PROCESSI DI PRODUZIONE E ADVANCED MANUFACTURING ISIA-Firenze

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- Knowledge and fundaments for a responsible design
- Materials Overview
- Suggestions

Shoes have a large environmental impact; every year we produce 21.000.000.000 pair of shoes worldwide and 95% of those ends up in the landfill. Such massive production of shoes is linked with high CO_2 emissions, enormous water consumption and the use of highly toxic products. A vast shift towards sustainability is a must. Yet, most fashion houses tend to focus on formal developments, rather than on process and material innovation, giving sustainable solutions the cold shoulder.
To research on such subject and in order to identify valuable alternatives but…

Do You Know the difference between

SUSTAINABLE,
ECOLOGIC,
ECOFRIENDLY?

SUSTAINABLE DEVELOPMENT IS A NOBLE AND NECESSARY ASPIRATION.
IT IS A VISIONARY DEVELOPMENT PARADIGM

The term, sustainable development, was popularized in Our Common Future , a report published by the World Commission on Environment and Development (WCED) in 1987.
Also known as the **Brundtland report**, Our Common Future included the "classic" definition of sustainable development:

"development which meets the needs of the present without compromising the ability of future generations to meet their own needs"

in 1992 leaders set out the principles of sustainable development at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, also referred to as the Rio Summit and the Earth Summit

AGENDA: LIST OF THINGS TO BE DONE (FROM LATIN VERB *AGO* = TO DO, TO MAKE)



THE 17 GOALS FOR AGENDA 2030



- the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and

- the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

Know the difference

ECO

The term “eco” is not regulated, so while the label may make “green” claims, that eco product may be filled with chemicals.

NATURAL

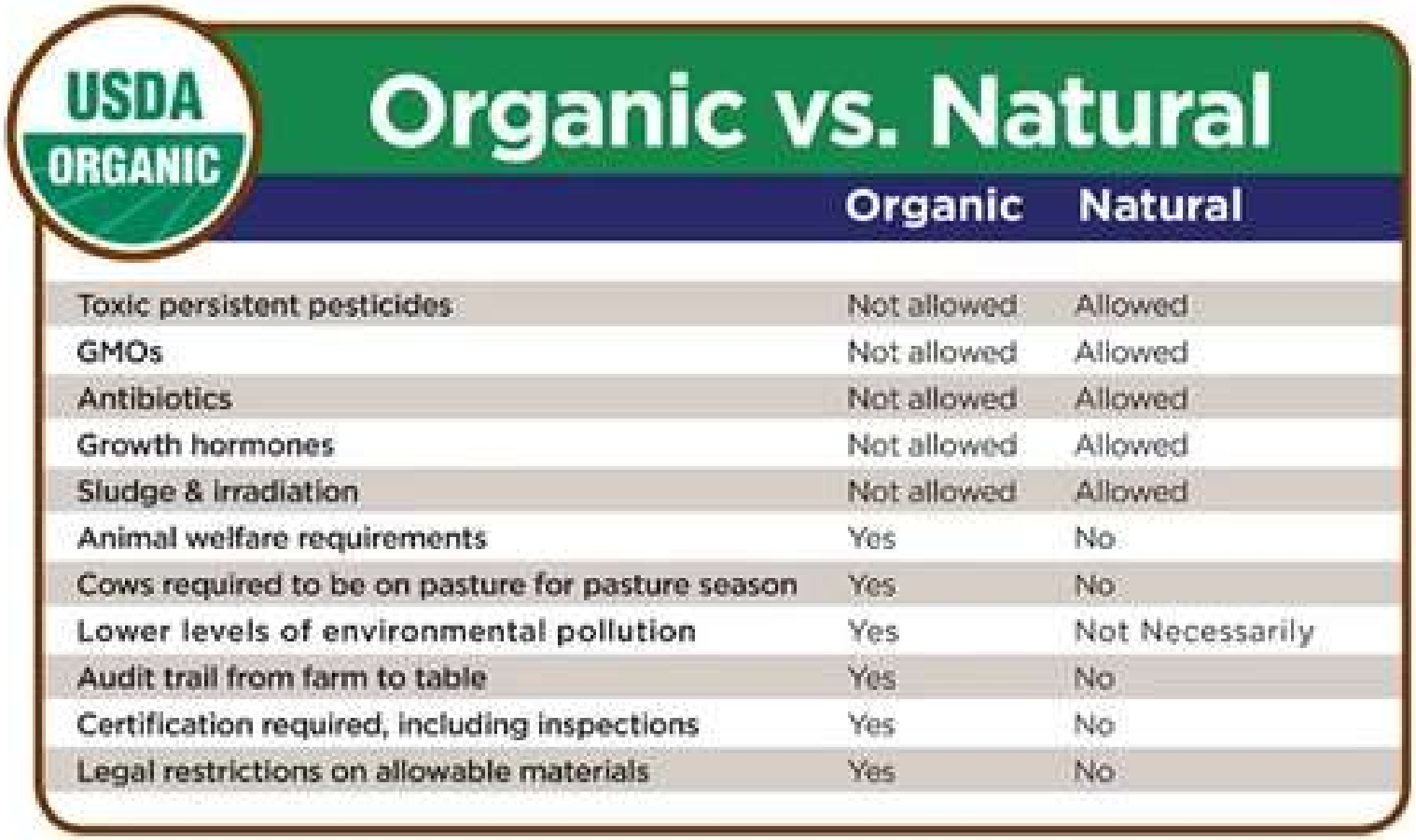
Basically the term is vague, as it assures nothing. The term “natural” is not regulated by the FDA, if a product has even a small amount of natural ingredients, a company can slap a “natural” label on it

ORGANIC

Regulated by the FDA, organic products like organic makeup are certified and tested. The ingredients in these products are organically farmed and are always guaranteed to be pesticide-free and not genetically modified. If the products want to be deemed as strictly organic, the product has to be made of 95% organic ingredients.
I.E. Organic cotton

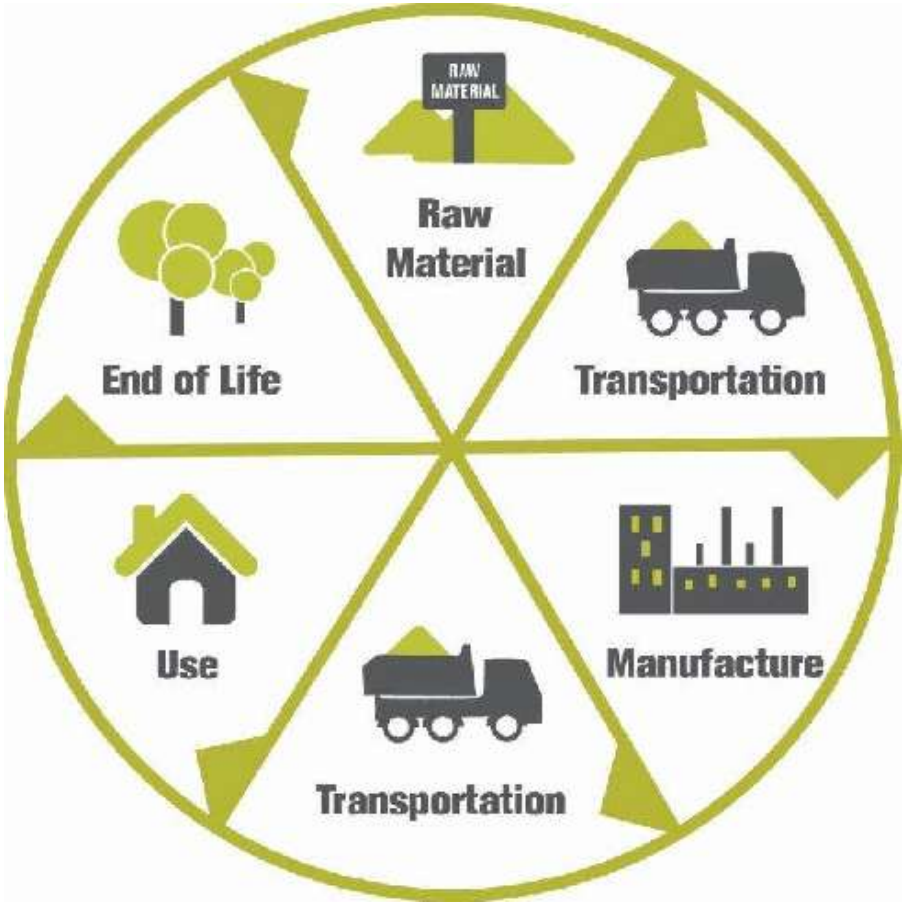
BIO

These terms do not mean that the products are of organic origin. If the terms “naturally pure” or “natural” are used, this means that the products neither additives nor residues of crop protection products or animal pharmaceuticals and that they have no been irradiated (to expose food to electromagnetic radiation to kill bacteria and delay spoilage). However, this does not mean that they were grown organically.



	Organic	Natural
Toxic persistent pesticides	Not allowed	Allowed
GMOs	Not allowed	Allowed
Antibiotics	Not allowed	Allowed
Growth hormones	Not allowed	Allowed
Sludge & irradiation	Not allowed	Allowed
Animal welfare requirements	Yes	No
Cows required to be on pasture for pasture season	Yes	No
Lower levels of environmental pollution	Yes	Not Necessarily
Audit trail from farm to table	Yes	No
Certification required, including inspections	Yes	No
Legal restrictions on allowable materials	Yes	No

LIFE CYCLE ASSESSMENTS, CARBON & WATER FOOTPRINTS

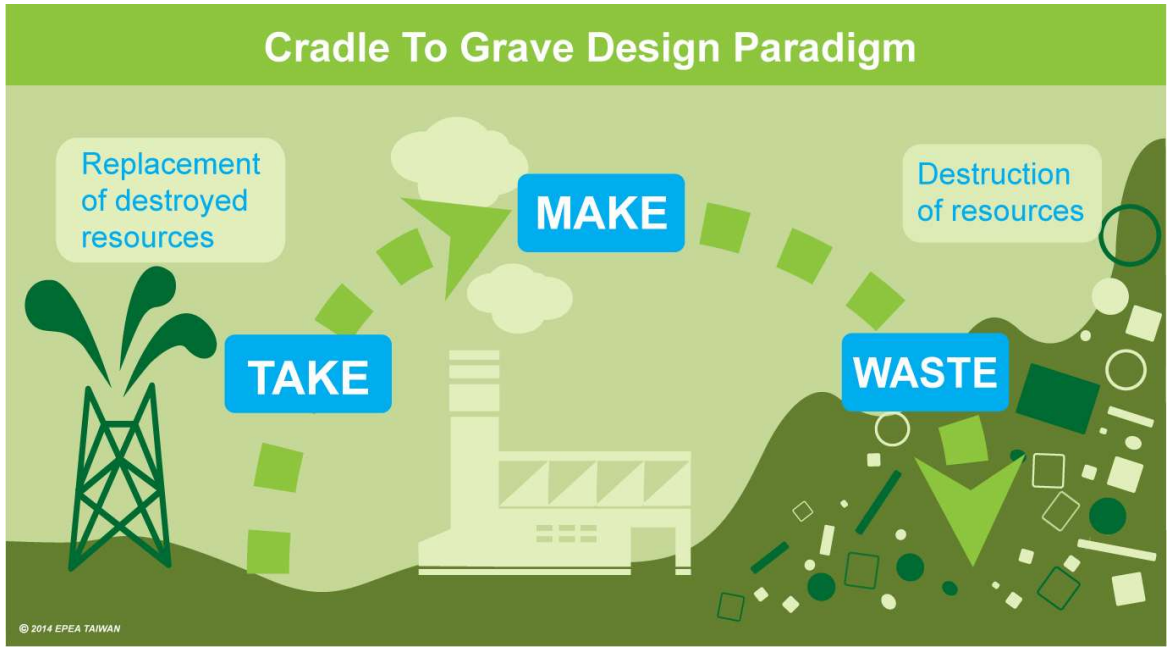


LCA

LIFE CYCLE ASSESSEMENT IS A TECHNIQUE TO EVALUATE THE ENVIRONMENTAL IMPACT ASSOCIATED WITH THE LIFE OF A PRODUCT OR SERVICE :

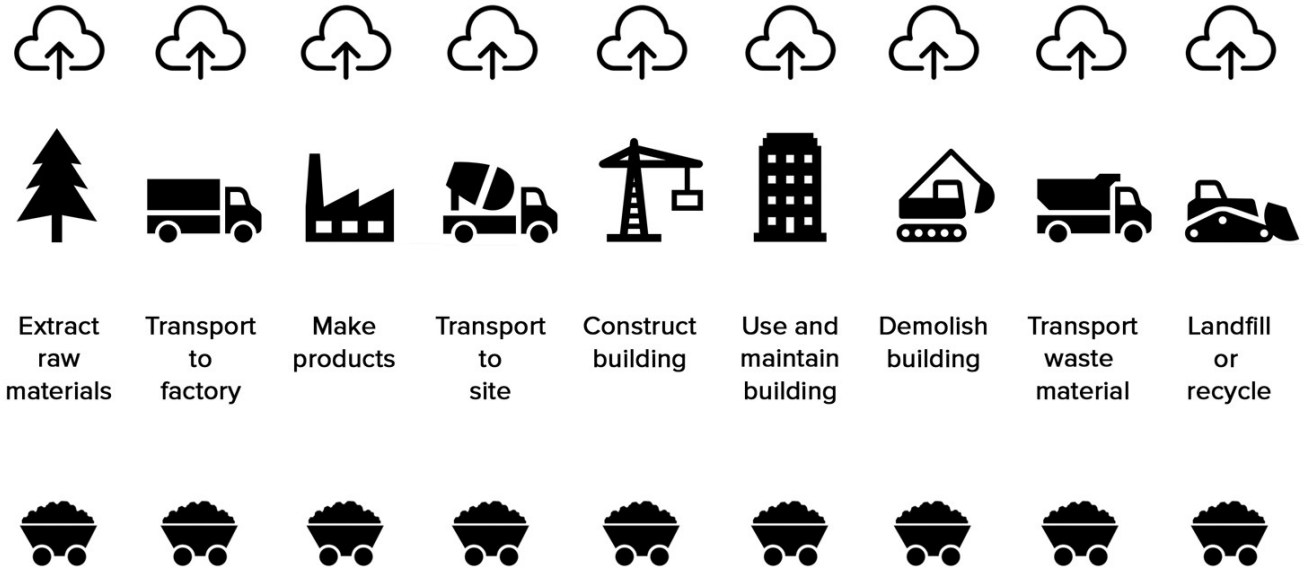
FROM **CRADLE** TO **GRAVE**.

Life-cycle assessment or life cycle assessment (LCA, also known as life-cycle analysis) is a methodology for assessing environmental impacts associated with all the stages of the life-cycle of a commercial product, process, or service. For instance, in the case of a manufactured product, environmental impacts are assessed from raw material extraction and processing (cradle), through the product's manufacture, distribution and use, to the recycling or final disposal of the materials composing it (grave).
An LCA study involves a thorough inventory of the energy and materials that are required across the industry value chain of the product, process or service, and calculates the corresponding emissions to the environment.[2] LCA thus assesses cumulative potential environmental impacts. The aim is to document and improve the overall environmental profile of the product



A livello internazionale la metodologia LCA è regolamentata dalle norme ISO della serie 14040's in base alle quali uno studio di valutazione del ciclo di vita prevede: la definizione dell'obiettivo e del campo di applicazione dell'analisi (ISO 14041), la compilazione di un inventario degli input e degli output di un determinato sistema (ISO 14041), la valutazione del potenziale impatto ambientale correlato a tali input ed output (ISO 14042) e infine l'interpretazione dei risultati (ISO 14043).

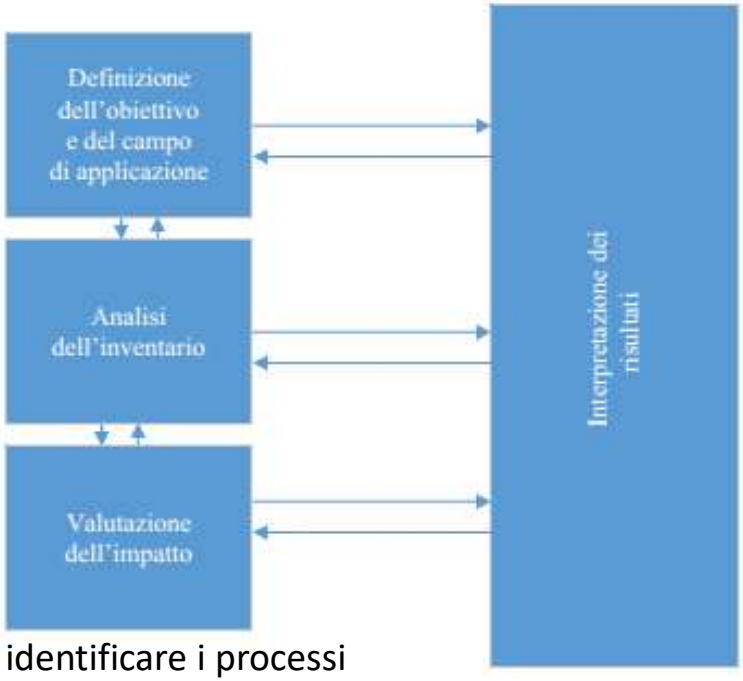
A livello europeo l'importanza strategica dell'adozione della metodologia LCA come strumento di base e scientificamente adatto all'identificazione di aspetti ambientali significativi è espressa chiaramente all'interno del Libro Verde COM 2001/68/CE e della COM 2003/302/CE sulla Politica Integrata dei Prodotti, ed è suggerita, almeno in maniera indiretta, anche all'interno dei Regolamenti Europei: EMAS (Reg. 1221/2009) ed Ecolabel (Reg. 61/2010).



L’analisi del ciclo di vita è un processo iterativo che comprende quattro fasi principali:

- definizione dell’obiettivo e del campo di applicazione
- analisi di inventario (LCI, in inglese Life Cycle Inventory)
- valutazione dell’impatto (LCIA, in inglese Life Cycle Impact Assessment)
- interpretazione

Durante lo svolgimento dell’analisi si rendono via via disponibili informazioni che permettono di affinare, e se necessario revisionare, ciascuna delle fasi che la caratterizzano



Quando si decide di effettuare l’analisi LCA di un prodotto, bisogna innanzitutto identificare i processi coinvolti nel ciclo di vita di ciascun componente del prodotto e del suo packaging. Generalmente, l’analisi considera:

Estrazione e fornitura materie prime
Produzione
Imballaggio
Trasporto dal sito di produzione al punto vendita
Utilizzo
Smaltimento del prodotto e del packaging

•**Definizione degli obiettivi e campo di applicazione**: vengono definite gli obiettivi dello studio, l'unità funzionale (misura o quantità di prodotto presa come riferimento per l'analisi dell'impatto), i confini del sistema (ampiezza del sistema considerato).

•**Inventario**: è la fase in cui vengono quantificati gli input e le relative emissioni, per ciascuna fase del ciclo di vita.

•**Valutazione degli impatti**: le informazioni ottenute durante la fase di inventario vengono classificate ed aggregate nelle diverse categorie di impatto.

•**Interpretazione dei risultati**: le informazioni e i risultati ottenuti vengono interpretati, per poi tradursi in raccomandazioni e interventi per la riduzione dell'impatto ambientale.

A cosa serve?

Studiando nel dettaglio ogni aspetto relativo a ciascun componente del prodotto, la LCA permette di sviscerare la complessità dell'intero ciclo di vita, permettendo così di individuare quali sono le fasi maggiormente impattanti e che necessitano di interventi. La LCA, quindi, può essere considerata una guida per il miglioramento dei prodotti esistenti e per la creazione di nuovi.
Inoltre, i risultati della LCA possono essere utilizzati per confrontare prodotti simili oppure diversi ma con la stessa funzione, per richiedere certificazioni ambientali e per comunicare la prestazione ambientale del prodotto.

CARBON FOOTPRINT



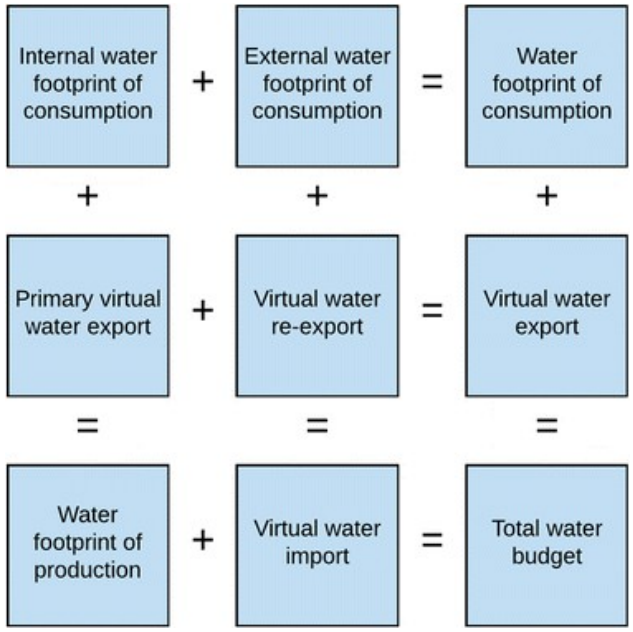
A **carbon footprint** is the total set of greenhouse gas emissions caused by an organization, event, product or person. They are called greenhouse gases because they absorb infrared radiation in the atmosphere, creating a "greenhouse effect" that contributes to global warming. They include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). Greenhouse gases were attributed a coefficient for their global warming potential (GWP) by the Intergovernmental Panel on Climate Change. They are expressed as CO_2e (e means 'equivalent') by multiplying their weight with the GWP value.

https://www.carbonfootprint.com/calculator.aspx

WATER FOOTPRINT

The water footprint is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in terms of water volumes consumed (evaporated or incorporated into a product) and/or polluted per unit of time.



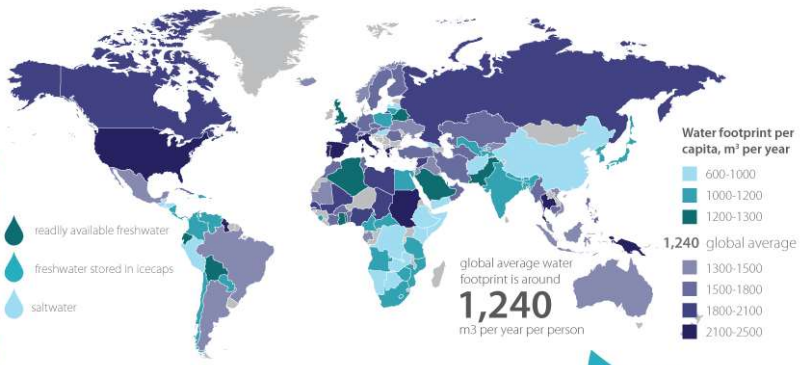


https://waterfootprint.org/

the global water footprint

US Infrastructure
www.americainfra.com

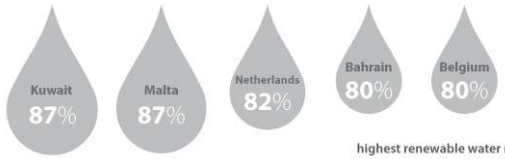
The 'water footprint' of a country is defined as the volume of water needed for the production of goods and services consumed by the inhabitants of the country.



amount of freshwater available



countries most dependent on water imports





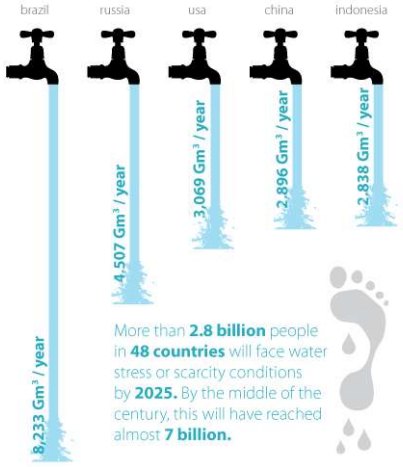
70%
of existing freshwater is withdrawn for irrigation in agriculture

the highest water footprints per capita



united states	greece	malaysia	italy	thailand
19%	**35%**	**28%**	**51%**	**8%**
import dependency	import dependency	import dependency	import dependency	import dependency

highest renewable water resources



water footprint of different foods



24,000 litres	**15,500** litres	**4,400** litres	**1,500** litres	**140** litres
1kg of chocolate	1kg of beef	1kg of olives	1kg of sugar	1 cup of coffee

More than **2.8 billion** people in **48 countries** will face water stress or scarcity conditions by **2025.** By the middle of the century, this will have reached almost **7 billion.**

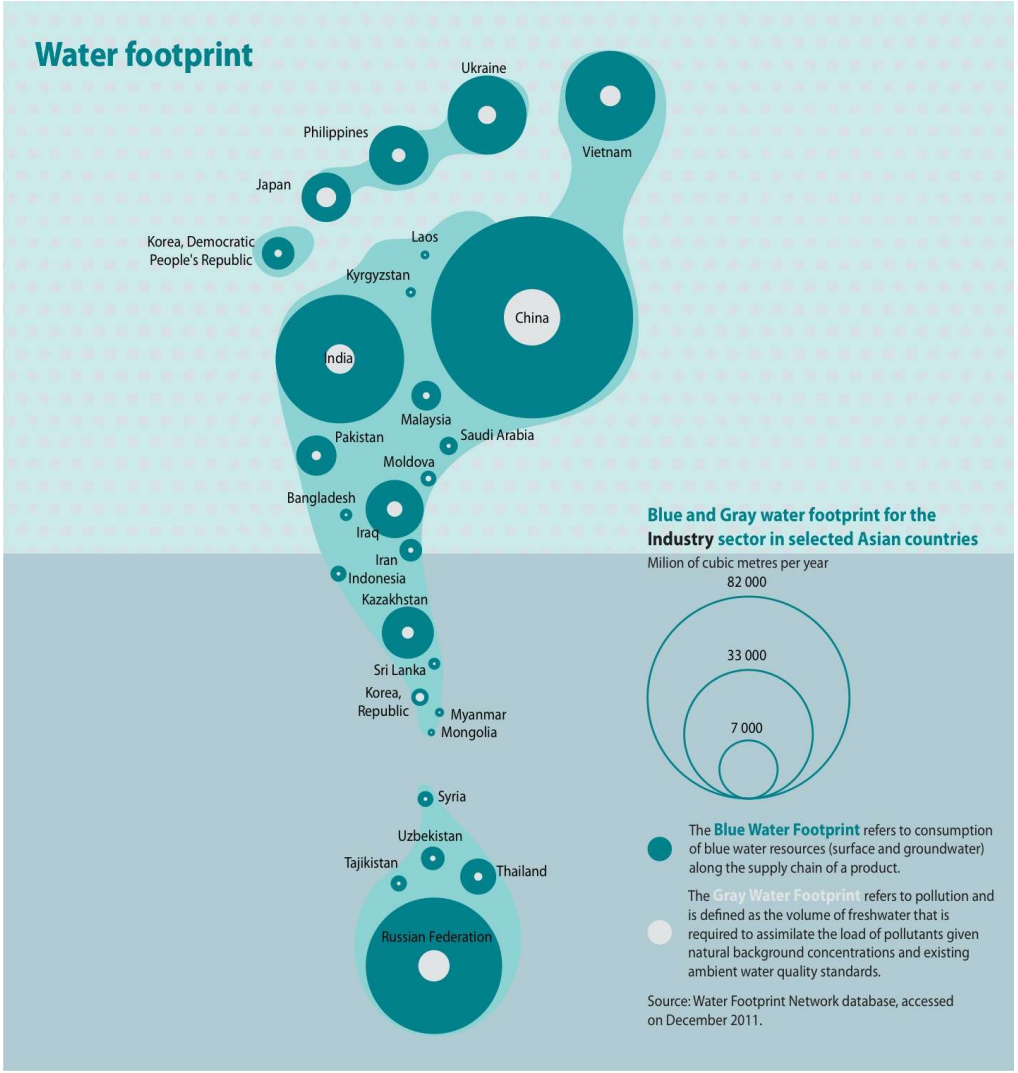
Source: WaterFootprint.org and WWF

The water footprint of a product is divided into three fractions, each of which identified by a different color: green, blue and gray.

The **green** element refers to the consumption of water contained in plants and soil in the form of moisture, without being part of any surface or body of groundwater. One example is rain water, provided that it does not stagnate in the soil and is able to filter into the ground. This element also includes the value of non-irrigated agriculture in terms of saving the blue element.

The **blue** element refers to the consumption of surface water resources and groundwater throughout the production chain of a particular product. In terms of consumption, it refers to the volume of water used and then evaporated or incorporated into a product; from either surface or groundwater, that is not returned to the reservoir from which it is drawn.

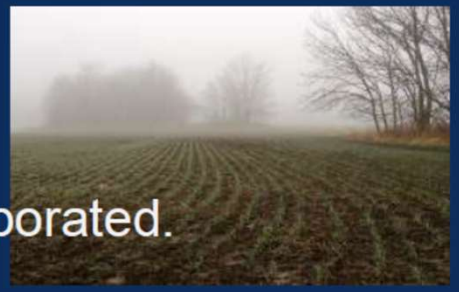
The **gray** element refers to the pollution of water resources and is defined as the volume of fresh water needed to dilute the pollutant load generated by a given process, so as to maintain unchanged the concentrations naturally present and the quality standards of the water from its original source.



The water footprint of a product

Green water footprint

- volume of rainwater evaporated.





Blue water footprint

- volume of surface or groundwater evaporated.



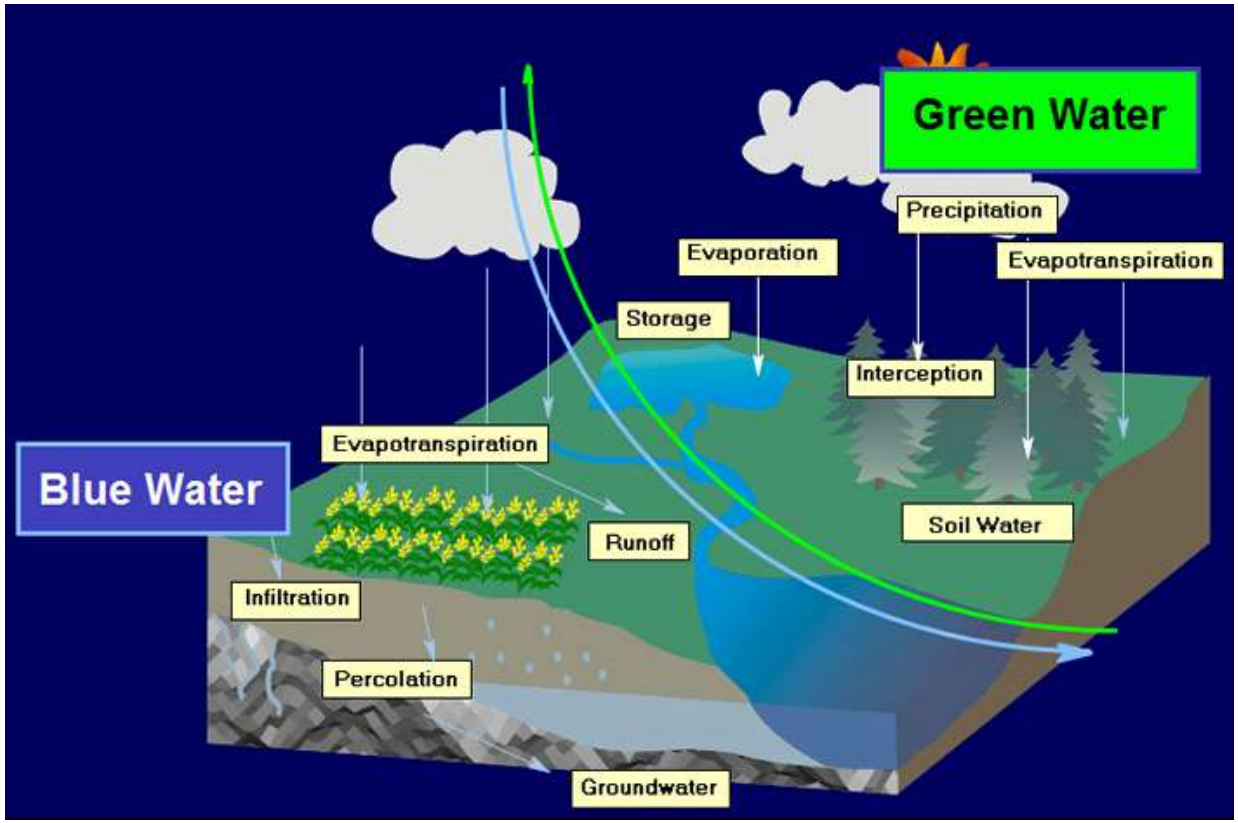


Grey water footprint

- volume of polluted water.





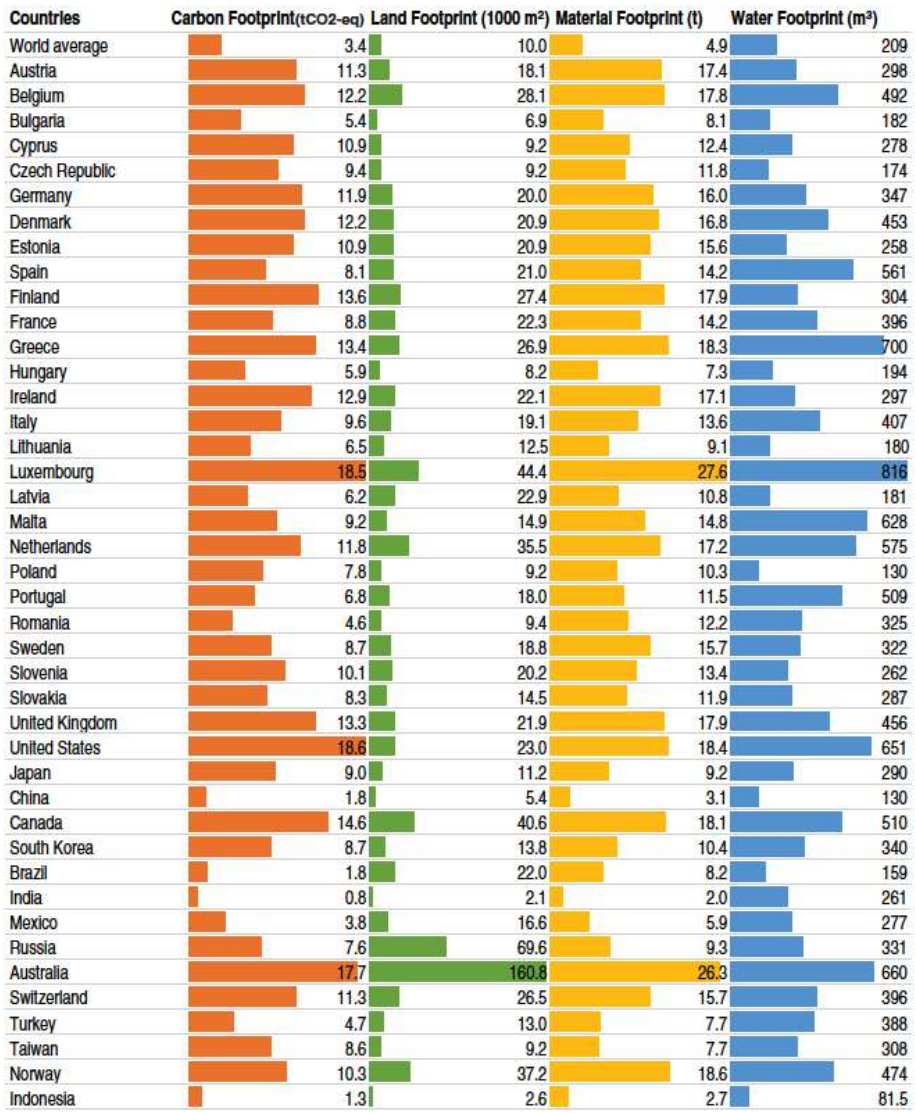


"Blue water" is the amount of rainfall that enters lakes, rivers and groundwater. This is the main source of water that we use and manage for industrial, domestic and irrigation purposes. Only 30-35% of all water within the hydrological cycle is blue water.

"Green water" is the amount of rainfall that is either intercepted by the vegetation, or enters the soil and is picked up by plants and evapotranspired back into the atmosphere. Some 65% of all rain water is cycled through the green water cycle and is the water source for rainfed agriculture.

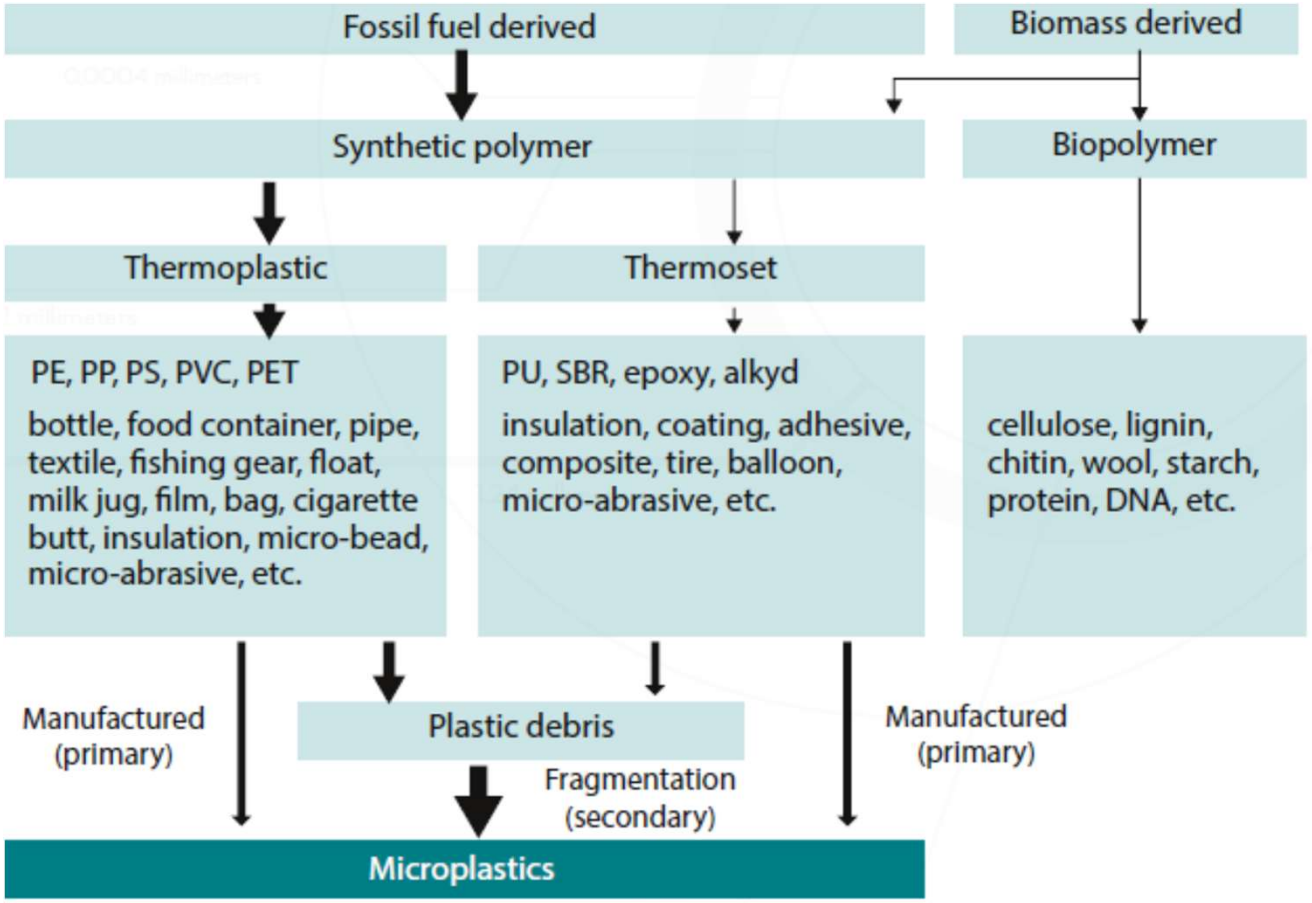
Water footprint of passenger transport when fueled with bio-energy

Transport mode	Energy source	Crop source	WF (litre per passenger km)		
			Green	Blue	Total
Airplane	Biodiesel	Rapeseed	133-278	103-214	236-492
	Bio-ethanol	Sugar beet	32-66	34-71	65-136
Car	Biodiesel	Rapeseed	61-200	47-154	109-355
	Bio-ethanol	Sugar beet	18-102	19-111	36-212
Bus	Biodiesel	Rapeseed	63-87	48-67	111-154
	Bio-ethanol	Sugar beet	15-21	16-22	31-43
Train	Bio-electricity	Maize	3-9	4-10	8-19
Electric car	Bio-electricity	Maize	5-6	6-7	11-13
Walking	Sugar	Sugar beet	2.1	2.3	4.4
Bike	Sugar	Sugar beet	0.8	0.9	1.7

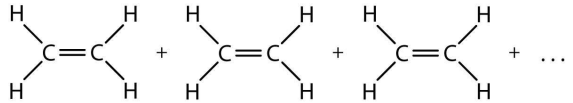


Countries	Carbon Footprint(tCO2-eq)	Land Footprint (1000 m²)	Material Footprint (t)	Water Footprint (m³)
World average	3.4	10.0	4.9	209
Austria	11.3	18.1	17.4	298
Belgium	12.2	28.1	17.8	492
Bulgaria	5.4	6.9	8.1	182
Cyprus	10.9	9.2	12.4	278
Czech Republic	9.4	9.2	11.8	174
Germany	11.9	20.0	16.0	347
Denmark	12.2	20.9	16.8	453
Estonia	10.9	20.9	15.6	258
Spain	8.1	21.0	14.2	561
Finland	13.6	27.4	17.9	304
France	8.8	22.3	14.2	396
Greece	13.4	26.9	18.3	700
Hungary	5.9	8.2	7.3	194
Ireland	12.9	22.1	17.1	297
Italy	9.6	19.1	13.6	407
Lithuania	6.5	12.5	9.1	180
Luxembourg	18.5	44.4	27.6	816
Latvia	6.2	22.9	10.8	181
Malta	9.2	14.9	14.8	628
Netherlands	11.8	35.5	17.2	575
Poland	7.8	9.2	10.3	130
Portugal	6.8	18.0	11.5	509
Romania	4.6	9.4	12.2	325
Sweden	8.7	18.8	15.7	322
Slovenia	10.1	20.2	13.4	262
Slovakia	8.3	14.5	11.9	287
United Kingdom	13.3	21.9	17.9	456
United States	18.6	23.0	18.4	651
Japan	9.0	11.2	9.2	290
China	1.8	5.4	3.1	130
Canada	14.6	40.6	18.1	510
South Korea	8.7	13.8	10.4	340
Brazil	1.8	22.0	8.2	159
India	0.8	2.1	2.0	261
Mexico	3.8	16.6	5.9	277
Russia	7.6	69.6	9.3	331
Australia	17.7	160.8	26.3	660
Switzerland	11.3	26.5	15.7	396
Turkey	4.7	13.0	7.7	388
Taiwan	8.6	9.2	7.7	308
Norway	10.3	37.2	18.6	474
Indonesia	1.3	2.6	2.7	81.5

Polymers and BioPolymers



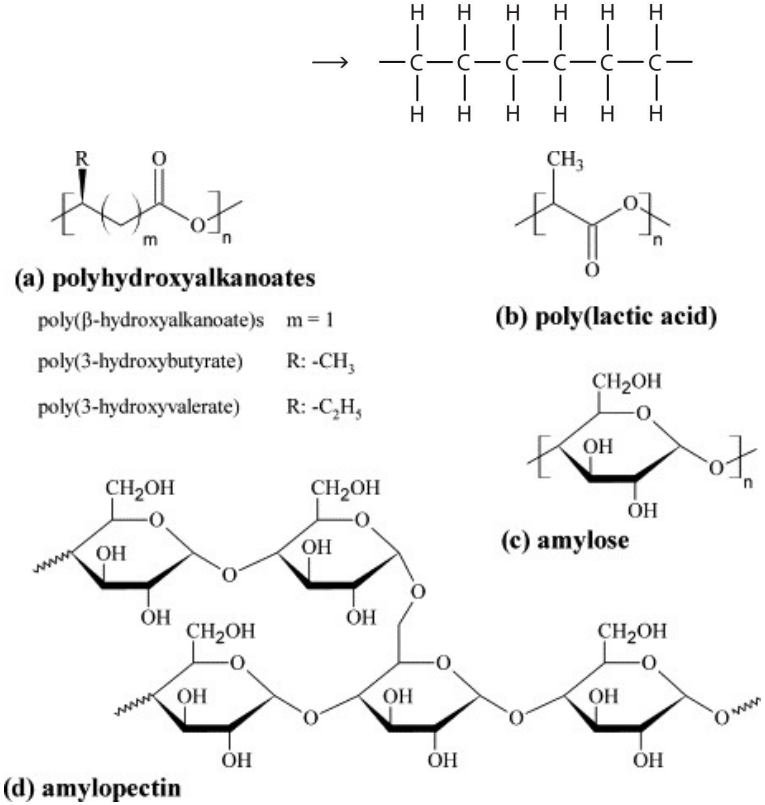
A *POLYMER* IS A LARGE MOLECULE, OR MACROMOLECULE, COMPOSED OF MANY REPEATED SUBUNITS. DUE TO THEIR BROAD RANGE OF PROPERTIES, BOTH SYNTHETIC AND NATURAL



Difference between Biopolymers and Synthetic Polymers

Major difference can be identified by their structure. All polymers are composed of monomers, the repetitive units. Lignocellulose is a biopolymer with a finite structure. In proteins, primary structure consists of specific chemical composition and all units are arranged in sequence. Numerous biopolymers naturally folds into compact shapes which defines biological functions.

Relatively synthetic polymers are simple and arbitrary structures. Their synthesis is regulated through template-directed process, this factor may point to the molecular mass distribution that is not found in biopolymers.



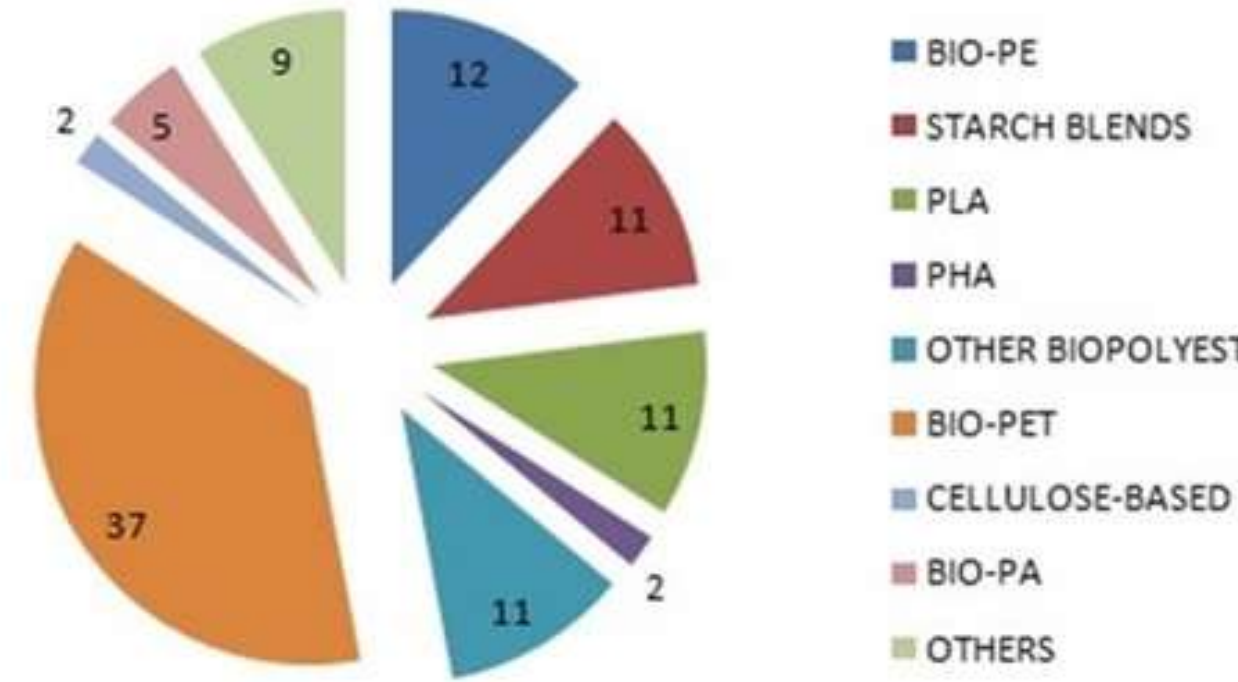
BioPolymers in Textile

there are three ways to produce biopolymers:

Polymers directly extracted or removed from biomass such as some polysaccharides and proteins. There may be partial modification of natural bio-based polymers (e.g., starch)

Polymers produced by microorganisms (fermentation) or genetically modified bacteria such as followed by polymerization or direct bacterial fermentation processes (e.g., polyhydroxyalkanoates).

Polymers produced by classical chemical synthesis starting from renewable bio-based monomers such as polylactic acid (PLA).



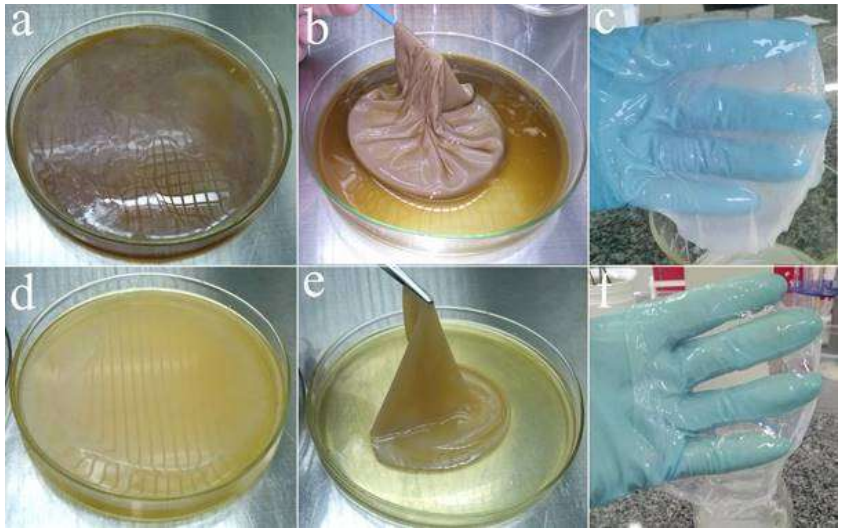
Degradation	The partial or complete breakdown of a polymer as a result of e.g. UV radiation, oxygen attack, biological attack. This implies alteration of the properties, such as discolouration, surface cracking, and fragmentation
Biodegradation	Biological process of organic matter, which is completely or partially converted to water, CO_2/methane, energy and new biomass by microorganisms (bacteria and fungi).

Compostable	Capable of being biodegraded at elevated temperatures in soil under specified conditions and time scales, usually only encountered in an industrial composter (standards apply)
Oxo-degradable	Containing a pro-oxidant that induces degradation under favourable conditions. Complete breakdown of the polymers and biodegradation still have to be proven.

Mineralisation	Defined here, in the context of polymer degradation, as the complete breakdown of a polymer as a result of the combined abiotic and microbial activity, into CO_2, water, methane, hydrogen, ammonia and other simple inorganic compounds

Bacterial cellulose

Biocellulose is a strong polymer consisting of nanofibrillar structures causing a large specific surface area and a microporous structure. This, in turn, creates ample opportunities for its modification, and, consequently, the production of various composite materials with significantly better characteristics.

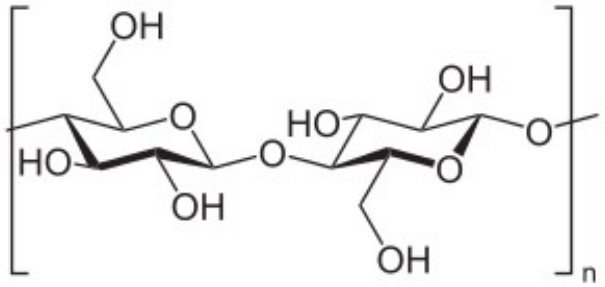




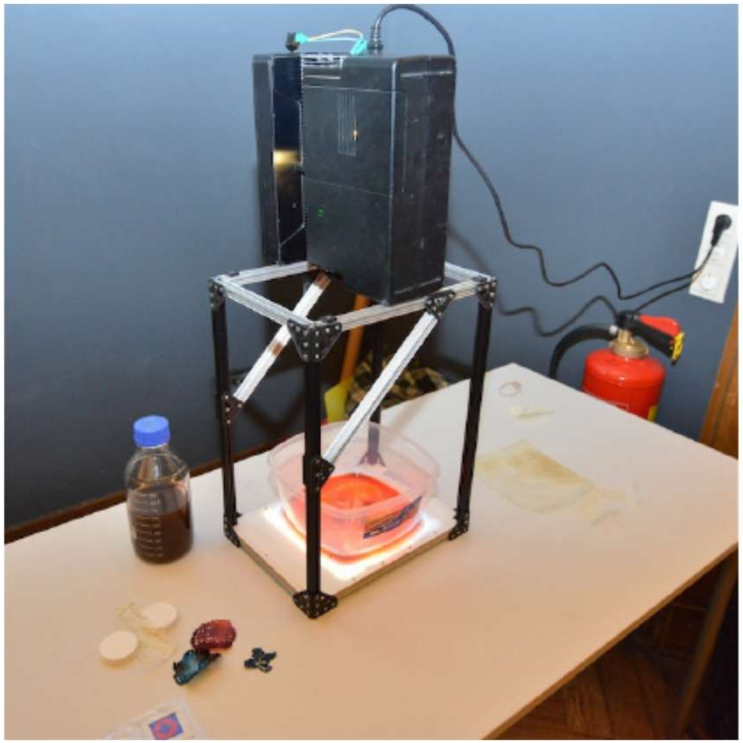
Suzanne Lee, who is working on the Bio-Couture project, recently talked about her work and how she grows and makes clothes from the Kombucha culture. The project, called Bio-Couture, explores the use of bacterial cellulose grown in the laboratory for the production of clothing.







JuicyPrint will be a 3d printer that can be fed with fruit juice and can be used to print out useful shapes made of bacterial cellulose, a strong and exceptionally versatile biopolymer.



The heart of JuicyPrint is our genetically engineered strain of the cellulose producing bacteria Gluconacetobacter hansenii (G. hansenii). G. hansenii (sometimes referred to as Acetobacter) is normally found growing in vinegar and is used in China to make a fermented tea called kombucha. G. hansenii can use lots of different liquids, such as fruit juice and beer brewing waste, as a food source, so almost anyone can grow them! Biohackspace, led by Levantis, have created a genetically modified version of this particular strain of bacteria. This bacteria's cellulose production is able to be turned on and off using light



https://biohackspace.org/projects/juicyprint/

https://www.ted.com/talks/neri_oxman_design_at_the_intersection_of_technology_and_biology/transcript?language=it#t-53059