affecting registration provisions and information requirements for nanomaterials, approximately 40% of surveyed companies have an unclear knowledge and 40% a don´t know response.

Finally, as conclusion regarding the enhancement of knowledge on the different areas related to the nanomaterials in textile, their properties and effects and risk assessment, can be stated that at the starting point of the Ecotexnano project, not a high knowledge level exists but an acceptable increase of knowledge can be observed for major part of those areas during the last studied period of time 2008-2013.

Area of knowledge that increased the most during the last years, is that of exposure and release estimations followed by physicochemical, toxicological, ecotoxicological properties of nanomaterials, fate and behaviour. A lower initial knowledge can observed for Risk characterization area. But in the case of environmental impacts of nanomaterials related with the textile industry, a very low level of knowledge exists, and only the number of studies on bacteria is increased, followed in a very lower amount by number of studies on freshwater vertebrates (fish).