Coffee Production and Sustainability

THE SUSTAINABILITY CONSORTIUM™

The Sustainability Consortium's
Commodity Mapping Report

September 2017

What is The Sustainability Consortium's Commodity Mapping Tool?

The Sustainability Consortium's Commodity Mapping Program uses a series of spatial models in a tool to identify source regions and trade networks of over 100 food, wood, and fiber commodities. TSC has created these proprietary models to link existing datasets in unique ways to help companies better understand the probable origins of their supply chains and what issues may be associated with the crops and fiber they source. The power of the tool is that even if a company has little information about the geographic origin of its supply, the Commodity Mapping Tool can predict the most likely origins to help get the sustainability discussions started.

Companies and NGO's can use the tool to visualize where crops, wood, and fiber originate and what hotspots occur in production regions. The goal of the tool is to raise awareness about source regions and geographic hotspots so companies and NGO's can take action to improve supply chains. The results of the tool provide a company with data in the form of dashboards and maps to further explore their footprint. The tool can answer questions such as:

- What are the most likely regions where my supply is grown?
- Are there hidden risks such as deforestation or child labor in the areas where my supply originates?
- Which of my vendors may be more at risk for these issues and where are they likely sourcing from?
- Are my high risk vendors covered by certification for important issues?
- Am I asking the right questions of my suppliers to assess my exposure to risk in the geographies my company sources from?

Companies can use TSC's survey questions or Key Performance Indicators with their suppliers to determine if the issues in their supply are being addressed. NGO's can use the results of the tool to better understand what issues may be occurring on the ground related to specific crops or forestry practices. The results of this tool can also be used to approach governments about regional issues associated with the production of consumer goods. It can also be used in jurisdictional approaches to determining high and low risk regions.

To learn more about TSC's Commodity Mapping Program visit https://www.sustainabilityconsortium.org/projects/commodity-mapping/.

Companies who have used TSC's Commodity Mapping include Campbell's, Dow, Kroger, Novozymes, Smuckers, and others who wish to remain anonymous while their projects are in progress. To learn more about Kroger's public commitment to TSC's Commodity Mapping Program visit http://sustainability.kroger.com/2020-goals.html.

What's in your cup?

This report is intended for anyone interested in the sustainability of coffee production. If you just enjoy a morning cup of joe or are an expert on coffee farming, this report should provide you with useful information about the key sustainability issues associated with growing and processing coffee beans. Maps highlight the key growing regions for coffee, the biggest importers and exporters of coffee, and where hotspot issues like child labor or deforestation are occurring related to coffee production. These maps, visuals, and information will help to answer the question "what's in your cup?"

The Scoop on Coffee

How is it made? Coffee comes in two main varieties, Robusta and Arabica, which are grown in different conditions and regions of the world. Coffee trees are grown in sun and shade production systems depending on the region which can affect the sustainability impacts. Coffee seedlings are grown in nurseries. Coffee trees take 3-4 years to be productive and can produce coffee fruits called cherries for 15-30 years depending on the system. There is typically one harvest a year where ripe coffee cherries are picked by hand or with a hand-held mechanical harvester for drying and processing. Coffee cherries can be dried whole, using sun or mechanical drying systems, or are processed using water to remove the pulp of the fruit first and dried afterwards. Before exportation the beans are mechanically hulled, polished, and sized. At this point they are called "green" beans meaning they are unroasted. Don't like the buzz? Green beans are decaffeinated using a variety of techniques including chemicals, plant hormones, water, or carbon dioxide. Green beans are roasted in small batches for tasting or "cupping" before being purchased by coffee companies. Once green beans are purchased they are shipped green, often blended from different regions, roasted, sometimes ground, and packaged before being shipped to retail stores and restaurants.

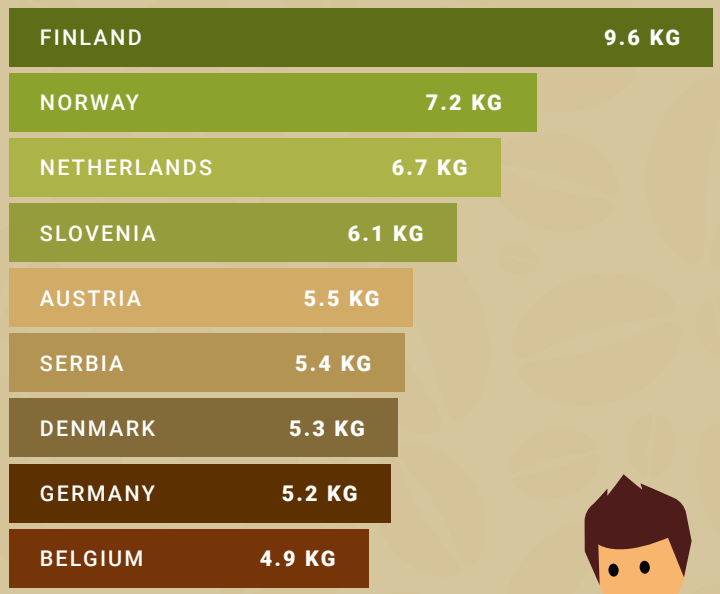
Which country is the most caffeinated?

World consumers consume almost 150 million bags of coffee per year. The U.S. and Brazil are nearly tied for highest total coffee consumption. Finland, Norway, and the Netherlands take the top spots for coffee drinking per person at rates 2-3 times greater than US coffee drinkers.

TOP 5 COUNTRIES BY SHEER TONNE COFFEE CONSUMPTION
(THOUSANDS OF TONNE)S

UNITED STATES **971** BRAZIL **969** GERMANY **425** ITALY **211** FRANCE **202**

AMOUNT OF COFFEE CONSUMED BY COUNTRY PER CAPITA
(PER PERSON ON AVERAGE)



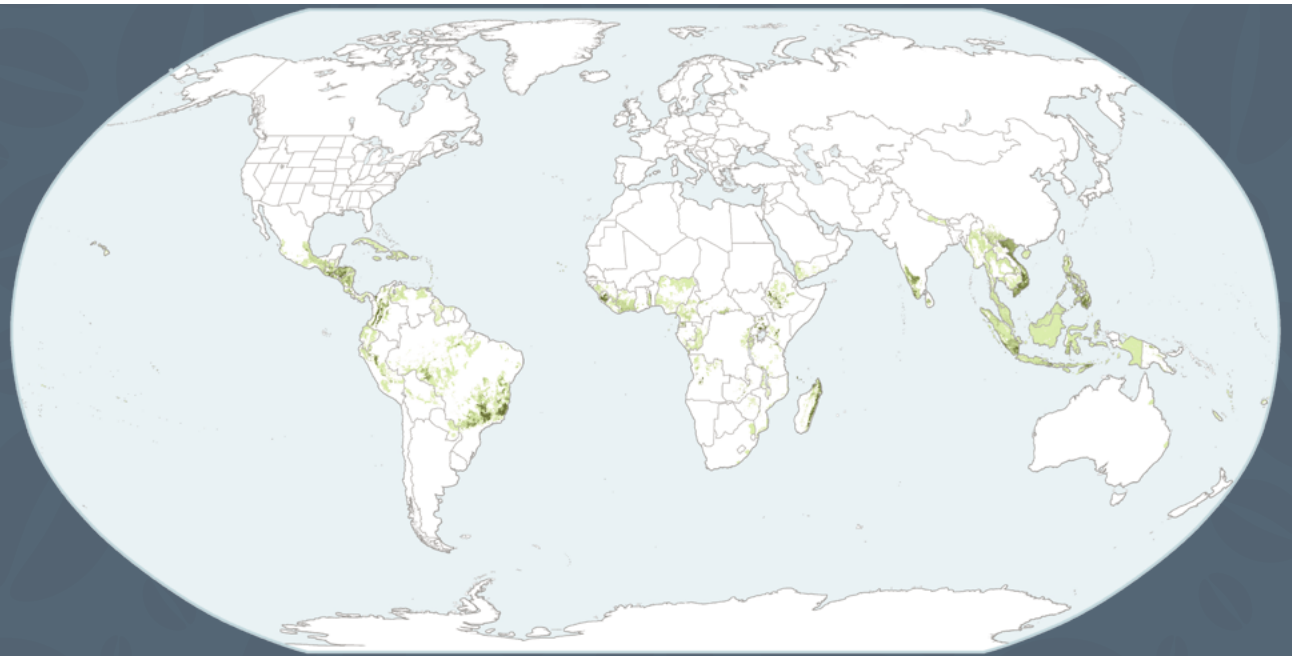
https://www.caffeineinformer.com/caffeine-what-the-world-drinks

Where in the world is coffee grown?

Coffee is grown in highland tropical regions around the world, with the majority of production occurring in Central and South America, Sub-Saharan Africa, and Southeast Asia. Arabica coffee beans are the most popular and comprise the bulk of global coffee consumption. Generally considered to have superior flavor, Arabica coffee beans command a higher price and dominate the medium to high-end coffee market. Arabica coffee is primarily grown in Central America, Brazil, and East Africa. Robusta coffee is a heartier or more 'robust' species that is able to survive at lower altitudes and under more variable conditions than Arabica coffee plants. This makes it better suited for cultivation in areas such as Southeast Asia, where the bulk of Robusta coffee is produced. Most instant coffee and discount coffee blends are made using Robusta coffee beans due to their lower cost (National Coffee Association, 2017).

Brazil and Vietnam are the major producers and exporters of coffee, followed by Colombia and Indonesia. Brazil and Colombia primarily produce Arabica coffee while Vietnam and Indonesia produce mostly Robusta coffee. The vast majority of this coffee production is exported to the United States and Europe, with the United States and Germany being the top two coffee importers.

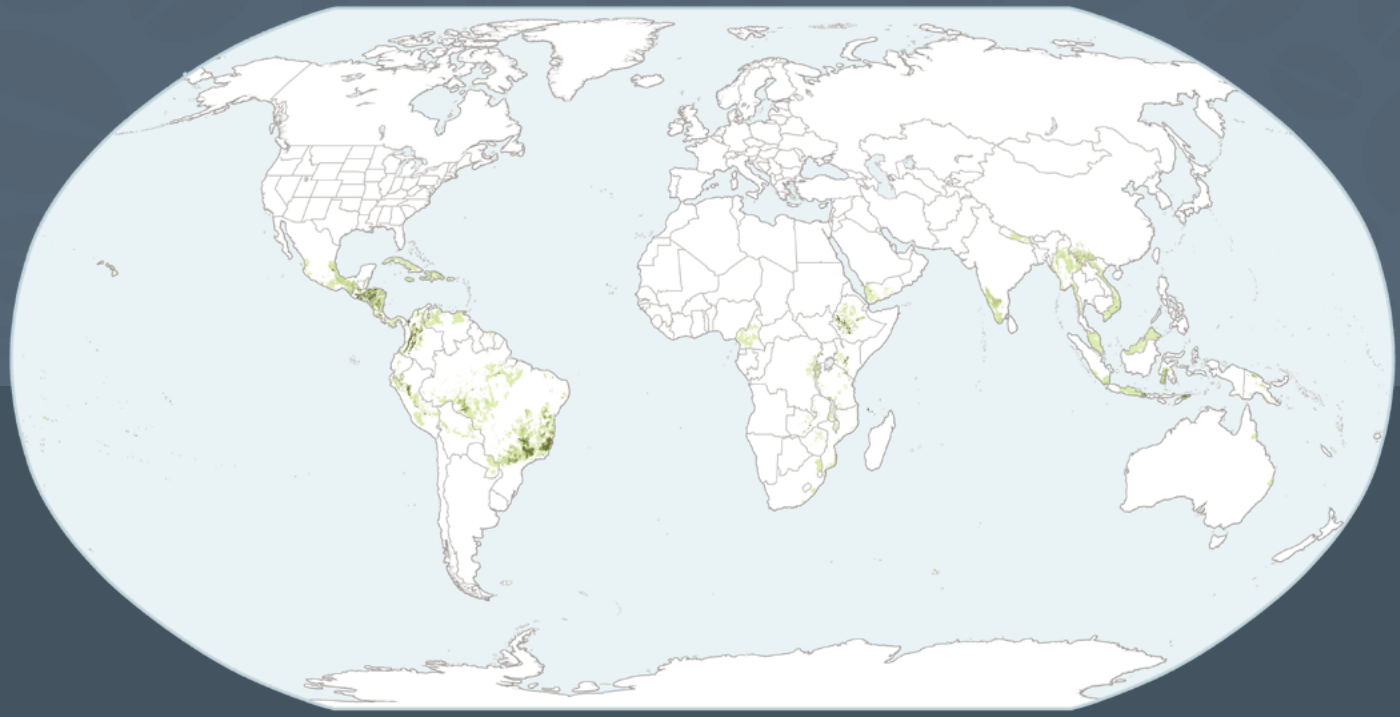
Global Coffee Production
(Arabica + Robusta)



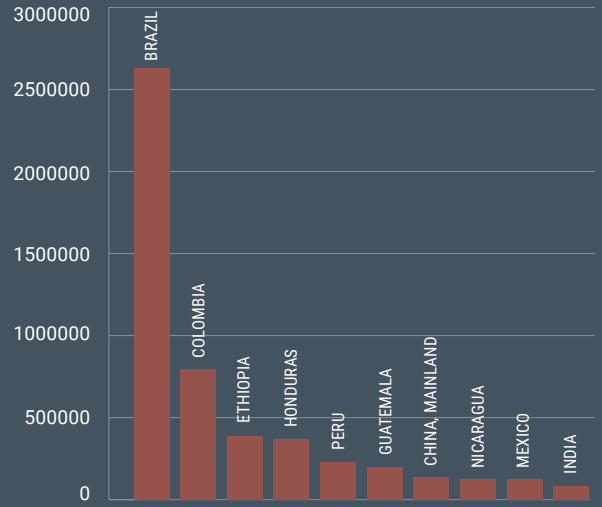
Arabica Coffee Production

COFFEE PRODUCTION

LOW HIGH



Top 10
Arabica Coffee Production



Global Arabica Coffee Production

CENTRAL AMERICA

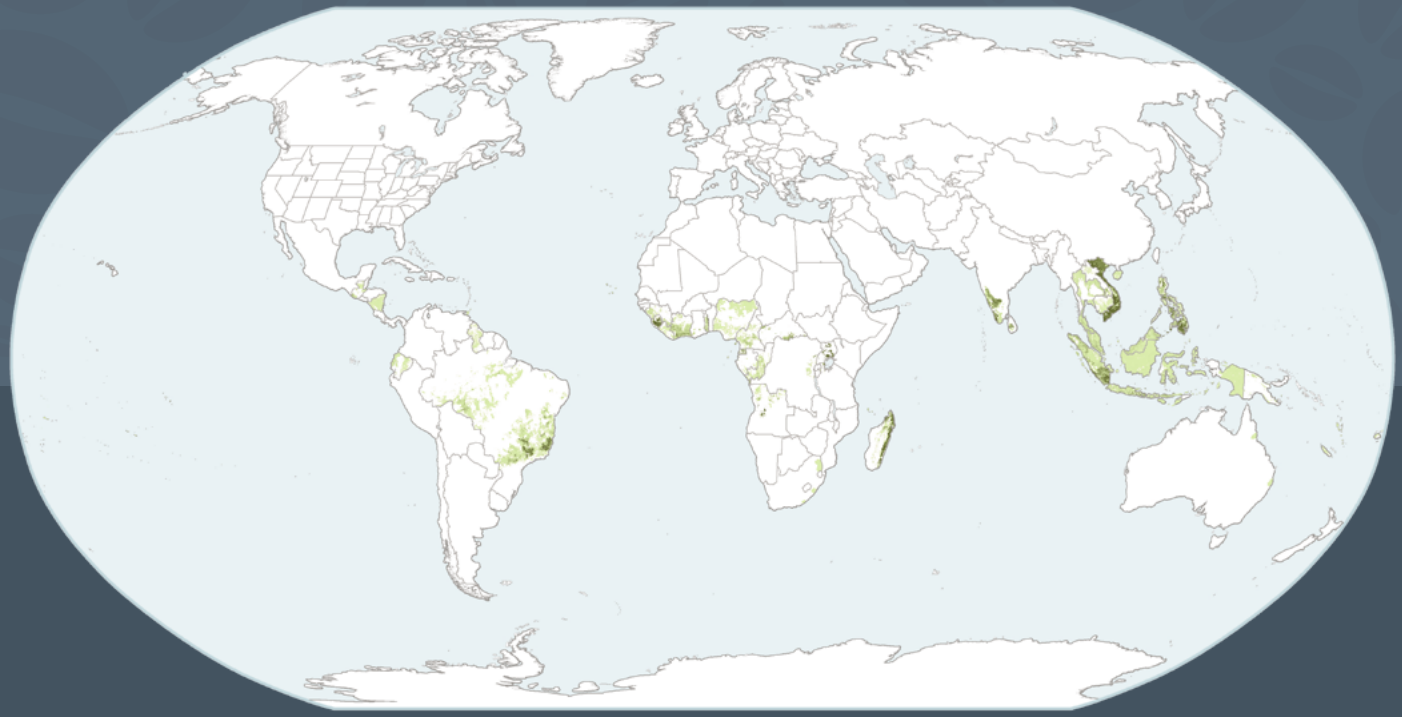
EAST AFRICA

SOUTH AMERICA

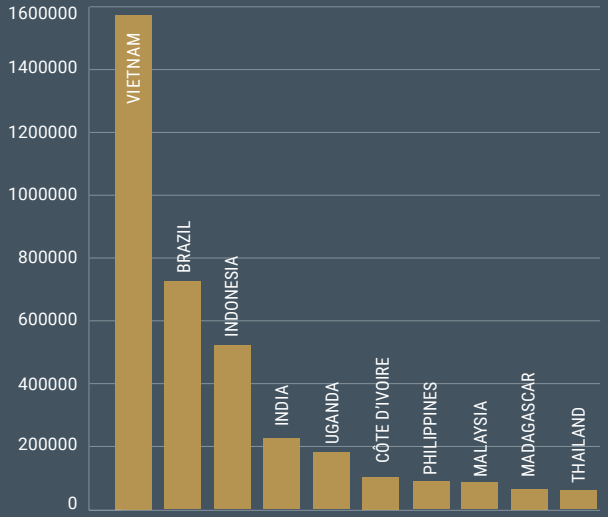
Robusta Coffee Production

COFFEE PRODUCTION

LOW HIGH



Top 10
Robusta Coffee Production



Global Robusta Coffee Production

SUB-SAHARAN AFRICA

SOUTHEAST ASIA

SOUTH AMERICA

Where in the world does coffee go?

Many countries import coffee from nations that do not produce any coffee of their own. This indicates that many nations act as brokers of coffee, meaning that they import coffee from a producing nation and re-export it to another country where it is roasted and either sold or re-exported again. To better understand these global supply chains, TSC created its Commodity Trade Network Model that is able to model trade connections and identify the likely source regions of any country's coffee supply. This approach allows broker nations to be identified and highlighted, as well as providing estimates of the ratio of Arabica to Robusta beans in a given country's supply. In particular, Germany and Belgium are major coffee brokers that indirectly supply much of Europe's coffee, as well as about 5% of the coffee consumed in the United States.

AVERAGE ANNUAL COFFEE CONSUMED
IN A U.S. HOUSEHOLD TRAVELS

572,000 MILES

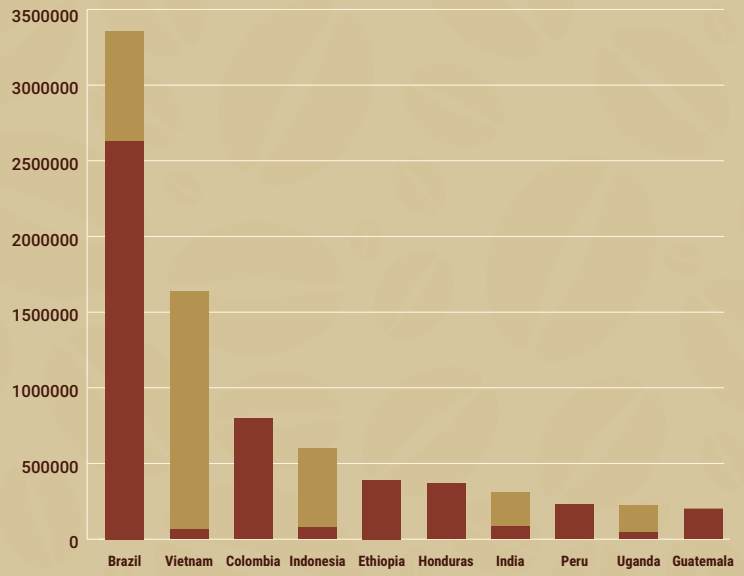
FARM TO U.S.

Because of these indirect trade networks from farm to broker nation to consumer, coffee often travels many miles before reaching your cup. The average annual coffee consumed in a U.S. household travels a total of 572,000 miles from farm to the U.S. (Humes 2016).

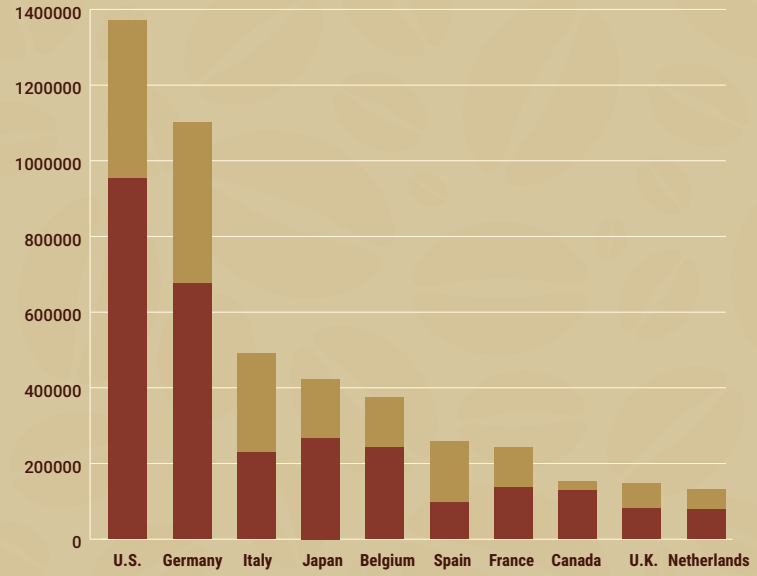
COFFEE ROBUSTA

COFFEE ARABICA

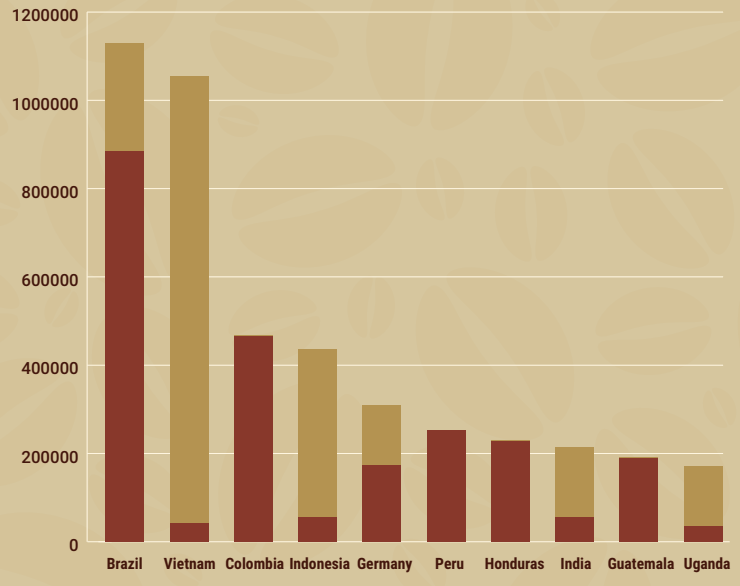
Coffee Production



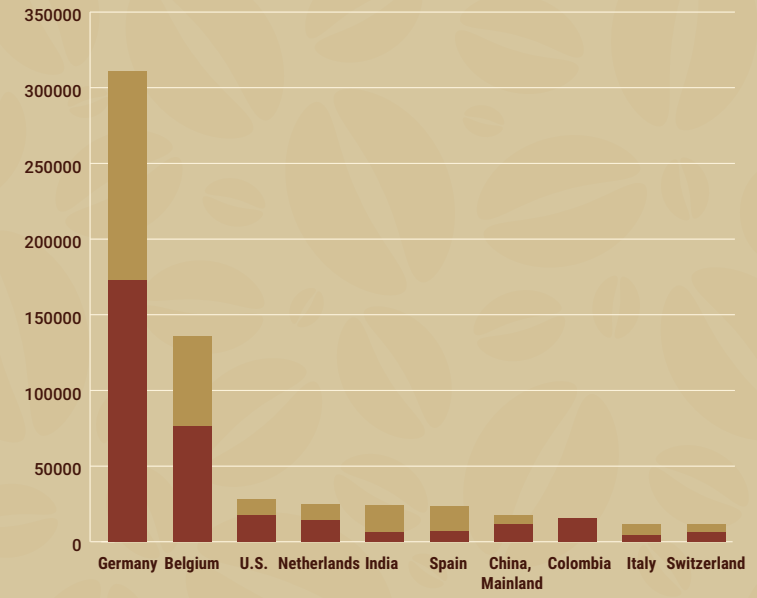
Coffee Imports



Coffee Exports

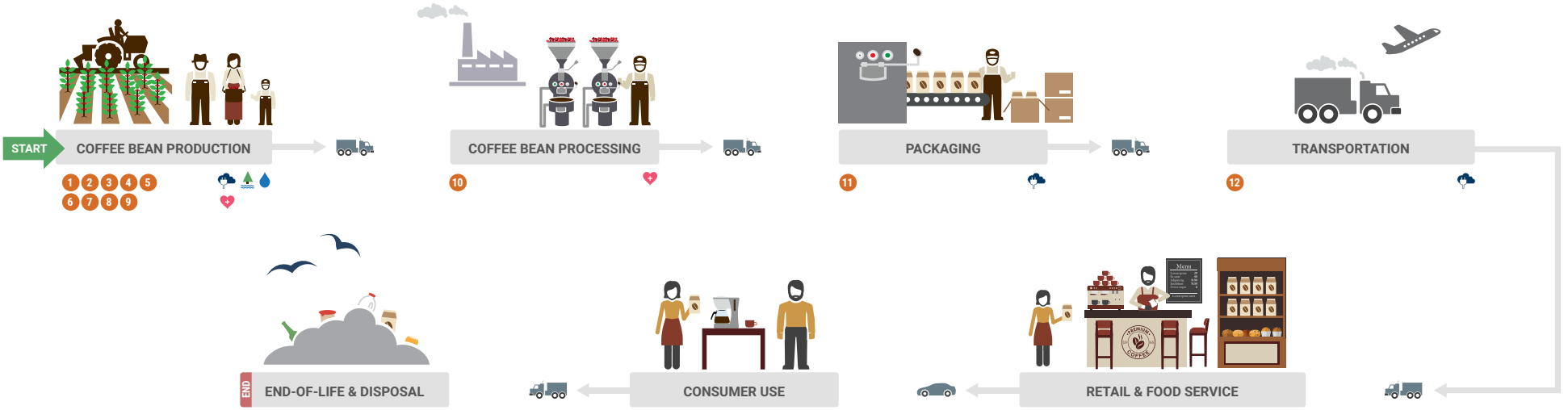


Re-exports (Broker Nations)



What are coffee's common hotspots?

A hotspot is an activity within a product's life cycle that is identified as having a substantial environmental or social impact that is supported by significant evidence.



1 **Access to opportunities for smallholder farmers - On-farm:** Operators of small-sized farms, especially women, face a number of challenges including access to agricultural inputs, services, and markets.

2 **Child labor use - On-farm:** Issues involved in child labor use in coffee farming may include no pay, long working hours, dangerous working conditions, and limited access to education.

3 **Energy consumption - On-farm:** Fuel combustion and energy generated to power farm operations can cause climate change, deplete resources, and impact human health.

4 **Fertilizer application - On-farm:** Fertilizer use can cause soil and water quality impacts and climate change.

5 **Labor rights - On-farm:** Farm workers are at risk of several labor rights issues such as unfair pay, discrimination, and sexual harassment and assault.

6 **Land transformation - On-farm:** The conversion of forest to coffee farms can lead to environmental impacts and climate change from deforestation.

7 **Supply chain traceability:** Due to the complexity of coffee supply chains, information about where the supply chain originates is limited, which is a challenge to improving issues.

8 **Water use - On-farm:** Using water for irrigation can deplete freshwater resources and lead to poor soil quality.

9 **Worker health and safety - On-farm:** Farm workers can develop serious health problems from exposure to chemicals, noise, and dust and physical injury from other occupational hazards.

10 **Worker health and safety - Manufacturing:** Processing workers can develop serious health problems from exposure to chemicals, noise, and dust and physical injury from other occupational hazards.

11 **Energy consumption - Packaging production:** Packaging production can result in depletion of resources and environmental and social impacts from extracting raw materials.

12 **Fuel combustion - Distribution:** Fuel combustion for transportation of the final product can cause climate change, deplete resources,and impact human health.

Sustainability Topics: Climate & Energy · Water Use · Land & Ecosystems · Health, Safety & Rights

Where do coffee's sustainability hotspots occur?

The sustainability impacts of coffee production vary depending on where the coffee was grown. Land use impacts and labor issues in particular vary by geography. These risks can be estimated by identifying the origins of a company's or community's coffee supply.

The hotspots in coffee production include among others, deforestation and biodiversity loss caused by land transformation, labor and human rights issues such as child or forced labor, and impacts to resource stocks such as ground and surface water depletion caused by irrigation water use in water scarce areas. Using TSC's Commodity Mapping Tool, the coffee supply of any given country or purchasing location can be modeled back to the likely coffee growing regions that originally produced the coffee beans. The risk of those locations containing sustainability hotspots is calculated by overlaying coffee production data with high-resolution spatial risk datasets. The results are then summarized into a risk index highlighting the likelihood that a sustainability hotspot exists in a given supply chain, and where in the world that hotspot is occurring if it is present. The charts on the following page summarize the risk of sustainability hotspots found in the coffee supply produced by the top coffee producing nations, as defined by the percentage of coffee sourcing regions at high risk for Biodiversity, Child Labor, Deforestation, Forced Labor, or Water Scarcity impacts.

TSC's Commodity Mapping Tool Can Help Discover

- **Where** coffee is produced for different supply chains
- **What** potential issues or risks occur in these producing regions
- **How** a company can address these issues by using TSC KPIs and working with partners on the ground.

Risk Index: % Global Coffee Source Regions at High Risk

Key

- **No High Risk Identified (0%)**
- 1 **Very Few** Source Regions at High Risk **(0-1%)**
- 2 **Few** Source Regions at High Risk **(1-5%)**
- 3 **Many** Source Regions at High Risk **(5-20%)**
- 4 **Many to Most** Source Regions at High Risk **(20-50%)**
- 5 **Most** Source Regions at High Risk **(50-100%)**

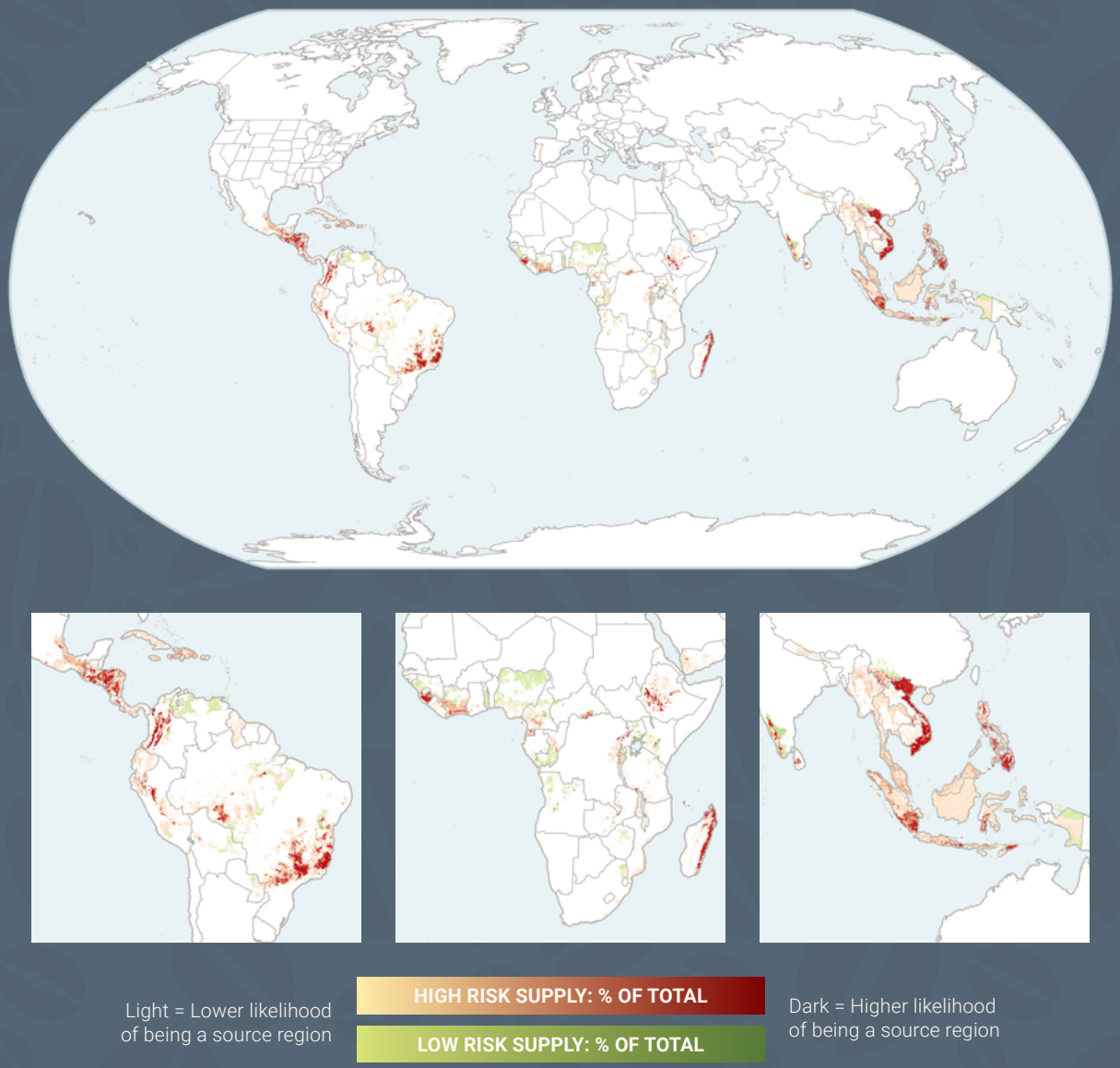
All Coffee (Arabica + Robusta)	Production Rank	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Brazil	1						
Vietnam	2						
Colombia	3						
Indonesia	4						
Ethiopia	5						
Honduras	6						
India	7						
Peru	8						
Uganda	9						
Guatemala	10						

Arabica Coffee	Production Rank	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Brazil	1						
Colombia	2						
Ethiopia	3						
Honduras	4						
Peru	5						
Guatemala	6						
China, mainland	7						
Nicaragua	8						
Mexico	9						
India	10						

Robusta Coffee	Production Rank	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Vietnam	1						
Brazil	2						
Indonesia	3						
India	4						
Uganda	5						
Côte d'Ivoire	6						
Philippines	7						
Malaysia	8						
Madagascar	9						
Thailand	10						

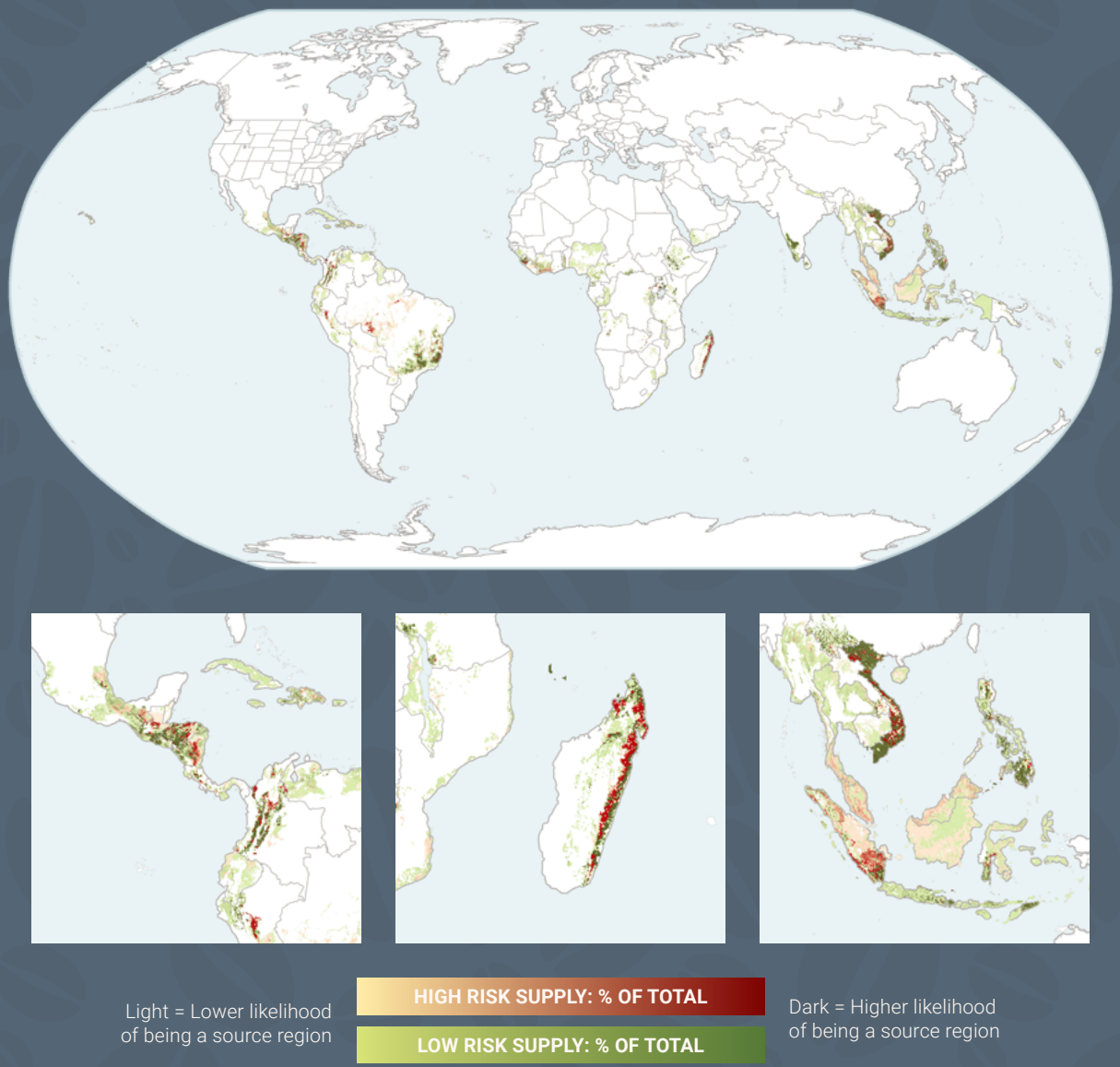
Biodiversity Risk – All Coffee

Almost all (approx. 98%) of coffee is grown in areas that contain high biodiversity. The mountainous regions in the tropics that are best suited for coffee production are also some of the most species-rich landscapes in the world. The maps above show the overlap between coffee production and ecosystems with high biodiversity. From the cloud forests of Central America to the rain forests of Vietnam and Indonesia, coffee production occurs side-by side to some of the last remaining habitat for thousands of species of plants and animals. The areas on the map indicate where biodiversity loss and coffee coincide but other factors besides coffee may be affecting biodiversity in these regions, too. Land-transformation of natural forests into coffee plantations is a cause of biodiversity loss in coffee producing areas. To address these impacts, coffee growers can manage and restore existing coffee plantations for long-term production and plant new coffee plantations on land that was previously cleared for agriculture rather than expanding into existing species-rich forests. Additionally, growers can implement biodiversity management plans on their land to help maximize the habitat offered by their plantations and minimize the impact to the surrounding ecosystems.



Deforestation Risk – All Coffee

Deforestation is a particular concern when it comes to land-transformation within coffee growing regions. Coffee plantations and natural forests often compete for the same growing space, so pressures to expand coffee production to new areas can lead to the clearing of land than contains high conservation value forests or high carbon stock forests. The maps above show the overlap between coffee production areas and regions that have had forest cover loss of >5% between 2000-2015, shown in red. There is significant forest clearing within the coffee producing regions of Malaysia, Indonesia, Madagascar, and Peru in particular. The deforestation shown on the maps may be due to coffee production or other factors but this map identifies areas that need further investigation into the connection between coffee and deforestation in these regions. The connection between risk of deforestation and biodiversity loss from coffee production is evident if you compare the two maps and observe the overlapping regions where both risks are occurring.



How do hotspots change with different supply chains?

Coffee supply chain risks vary depending on where in the world coffee is produced. The United States buys coffee from a variety of countries, primarily Brazil (26%), Vietnam (16%), and Colombia (14%). Within each country there are particular regions where coffee is grown, and the sustainability impacts can vary between countries and between individual growing regions within a single country. For example, most of the coffee growing regions in India are at high risk of water scarcity, whereas Brazil's coffee growing regions are almost entirely low risk for water scarcity. Some risks such as water scarcity or biodiversity vary because landscapes and climate are different, making certain growing regions more or less likely to be at high risk. Other risks such as child labor, forced labor, or deforestation are more closely linked to social conditions and human activity and can vary according to government policies, local culture, and poverty, among other causes. Considering how different some coffee growing regions are from one another around the world, it is important to understand where coffee was produced in order to understand what its sustainability impacts are. The following charts show how the hotspot risks within the U.S. coffee supply chain vary depending on were the coffee was originally grown.

United States Modeled Growing Regions - % of Supply

Risk Index: % U.S. Coffee Source Regions at High Risk

Key

- **No High Risk Identified (0%)**
- 1 **Very Few** Source Regions at High Risk **(0-1%)**
- 2 **Few** Source Regions at High Risk **(1-5%)**
- 3 **Many** Source Regions at High Risk **(5-20%)**
- 4 **Many to Most** Source Regions at High Risk **(20-50%)**
- 5 **Most** Source Regions at High Risk **(50-100%)**

United States Trade Partner Supply Chain Risk All Coffee (Arabica + Robusta)	% of U.S. Supply	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Brazil	26%						
Vietnam	16%						
Colombia	14%						
Guatemala	7%						
Mexico	6%						
Indonesia	5%						
Germany	4%						
Peru	4%						
Costa Rica	3%						
Nicaragua	3%						
All Other	11%						

United States Trade Partner Supply Chain Risk Arabica Coffee	% of U.S. Supply	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Brazil	29%						
Colombia	20%						
Guatemala	10%						
Mexico	8%						
Peru	6%						
Costa Rica	5%						
Nicaragua	4%						
Honduras	4%						
Germany	3%						
El Salvador	3%						
All Other	8%						

United States Trade Partner Supply Chain Risk Robusta Coffee	% of U.S. Supply	**Average**	Biodiversity	Child Labor	Deforestation	Forced Labor	Water Scarcity
Vietnam	52%						
Brazil	18%						
Indonesia	14%						
Germany	6%						
Mexico	2%						
Uganda	2%						
Cameroon	1%						
India	1%						
Guatemala	1%						
Tanzania	1%						
All Other	3%						

What can you do?

By reading this report you have hopefully gained new knowledge about the production and sustainability of coffee. Companies and consumers can look for certifications and labels that have criteria to protect biodiversity, deforestation, and workers such as Fair Trade, Organic, Rainforest Alliance, Smithsonian Bird Friendly, UTZ, 4C Common Code, and others. As a consumer you can inquire about sustainability practices to your favorite coffee brand. Companies want to meet consumer needs and asking about sustainability is a way to send the message that consumers care about sustainable coffee production. There are many resources available to continue to learn about issues in coffee. One initiative to follow is the work of Conservation International's Sustainable Coffee Challenge which is working to ensure we all have our cups of coffee into the future.

Data Sources for TSC Commodity Mapping Analyses of Coffee

Coffee Production, Import, and Export Data

FAOSTAT. 2017. Data analyzed from 2010-2014. Accessed on (August 10, 2017). https://s3-us-west-2.amazonaws.com/adms3/Our-Company/Procurement/SupplierExpectations.pdf

International Coffee Organization. 2017. Accessed on (August 10, 2017). http://www.ico.org/monthly_coffee_trade_stats.asp

USDA Foreign Agriculture Service, Coffee World Markets and Trade.2017. Accessed on (August 10, 2017). https://www.fas.usda.gov/data/coffee-world-markets-and-trade

You, L., U. Wood-Sichra, S. Fritz, Z. Guo, L. See, and J. Koo. 2014. Spatial Production Allocation Model (SPAM) 2005 v2.0. Accessed on (August 10, 2017). http://mapspam.info

Risk Data

Conservation International. 2011. Biodiversity Hotpots Revisited. Accessed on (August 10, 2017). https://databasin.org/datasets/23fb5da1586141109fa6f8d45de0a260

Gassert, F., M. Luck, M. Landis, P. Reig, and T. Shiao. 2013. "Aqueduct Global Maps 2.0." Working Paper. Washington, DC: World Resources Institute. http://wri.org/publication/aqueduct-global-maps-20

Global Forest Watch. 2014. World Resources Institute. Accessed on (August 10, 2017). www.globalforestwatch.org

Hansen, M.C. et al. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science. 342 (6160): 850-853.

Olson, D.M., et al. 2001. Terrestrial ecoregions of the world: A new map of life on Earth. BioScience 51(11): 933-938. Accessed on (August 10, 2017). https://databasin.org/datasets/a5b34649cc69417ba52ac8e2dce34c3b

Olson, D.M. and E. Dinerstein. 2002. The global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden. 89: 199–224.

U.S. Department of Labor. 2016. List of goods produced by child labor or forced labor. Accessed on (August 10, 2017). https://www.dol.gov/ilab/reports/child-labor/list-of-goods/

Literature Cited

Caffeine Informer (data from EuroMonitor). 2017. Accessed on (August 10, 2017). https://www.caffeineinformer.com/caffeine-what-the-world-drinks

Casa Brazil Coffees. 2017. Accessed on (August 10, 2017). http://www.casabrasilcoffees.com/learn/harvesting/methods-of-coffee-harvesting-selective-and-strip/

Conservation International Sustainable Coffee Challenge. 2017. Accessed on (August 10, 2017). http://www.conservation.org/stories/sustainable-coffee-challenge/Pages/overview.aspx

Humes, Edward. 2016. Door to Door: The Magnificent, Maddening, Mysterious World of Transportation. Harper Collins, New York, NY. Pg 61-78.

International Coffee Organization. 2017. Accessed on (August 10, 2017). http://www.ico.org/monthly_coffee_trade_stats.asp

National Coffee Association. 2017. Accessed on (August 10, 2017). http://www.ncausa.org/About-Coffee/10-Steps-from-Seed-to-Cup

The Sustainability Consortium (TSC) Commodity Mapping Tool. 2017. https://www.sustainabilityconsortium.org/projects/commodity-mapping/

THE SUSTAINABILITY CONSORTIUM™

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