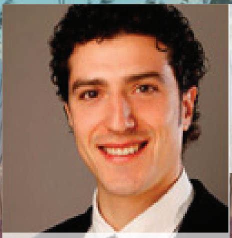

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SUSTAINABILITY

PEER REVIEWED

Deforestation-free and traceable supply chains for the production of sustainable surfactants

KEYWORDS: Sustainability, Surfactants, ISCC PLUS, GRAS, Deforestation-free supply chain, Detergents and cosmetics.

ABSTRACT: Thanks to its technological characteristics and availability on the international market, palm kernel oil is the main feedstock used for the production of bio-based surfactant. However, the production of this biological feedstock is often associated to deforestation practices in the countries of origin. As a consequence, reliable certification standards are needed in order to guarantee deforestation-free palm kernel oil and preserve the sustainability characteristics of the feedstock throughout the whole supply chain. This article illustrates the solutions that ISCC PLUS offers to support the surfactants industry in adopting the use of sustainable feedstock. In addition, the Global Risk Assessment Services (GRAS) tool is presented to demonstrate how current remote sensing technology can support the sourcing of sustainable material and therefore serve global detergent and cosmetic manufacturers in fulfilling their no deforestation commitments.

THE EUROPEAN SURFACTANTS MARKET AND THE ROLE OF BIO-BASED SURFACTANTS

The role of surfactants is particularly relevant for the production of detergents and body care products (1) (Cesio in Tegewa 2014). According to the European Committee of Organic Surfactants, in 2014 circa 2.5 millions of surfactants have been used by the western European industry (figure 1). Two thirds of these amounts, corresponding to 1.5 million tonnes, have been used for the production of households and industrial detergents. Additional 380,000 tonnes of surfactants have been used for cosmetic and pharmaceutical goods production.

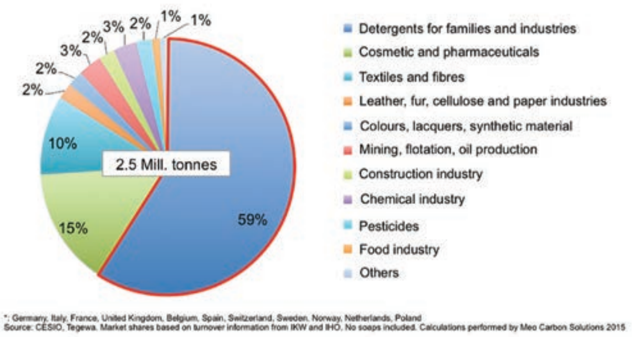


Figure 1. Surfactants usage by sector in selected European countries* in 2014.

In figure 2 it is illustrated the European Union production of surfactants divided by country. According to Eurostat (2) (2016), Germany produced one third of the overall surfactants in the European Union in the year 2014. Currently, no official statistics on the use of feedstock for surfactants manufacturing is publicly available. Due to its relevant role in the European surfactants industry panorama, we can assume that the German industry can be considered a good proxy in relation to the type of feedstock used for surfactants manufacturing.

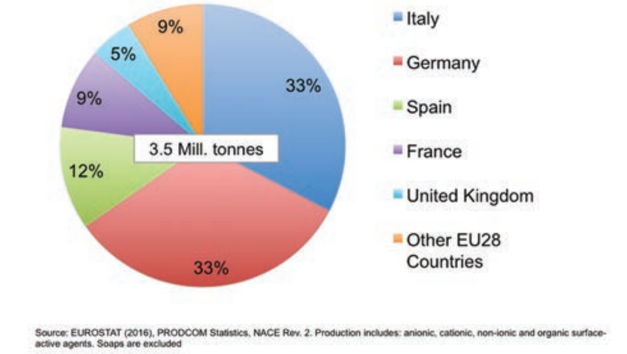


Figure 2. Surfactants production by country in Europe* in 2014.

The types of feedstock used in recent years for the production of surfactants in Germany has been investigated in 2014 by the German Agency for Renewable Resources (FNR, Fachagentur Nachwachsende Rohstoffe e. V.). According to the FNR study, surfactants can be produced partly or entirely from biological feedstocks such as palm kernel oil, coconut oil and, in minor measure, from starch and sugar of maize, wheat and potatoes (3) (FNR, 2014). In 2015, Meo Carbon Solutions, an international consultancy active in the field of renewable resources that supported the FNR in the production of the above-mentioned study, further analysed the market of biological feedstocks for surfactants production. The analysis, commissioned by the German Corporation for International Cooperation (GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit), an agency of the German government, had the objective of estimating the use of palm oil and palm kernel oil in the German market sectors (4). Part of the analysis was a workshop with experts from the surfactants, detergents and cosmetics industries.

Through the workshop, it was elicited that surfactants in detergent products consumed in Germany in 2013 relied for 56% on biological and fossil feedstock, for 2% on biological feedstock, for 19% on fossil feedstock (5) (Meo Carbon Solutions, 2015). The origin of feedstock of the remaining 23% of surfactants could not be traced back (Figure 3).

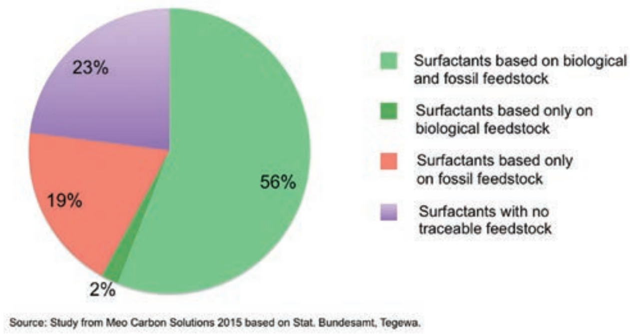


Figure 3. Typical surfactants composition of detergents in the German market.

Surfactants based on biological and fossil feedstock reported in figure two are mainly fatty alcohols. The amount of fatty alcohols used in cosmetic products is higher than in detergents. Figure three shows that 90% of all surfactants used in cosmetics production in Germany were based predominantly on fatty alcohols. The remaining 10% of used surfactants in cosmetics are produced from chemicals derived from fully biological feedstock and from fully fossil feedstock (Figure 4).

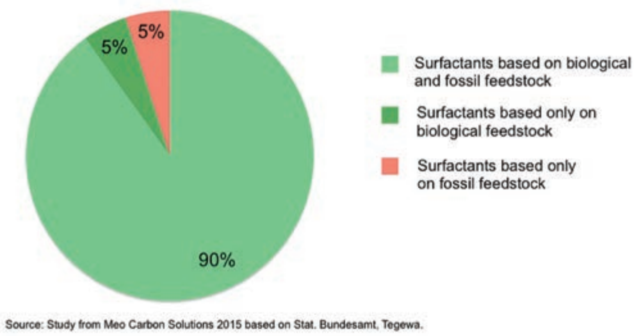


Figure 4. Typical surfactants composition of cosmetics in the German market.

The proportion of biological feedstock used for the production of surfactants in detergents and cosmetics reported in figure 3 and 4, even though referring to the year 2013, is the most recent estimation currently publicly available on the German surfactants market. Moreover, the market of surfactants production in Germany has been relatively stable in the last three years; hence, it is possible to consider the results above displayed still representative of the state of the art of biological feedstock use in the overall German market.

As reported by the FNR study (2014) (3) and by Berger (2009) (6) the use of lauric oils is particularly suited, as a feedstock of vegetable origin, for the production of chemical compounds used in the detergent and cosmetic industry. In the group of lauric oils are comprehended vegetable oils, which contains mainly fatty acids with mid and short chain length. Mid and short fatty acid chain length impart good foaming characteristics to soaps and detergents strengthening their cleansing action by suspending the particles of dirt. Compounds deriving from mid and short fatty acid chain length of oleochemical origin are in direct competition with petrochemical molecules; nevertheless, due to their availability and technological features, they are considered with much more interest from the detergent and cosmetic industries in the recent years.

Sustainable certified palm kernel oil for bio-based surfactants

Main vegetable oils with a mid and short chain fatty acids profile and which are available for commercial purposes in the international market are palm kern oil, coconut oil and babassu oil, whereby the latter is traded only in minor volumes in comparison to the first two. Among these three oils, palm kernel oil has the highest relevance as a feedstock in terms of produced and exported volumes for manufacturing of fatty acid compounds such as esters, fatty alcohols, a variety of nitrogen compounds and metal soaps used in the detergent and cosmetic industries (Berger 2009).

According to the study of Meo Carbon Solutions (2), in Germany circa 62,000 tonnes of palm kernel oil have been used for the production of consumed detergent and cosmetic products.

The use of palm kernel oil as a feedstock can be debatable, from an environmental perspective, in a phase of production of the raw material. This is due to the potential release of GHG emissions caused by the land use change, from forested to agricultural land, generated through the installation of the palm tree plantation. Palm kernel oil is in fact produced from the kernel of the fruit of the oil palm tree (Elaeis guineensis). Large surfaces of agricultural land with palm trees plantations are present in Indonesia, Malaysia, Papua New Guinea and on a much smaller magnitude in Ghana, Colombia, Brazil, Ecuador. According to ISTA Mielke (2016) (6) circa 80% of the globally produced palm oil and palm kernel oil in 2015 have been supplied by Indonesia and Malaysia. The same two countries are the main exporters of palm oil and palm kernel oil to the European Union.

The palm oil industry in these two countries has been criticized in recent years for unsustainable practices such as deforestation in high conservation areas (Friends of the earth Europe, 2010) (8) and violation of workers rights (The Wall Street Journal, 2015) (9) (Report, 2015) (12). As a consequence, many NGOs started communication campaigns to induce the procurement of palm oil produced with sustainable practices by multinational groups manufacturing fast moving consuming goods (WWF DE, 2015) (10) (Greenpeace, 2016) (11). The global players of the detergent and cosmetic industries, in order to reassure consumers, reacted to the media pressure by issuing sustainability policies with clear commitments on no deforestation related to the sourcing of palm oil and palm kernel oil (Figure 5).

Many product manufacturers adopted sustainability certification schemes and traceability systems for guaranteeing the sustainability of their raw materials. In the following part of the article we describe, through the example of the International Sustainability and Carbon Certification System (hereafter ISCC System), the mechanisms allowing the certification of global sustainable supply chains.

P&G	Ensure traceability of palm oil and palm kernel oil to our supplier mills by December 31, 2015 and to plantations by 2020 to ensure zero deforestation in our palm oil supply chain
Unilever	Working with governments and other partners to embed no-deforestation objectives into national and international policies
Colgate-Palmolive	As a socially responsible company we are committed to addressing deforestation. Colgate has joined the Consumer Goods Forum (CGF) in pledging to mobilize resources to help achieve zero net deforestation by 2020
L'ORÉAL	L'Oréal committed to zero deforestation and says it will source 100 percent renewable raw materials from sustainable sources by 2020
Beiersdorf	We want to support the building and expansion of sustainable palm and palm kernel oil industry, which does not contribute to any rainforest deforestation of ecologically important primary or secondary forests, including "High Carbon Stock" (HSC) forests, High Conservation Value areas (HCV) or peat land
Henkel	We are committed to zero net deforestation by 2020. This means that palm and palm kernel oil that we use should not contribute to deforestation of primary or secondary forests with significant ecological value. This includes "High Carbon Stock" forests and peat lands
Reckitt Benckiser	We are committed to: zero deforestation, zero development on peatlands (of any depth), zero exploitation of workers or communities, being transparent on our requirements and our progress with implementation
Johnson	As a member of the Consumer Goods Forum (CGF), we share their commitment to net-zero deforestation by 2020 through the sustainable sourcing of pulp, paper, packaging and palm oil
Groupe Rocher	Committed to its promise to conserve nature and its resources, Groupe Rocher has decided to reinforce its commitments with a policy for palm oil supplies free of deforestation or exploitation.

Figure 5. Commitment on no deforestation policy related to palm oil and palm kernel oil supply of surfactants, detergents and cosmetic products manufacturers.

In addition, we illustrate how the innovative tool Global Risk Assessment Services (hereafter GRAS) can support manufacturers of surfactants, detergents and cosmetic products in guaranteeing their no deforestation commitments in relation to the specific feedstock of palm kernel oil.

THE INTERNATIONAL SUSTAINABILITY AND CARBON CERTIFICATION SYSTEM

The International Sustainability & Carbon Certification (ISCC) is a globally leading certification system covering the entire supply chain and all kinds of bio-based feedstocks and renewables (figure 6). Since ISCC's start of operation in 2010, more than 11,000 certificates in 100 countries have been issued.

ISCC is based on a multi-stakeholder initiative governed by an association with more than 80 members. The German Federal Ministry for Food and Agriculture supported through the Agency for Renewable Resources (FNR) the ISCC initiative development. ISCC was developed through an open multi-stakeholder process involving around 250 international associations, corporations, research institutions and NGOs from Europe, the Americas and South East Asia. ISCC supports the United Nations Global Compact Initiative and the UN Sustainable Development Goals (Figure 7).

Figure 7. Support of UN sustainable development goals through ISCC certification principles.

The certification system offered by ISCC can be applied in various markets including the bioenergy sector, the food and feed market and the chemical market. Requirements of ISCC ensure the ecologically and socially sustainable production of biomass and more specifically that:

- biomass is not produced on land with high biodiversity and high carbon stock,
- no deforestation is taking place,
- good agricultural practices and the protection of soil, water and air are applied,
- human, labour and land rights are respected,
- greenhouse gas emissions from biomass production respect defined reference levels.

Material certified with the above mentioned features is traceable through the whole supply chain. ISCC certificates are site specific (figure 8) and are issued by independent certification bodies, which conduct audits on a regular basis on the certified production sites throughout the year.

Supply chains for biochemical products such as surfactants are certified by ISCC under the specific scheme of ISCC PLUS. This scheme implies the sourcing, by certified downstream recipients, of exclusively ISCC certified material. ISCC PLUS allows through the use of modular add-ons to cover supplementary environmental aspects in respect of basic ISCC requirements, namely:

- accounting for GHG emissions and documenting their reduction,
- managing and reducing risks for incorrect practices in the use of water, energy, soil and biodiversity,
- implementing measures for phase out of hazardous chemicals,
- avoiding the use of GMOs for the feedstock production.

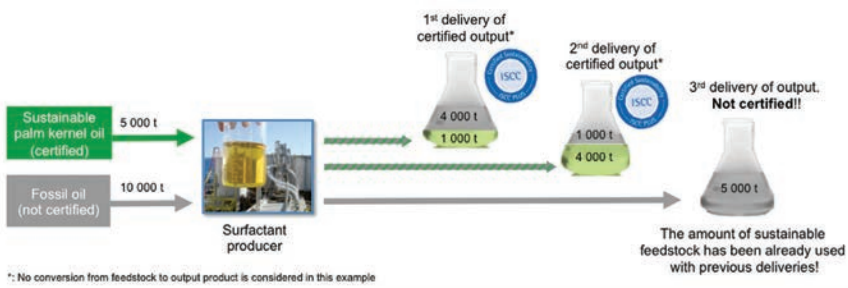
Figure 6. Feedstock coverage and global presence of ISCC system.

Under ISCC PLUS scheme, the sustainability features of the output certified at the production site (e.g. sustainable palm kernel oil from certified palm kernel mill) can be passed down the supply chain through different chain of custody systems. ISCC PLUS allows handling certified material on a mass balance base (MB) as well as on a segregated base (SEG). In addition, when processing of vegetable oil and fossil oil is carried out simultaneously (co-processing) and the final product is a mixed product (e.g. fatty alcohol), a free attribution of the sustainability feature of the certified vegetable oil to the final product is possible.

In figure 9 and in figure 10, it is displayed how the information on the amount of certified material is passed on through the output product respectively for mass balance and segregation. Moreover, below the graphic, for both chain of custody systems are reported main requirements, advantages and disadvantages, and criteria for claims on the certified material.

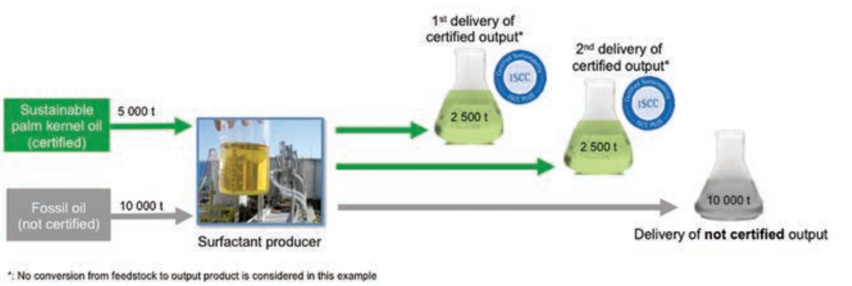
In the case of a mass balance system, the certified surfactants production site can mix, for the manufacturing of its final product, both sustainable and not sustainable material.

As long as it can be verified that the sustainable material arrived at the production site and it was part of the stock of raw materials for the surfactant production, independently from the physical presence in the output product of parts of the sustainable feedstock, the certified entity can sell its product as sustainable. However, the sale of sustainable material should not in any case exceed the overall amount of purchased sustainable feedstock within a given amount of time (three months in the case of ISCC PLUS certification scheme).



Requirements and characteristics	Advantages (+) and disadvantages (-)	Possible claims
• The certified sustainable "bio-content" is in relation to equivalent certified bio-based input. • Due to mass balance period and to initial small volumes, physical bio-based content can be low (or even zero). • Analytical detection through advanced technologies (e.g. C_{14} analysis) is possible.	+ Easy handling of products, as no segregation is required. + Independent from the amount of sustainable material in the product , as long as the quantity of initial sustainable feedstock is not used up, it is possible to sell certified material. + Use of certified renewables in existing infrastructure. No need to develop additional infrastructures. + Multiple sustainable products can be supplied if number of customers increases. + Certified volumes are easier to achieve than with segregation. – Weaker claims compared to segregation as no reference to physical content is possible, unless analytically detected.	• Claims with respect to effort to contribute to the responsible sourcing of bio-products or that fossil resources are saved. • References to the physical product not possible as this would be misleading (unless bio-content is analytically detectable).

Figure 9. Mass balance system in a three-months time period for the production of bio-based surfactants.



Requirements and characteristics	Advantages (+) and disadvantages (-)	Possible claims
• The certified sustainable "bio-content" is in relation to equivalent certified bio-based input. • Due to segregated production, certified bio-content can be determined and is 100% if all inputs are bio-based. • Physical mix with not sustainable material is not allowed.	+ Good marketing possibilities due to identity physically preserved bio-material. + Reduced bookkeeping effort. – Segregated production unit and supply chain need to be set up. – High investment costs. – No flexibility.	• Claims with respect to the physical content of 100% certified sustainable material within the product (e.g. "this surfactants is made of 100% certified sustainable material").

Figure 10. Segregation system in three-months time period for the production of bio-based surfactants.

In the case of a segregated chain of custody system, the sustainable feedstock is not mixed during the production of the surfactant with other not certified materials. The final product being certified through segregation derives exclusively from sustainable material (Figure 9).

ISCC is well established in the palm sector with more than 248 valid certificates for palm oil and palm kernel oil mills and respective plantations in Indonesia and Malaysia.

As further proof of ISCC expertise in the field of palm oil and palm kernel oil supply chains, its certification scheme ISCC PLUS has been selected and proposed as an option for sustainability certification by the German Forum on Sustainable Palm Oil (FONAP).

To better tackle the environmental and social issues rising from the production of palm oil and palm kernel oil, ISCC has developed a Technical Committee for South East Asia, a special Plantation Audit, and a Land Use Assessment Training.

The specific issue of deforestation is tackled by ISCC by means of the Global Risk Assessment Services tool. This tool allows for the identification of violations, by palm kernel oil producers, to ISCC principle 1 (Production of agricultural raw material not allowed on high conservation areas) and therefore strengthen the reliability of ISCC certification system when adopted for implementation of no deforestation policies.

THE GLOBAL RISK ASSESSMENT SERVICES TOOL FOR THE MONITORING OF COMMITMENTS ON NO-DEFORESTATION

The Global Risk Assessment Services tool is an innovative, user-friendly web-platform that provides information on social and environmental sustainability (e.g. land use change) related to geographical areas. The GRAS tool has a global scope and it serves the needs of many potential stakeholders such as certification bodies, auditors, companies, investors as well as authorities and NGOs that have a strong interest in assessing the actual risk for sustainability of agricultural or forestry production.

The GRAS captures the sustainability risk by synthesizing data on biodiversity, carbon stock, land use change and social indices sources in one single indicator, the GRAS-index. The GRAS-Index reports the sustainability of a sourcing region on an easy-to-interpret map (Figure 11).

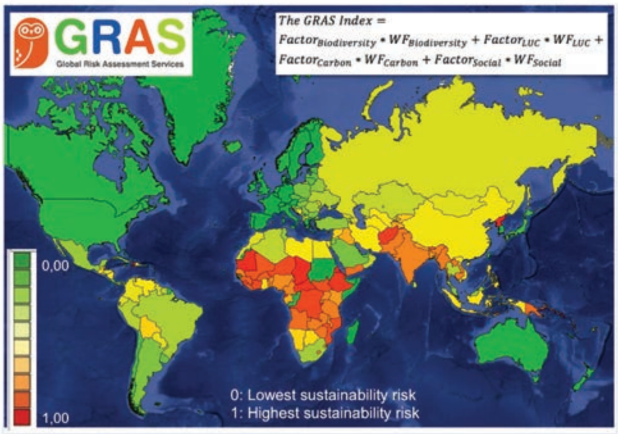


Figure 11. GRAS map displaying the sustainability risk according to the GRAS-Index value for world countries.

An important feature of the GRAS is the detection of land use change (hereafter LUC) and the identification of unsustainable practices such as deforestation. Through this specific GRAS feature, surfactants as well as detergent and cosmetic manufacturers can monitor the sustainability of their feedstock supply base at a palm plantation level.

The first step for the detection of deforestation practices in the palm kernel oil supply chain is the identification and localization of the palm oil and palm kernel oil mills supplying the feedstock (often palm oil mills and palm kernel oil mills coexist as single integrated installation). This information can be recalled through contracts of supply. Further, it is necessary to identify the palm plantations and concessions providing the palm fruit to the palm oil and palm kernel oil mills. In absence of this information, the GRAS system allows the selection of a circular area surrounding the palm oil and palm kernel oil mills up to 200 kilometres for the performance of the land use change analysis. By selecting the land use change analysis heat map, surfaces presenting a change in their vegetation coverage after the year 2008 can be localized (Figure 12).

The person in charge of the sustainability analysis (e.g. raw materials procurement manager, sustainability managers) can then place markers within the highlighted land use change areas to detect in which exact period of time the land use change took place. This LUC historical analysis is possible by

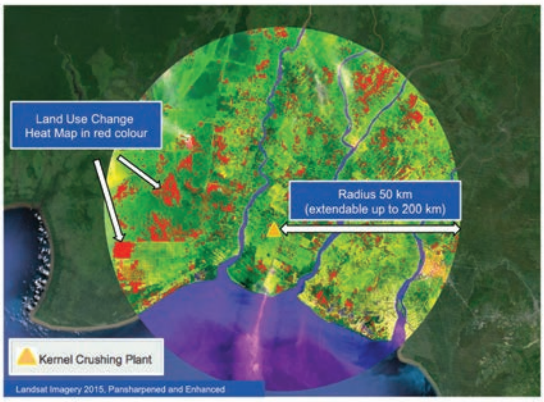


Figure 12. Heat map for land use change (red colour) in a radius of 50 km from the palm kernel oil crushing plant.

means of the GRAS Enhanced Vegetation Index (EVI). This index is calculated from the spectroradiometer data of MODIS satellite and allows differentiating among types of green cover and therefore reconstructing the land use history and identifying in which exact period of time the LUC took place (Figure 13).

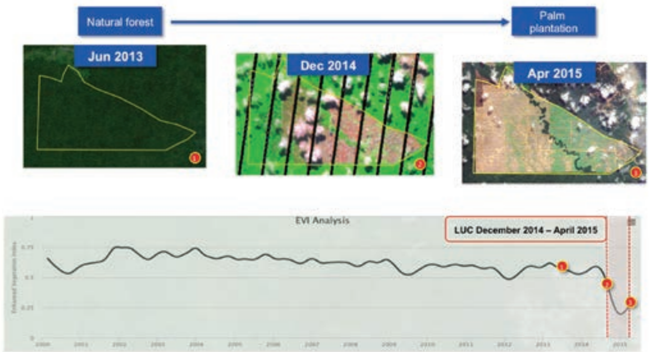


Figure 13. GRAS EVI index for detection of deforestation.

Once the time frame within which the LUC took place is identified, depending on the type of crops (for not perennial crops this step can be excluded), an additional in-depth analysis of the surfaces through satellite images can be executed to exclude replantation practices; clearly defining whether or not deforestation practices took place. In this case the plantations and the palm oil and palm kernel oil mills receiving palm fruits produced through unsustainable practices can be expelled from the supply base of the surfactants producers (Figure 14).

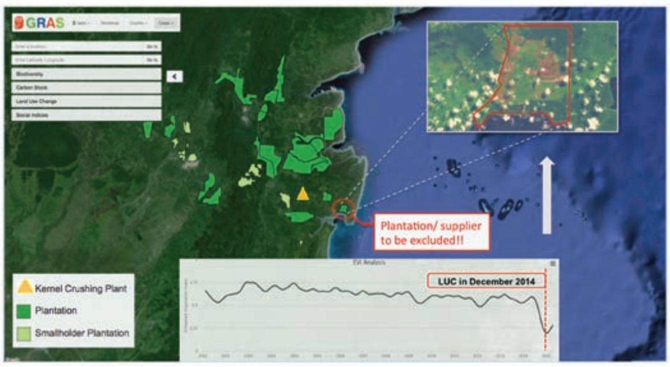


Figure 14. Exclusion of palm plantation - deriving from a previously forested area – from the supplier list of the palm kernel crushing plant.

CONCLUSIONS

Palm kernel oil is the most important vegetable feedstock for the production of surfactants present in the detergent and cosmetic industries. Its environmental benefits in phase of disposal of the detergent and cosmetic products are nevertheless counterbalanced by the risk of deforestation in the country of origin where it is produced. Producer of surfactants, detergents and cosmetics can secure the sustainability of their palm kernel oil supply by procuring material certified through credible and business friendly sustainability certification schemes. In this article we report as explicative example, the ISCC PLUS standard. The fulfilment of deforestation claims can be further supported by means of the GRAS tool. This tool allows identifying deforestation practices on areas where palm kernel oil are produced. As a consequence, unsustainable palm fruits and their recipients can be excluded from the list of feedstock providers for a deforestation-free supply chain.

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