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IISD REPORT

Meeting China's Global Resource Needs

Managing Sustainability Impacts to Ensure Security of Supply

The IISD Supply Risk Tool Methodology

Jason Potts
Gabriel A. Huppé
Jason Dion
Vivek Voora
Maya Forstater

February 2014

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Head Office
161 Portage Avenue East, 6th Floor, Winnipeg, Manitoba, Canada R3B 0Y4
Tel: +1 (204) 958-7700 | Fax: +1 (204) 958-7710 | Website: www.iisd.org

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About this Paper

This report summarizes work to date on ***how sustainability risks in China's global inward supply chains could be understood and managed to ensure security of supply.***

This study, presented in the Synthesis Report and three working papers (methodology, and copper and palm oil pilot studies), has been prepared by a team led by the International Institute for Sustainable Development (IISD), with support from the UK Department for International Development (DFID).

This working paper has been led by IISD Senior Fellow, Dr. Simon Zadek, and a combined Chinese and international research and engagement team comprising of Han Cheng, Jason Potts, Gabriel A. Huppé, Jason Dion, Vivek Voora, and Maya Forstater.

Mark Halle, Executive Director of IISD-Europe, and Shantanu Mitra, Senior Economic Advisor at DFID China, have also provided insight and guidance. We would in particular like to acknowledge and appreciate the contributions, through participating in surveys, reviewing this report and/or attending the consultation workshop in Beijing on January 10th 2014, from the following, in no particular order. DFID London, Bie Tao and Yan E (MEP), Xu Qingjun and Peng Jing (MOFCOM), Zhang Shiguo (CODA), Zhang Jianping (NDRC), Chen Xiaohong (DRC), Jiang Heng (CAITEC), Wang Haiqin (DRC), Zhang En (CASS), Chen Ying (CCCFNA), Li Yusheng (CNIA), Chang Xingguo (CMA), Wei Xueyan (CBCSD), Adam Lane and Bao Min (BSR), Ren Peng and Zhu Rong (GEI), Yang Jie (Greenpeace), Bai Yunwen (G-Hub), Li Nan (WWF), Zhang Su (DFID), Jill Peng (RSPO), Ji Guojun and Ji Guojun (Xiamen University), Liu Xianbing (IGES), Thomas Kastner (Alpen-Adria University), Lizzie Parsons (Global Witness), Feng Kuishuang (University of Maryland), and many other experts in China and internationally.

Errors and omissions in the Report are the sole responsibility of IISD

Comments on the paper are welcomed in English to the Project Director, Simon Zadek (simon@zadek.net), or in Chinese or English to Han Cheng, Project Manager (chenghan528@gmail.com)

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Introduction

China's large and growing inbound supply chains are amongst the most direct ways in which China's rise impacts economies worldwide. For exporting countries this trade brings economic benefits such as employment, income and investment, but can also be associated with social and environmental (or "sustainability") problems. Negative impacts on land, water, air, biodiversity and communities can translate back into supply chain problems for China, whether through short-term disruptions or the broader impact on China's "brand" in international markets, which can affect the ability of Chinese enterprises to access international capital, resources, markets and talent.

China's strategic concerns to address resource scarcity and build an "ecological civilization" make effective management of the social and environmental footprint of inbound supply chains increasingly critical. Sustainability risks therefore should count for enterprises and policy-makers concerned with China's inbound supply chains. Yet for most companies operating in China, sustainability risks in inbound supply chains are poorly understood and often inadequately managed.

This initiative of the International Institute for Sustainable Development (IISD), supported by the UK Government's Department for International Development (DFID), is intended to help overcome this gap. The project:

- Developed and tested a methodology for assessing the relationship between sustainability and security of supply risks in inbound supply chains.
- Undertook two pilots to test the methodology, based on desk research, looking at the copper and palm oil supply chains.
- Surveyed and convened discussion with business people, policy-makers, academics, and NGOs to test the concepts, methodology and findings and to identify policy-relevant conclusions.

This paper, which outlines the methodology, is therefore complemented by papers on the two pilots. These three input papers feed into the overall synthesis paper, which integrates the overall findings and draws out conclusions and policy recommendations, which are summarized below.

Summary of Conclusions from the Overall Synthesis

This project has demonstrated a systematic approach to assessing sustainability-related security of supply risks, at both an enterprise and a national level. The methodology is an initial foundation which demonstrates the feasibility and relevance of applying a common framework to identify "hot spots" and systematically draw business and policy-makers' attention to them.

It is clear from international and Chinese experience that there are policy measures that can be taken to support better management of supply chain risks. Five policy steps are outlined, which could be targeted to key product and country risks to ensure that supply chain sustainability is recognized as a strategic issue and addressed in a professionalized manner reflecting its importance:

1. **Build supportive capabilities of Chinese embassies and consulates**. The Chinese government through the Ministry of Commerce (MOFCOM) should build the capacity of the Economic and Commercial Affairs Sections of its embassies and consulates to support Chinese companies in identifying and addressing social and environmental impacts.

2. **Strengthen engagement with international standards.** The Chinese government, through MOFCOM and the China National Institute of Standardization (CNIS) should accelerate its engagement with international standards that relate to strategic commodity supply chains at risk, identifying and addressing key gaps and risks, and building on its existing engagement with standards in areas such as conflict minerals and forests.

3. **Explore fiscal measures.** Fiscal measures may offer a lever for encouraging Chinese enterprises to address their own sustainability footprint, and that of their overseas suppliers. The Chinese government could engage in research to understand the potential of fiscal measures to incentivize the development of sustainable supply chains.

4. **Integrate supply chain sustainability** *into green public procurement*. Public procurement criteria can provide a further driver to improve sustainability impacts of China's inbound supply chains. The Chinese government, through MOFCOM, the Ministry of Environmental Protection (MEP) and key provinces could develop and pilot supply chain related green procurement criteria for a limited and targeted set of products.

5. **Develop supply chain risk criteria in existing corporate social responsibility (CSR) and green business guidelines.** Integrating supply chain risk into responsible business guidelines would make them more useful to companies and investors. This could draw on international best practice and the experience of leading Chinese companies

In addition, an overarching approach is needed to China's international supply footprint part of its vision for resilient and sustainable development. One of the most notable findings from the discussions and consultations in developing this project is that there is no ministry or department with an overall vision and mandate for understanding China's import footprint and how it can be managed more effectively. Taking strong action depends on there being an overall vision articulated as part of the broader view of development. The National Development and Reform Commission (NDRC) could consider developing a broader goal and metric of performance on supply chain sustainability, as part of the national planning process in the lead up to the 13th five-year plan, and as part of China's development as an "ecological civilization."

The International Institute for Sustainable Development is committed to working in and with China to advance sustainable development, and views the area of inbound supply chains as a key strategic opportunity to achieve this mutual goal.

1.0 Key Concepts

1.1 The Components of Risk

Efforts to address the implications of the frequency, intensity and duration of supply risks need to account for, not only the probability and impact of physical, geopolitical, economic conditions and events, but also the vulnerability of China and Chinese enterprises to these hazards. The effective adaptation to and management of these risks therefore depends on an understanding of the dimensions of both exposure and vulnerability to these hazards as well as an assessment of the changes in those dimensions.

Vulnerability refers to the propensity of manufacturing companies, key industrial sectors and consumers to suffer adverse effects when impacted by a hazard event (Cardona, et al., 2012). It is possible for an enterprise to be exposed to a hazard but not be vulnerable to negative effects. For example they may use futures and forward contracts to mitigate price risks. Therefore, when an entity is exposed to a hazard, but not vulnerable, the hazard does not represent a risk.

A multi-level view of supply risks should account for:

- Domestic National Vulnerability and Exposure: vulnerability and exposure of the Chinese economy to commodity supply disruptions.
- Domestic Enterprise Vulnerability and Exposure: vulnerability of key sectors and companies to commodity supply disruptions.
- Foreign Country Supply Hazards: potential country level hazards affecting production and trade representing the bulk of commodity sourcing to China.
- Foreign Producer Supply Hazards: potential company level hazards affecting production and trade representing the bulk of commodity sourcing to China.

This multi-level view is depicted in figure 1.

1.1.1 Domestic Vulnerability and Exposure

Domestic National Vulnerability

Domestic national vulnerabilities fall in either of two categories: the availability of the commodity and the affordability of the commodity at a national level. *Availability and affordability* vulnerabilities are common factors found in many security of supply frameworks, including frameworks developed by the Asia-Pacific Energy Research Council (APERC) and the World Energy Council (Hughes & Shupe, 2010). *Availability* vulnerabilities indicate domestic and global availability of the commodity resource, and is the most important component of security of supply. The concept of *Availability* is a measure of the physical ability of the country to meet its commodity consumption needs by either producing it domestically or securing a reliable flow of commodity imports to consistently and reliably meet its consumption needs. The more a country is dependent on external sources for supplying its consumption, the more it is vulnerable to external supply risks. The less diversified this supply the more likely it is that these risks will be systemic. *Affordability* is limited to the commodity's price levels and stability as well as infrastructure costs of transportation and storage. The concept of *Affordability* is a measure of the level and stability of commodity costs, and, therefore, the exposure to economic risks at the national level.

Domestic National Exposure

Economic importance is a measure of the importance of the commodity to key sectors of the national economy. The more important the commodity to these sectors, and the more critical these sectors to the national economy, the higher the costs of disruptions in terms of employment, investment levels, competitiveness, and research and innovation at the national level. Highly economically important commodities represent a higher *loss exposure* than those that are less economically important.

Domestic Enterprise Vulnerability

Domestic enterprise vulnerabilities fall under the same categories as domestic national vulnerabilities, only the factors that comprise this category are geared towards the individual enterprises that consume the commodities for the manufacturing of their products. *Availability* is determined by factors like supply chain diversification and the level of supply chain integration. *Affordability* vulnerabilities concern the commodity price level and stability and how these may impact profitability.

Domestic Enterprise Exposure

Economic importance factors are similar to those found at the national levels, but are being applied to the individual enterprise to determine how supply hazards may affect working capital requirements, capital costs, return on assets, brand and reputation, profits and other measures of operational and financial performance.

1.1.2 Foreign Supply Hazards

Foreign Country Supply Hazards (Country Environment)

The geographical source of a commodity supply is a contributor to supply risk. The main hazards involved at the country level are those affecting the *accessibility* of the commodity. *Accessibility* hazards are those that can limit the continuity of a national supply due to institutional, governance and market factors that can act as barriers to the continuity of supply and lead to disruptions to production levels or trade flows, as well as other geographical hazards like weather events, droughts, disease and transportation disruptions. These factors represent geopolitical risks and generalized sustainability risks. The second category is composed of external sustainability events or conditions that affect production and trade. These are often the result of externalized social and environmental costs and include climate change induced disasters and conditions.

Foreign Producer Supply Hazards (Sustainability Issues)

The foreign commodity producers are subject to various sustainability risks that, under the certain circumstances, can translate into material supply chain risks for Chinese enterprises. These are also related to the *acceptability* of the commodity being produced. The *acceptability* factors are sustainability related and consider how the operations of the producer affect land use, water, climate change, biodiversity and other social and environmental issues. The more harmful the enterprise's operation are to the environment and local communities, the higher the sustainability risks, and the less acceptable is the commodity being produced. Acceptability is a combination of domestic vulnerability and

foreign-producer hazards. If a commodity becomes unacceptable, these sustainability risks become material by way of diminishing the brand and reputation of the Chinese enterprise or by physically disrupting the ability of a producer to produce and supply commodities to its buyers, as in the case of poor maintenance and safety controls causing a mining collapse, the destruction of machinery and facilities, or in the case of poor labour rights and working conditions leading to strikes and social conflicts. Governance and transparency risks can be similarly material by way of reputational and supply disruption effects, and include poor corporate governance, high levels of corruption, poor transparency, litigation risks and poor regulatory compliance which can cause significant disruptions in production and supply. Governance and transparency factors can also serve as a proxy for *acceptability* risks and the probability of negative social and environmental events due to poor managerial and governance controls.

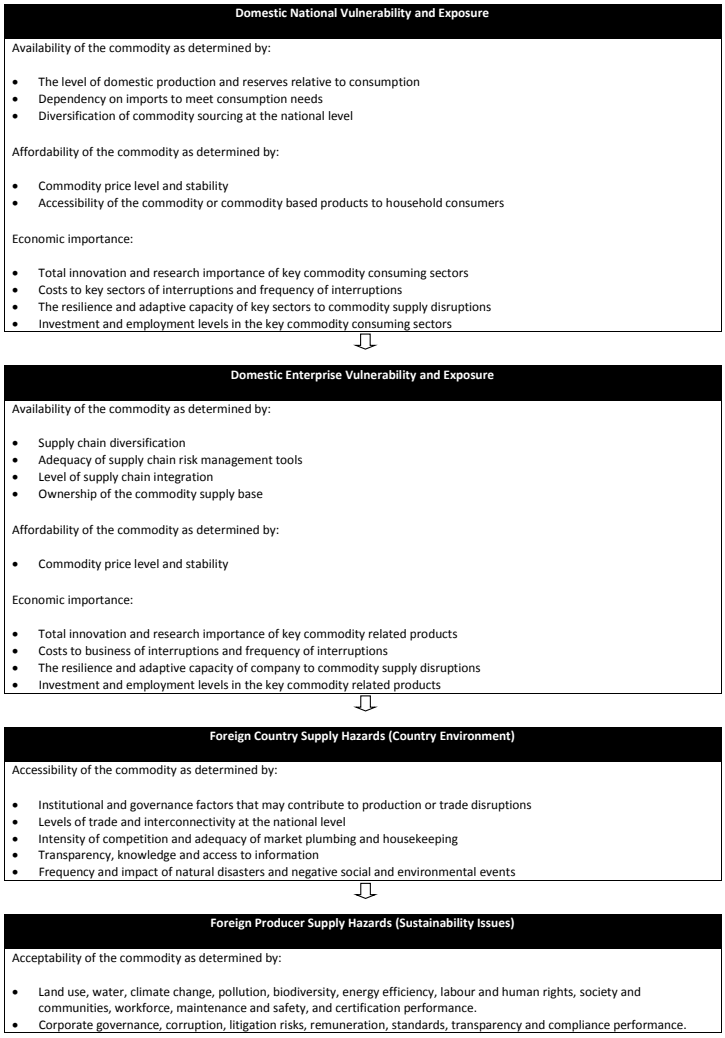

FIGURE 1. LEVELS OF SUPPLY RISK

1.2 Security of Supply

The security of supply of key agricultural and mineral resources is underpinned by two main factors: the scarcity of commodities as the determined physical *availability* of the resource, and various *supply constraints* based on the *acceptability*, *accessibility* and *affordability* of available supplies.

The physical *availability* of the resource is a source of *physical risk*, when countries and companies rely on external sources for satisfying their resource consumption needs. When there are limited volumes of a commodity produced annually, the *accessibility* to and *acceptability* of these resources can be a *supply constraint* on the ability of enterprises and countries to procure these commodities. Supply constraints can be imposed by either the supply-side or demand-side of the commodity chain. On the supply-side, the location of commodity production implies *geopolitical risks* as well as *generalized sustainability risks* (i.e. droughts and storms) that can reduce the accessibility of an enterprise or country to these resources. On the demand-side, certain sources of commodities are unacceptable to countries and enterprises due their relatively high environmental and social repercussions. Commodity buyers can decide to limit the environmental and social externalities of their supply chains by favouring countries and producers with commodity production processes that are more environmentally and socially responsible. Together, resource *availability*, *accessibility* and *acceptability* combine into *economic risks*, when conditions affecting *scarcity*, or heightened competition for these resources, and the *supply constraints* on these commodities cumulate into higher and more volatile price levels, affecting the *affordability* of these resources.

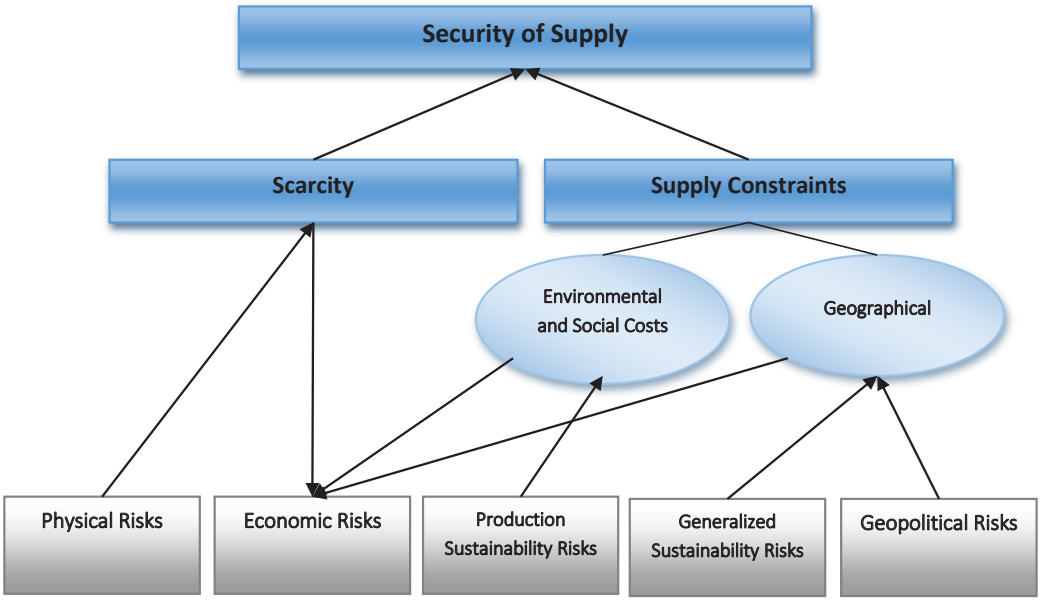

FIGURE 2. SECURITY OF SUPPLY

Key security of supply risks:

- **Physical Risks:** physical risks occur when the limited availability of resources poses the possibility of supply-lagging demand. Over the last century, increased competition for renewable and non-renewable resources has resulted in the most easily accessible resources being exploited, making physical risks a significant concern for key commodities including copper, phosphorous, water, gold, oil, coal and other materials.
- **Production Sustainability Risks:** production sustainability risks occur when the environmental, social or governance (ESG) performance of the supplying producer can compromise production and trade in raw materials, and thus significantly disrupt supply. ESG risks become material when they manifest in the company's supply chain system as either a threat to the company's brand and reputation or actual disruptions in the supply from the affected source of raw materials.
- **Generalized Sustainability Risks:** generalized sustainability risks occur when macro sustainability-related events affect production or trade in a particular commodity system or supply chain. When social or environmental externalities occur, they can spill over to affect the efficiency of commodity producers or encumber the ability to move raw materials from the site of production to the importing company. The most significant of these risks are environmental events and natural disasters like those related to climate change, including increasing incidents of drought, flooding, storms, the propagation of pests, forest fires, and the decreasing availability of water in some areas.
- **Geopolitical Risks:** geopolitical risks occur when the production of a commodity is concentrated in a relatively small number of countries. Many geographical and political factors can positively or negatively impact both the production and trade of commodities in these countries, including events like civil wars, labour strikes, general elections and highly politicized affairs.
- **Economic Risks:** Economic risks occur when physical risks, geopolitical risks and sustainability risks feed into price volatility and inflation. During the last decade, commodity prices have been volatile and increasing due to rising demand from rapidly growing Brazil, Russia, India and China (BRIC) economies. Forecasts predict that commodity prices for many agricultural and mineral commodities will continue at historically high levels over the next 10 years (OECD-FAO, 2013).

1.3 Understanding the nexus

A hazard's potential effect on a national or enterprise level entity is understood as a *loss exposure*, which is a metric that assesses the linkage between the implication of the hazard for the particular commodity sector in terms of its impact on production and trade (quantity and reliability of available supply), and its impact on the source-specific characteristics of that supply (quality of supply) that may have a direct economic effect on the micro and/or macro entity. *Loss exposure* is inextricably linked to the *economic importance* of the resource to the micro and/or macro entity. A hazard loss exposure determines the potential materiality of the hazard in relation to the economic importance of the commodity at the domestic/national or enterprise level entity, assuming that this entity is vulnerable to the hazard.

The other important metric for assessing supply risk is the determination of the national or enterprise level entity's *vulnerability* to the hazard. By combining loss exposure and *vulnerability* assessments, one is able to arrive at a determination of overall supply risk for the entity. Supply risk can be determined on the basis of individual or aggregated hazards.

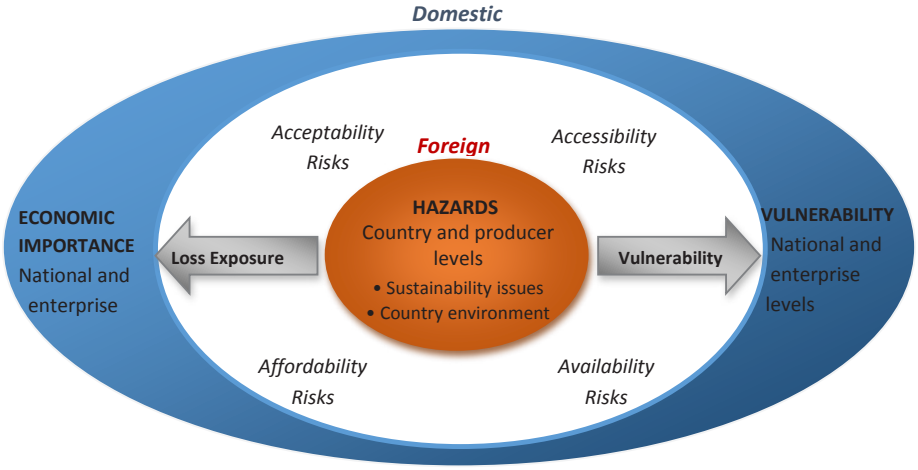

FIGURE 3: SUPPLY RISK

It is increasingly recognized that there is a nexus of interactions between supply chain *sustainability impacts*, and *hazards to supply*. This relationship is mediated through the dynamics of institutions, market societies and ecosystems, which can both exacerbate or ameliorate hazards. Some key examples of how sustainability issues can become material issues for importing enterprises or companies are outlined in Table 1.

TABLE 1. MAPPING THE NEXUS OF SUSTAINABILITY ISSUES AND SUPPLY CHAIN RISKS

	Supply chain risks									
	Price rise and volatility/ affordability risk			Supply disruption/ accessibility risk				Reputation/ acceptability risk		
Production associated with:	Resource pressure	Compliance costs	Environmental pricing	Local protests	Contract risk	Accidents, disasters	Export bans	Public concern at home	Consumer concern	International standards
Large areas of land use	■					■	■			
Water use in areas of water shortage	■	■	■	■		■				
High levels of GHG emissions		■	■					■	■	■
High levels of local pollution		■	■	■		■		■	■	■
Deforestation	■	■		■			■	■	■	■
Impacts on biodiversity		■		■			■	■	■	■
High energy use	■					■				
Labour and human rights abuse		■		■		■		■	■	■
Tensions with local communities	■			■				■	■	■
Maintenance and security risks		■				■		■	■	■
Corruption				■	■			■	■	■
Litigation and compliance risks		■								
Concerns over lack of transparency					■			■	■	■

This is a broad-brush analysis of linkages; in practice the specific relationships between sustainability impacts and commercial risks vary from sector to sector, and over time. Public and consumer concerns may apply in many cases, but whether they are a compelling force depends on the type of product, its consumer niche, and the evolving public expectations of brands and sectors. While reputation can play a key role, there are also more direct cases where local sustainability issues lead to supply chain disruption.

TABLE 2. DEFINITION OF KEY TERMS AND CONCEPTS COMPRISING THE SUPPLY RISK METHODOLOGY

Availability	The *availability* of resources nationally in China and globally. Availability is a measure of the ability of the country to meet its commodity consumption needs by either producing it domestically or securing a reliable flow of commodity imports to consistently and reliably meet its consumption needs. The more a country is dependent on external sources for supplying its consumption, the more it is vulnerable to supply risks.
Affordability	The *affordability* of resources in terms of price levels and stability. Affordability is a measure of the level and stability of commodity costs, and, therefore, the exposure to economic risks at the national level.
Accessibility	The *accessibility* of resources in terms of factors that may act as barriers to production or trade at the country level. Accessibility hazards are those that can limit the continuity of a national supply due to geopolitical risks or negative environmental or social events such as natural disasters or social protests.
Acceptability	The *acceptability* of resources in terms of the social and environmental externalities of the commodity producers. Acceptability factors are sustainability related and consider how the operations of producers affect land use, water, climate change, biodiversity and other social and environmental issues relative to international norms and public expectations.
Economic importance	The *economic importance* of the commodity to key sectors of the national economy, and enterprises within those sectors. The more important the commodity to these sectors, and the more critical these sectors to the national economy, the higher the costs of disruptions in terms of employment, investment levels, competitiveness, and research and innovation at the national level. At the enterprise level, supply disruptions may affect working capital requirements, capital costs, return on assets, brand and reputation, profits and other measures of operational and financial performance
Vulnerability	A *vulnerability* is the propensity of exposed elements, such as manufacturing companies, key industrial sectors and the national economy, to suffer adverse effects when impacted by physical, geopolitical, economic and sustainability hazards.
Hazard	A *hazard* is an agent or a characteristic of supply that is likely to cause supply disruptions or brand and reputational effects if not effectively mitigated or managed.
Loss Exposure	A *loss exposure* is the estimated effect of a hazard on a national or enterprise level entities' economic performance, accounting for the prospective impact of a hazard, the likelihood of that impact occurring, and the prevalence of this hazard in the entities' supply chains.

2.0 Assessment Methodology

This methodology has been designed to be useful for demand-side national and enterprise level actors trying to understand the implications of supply-side sustainable development related hazards on demand-side commodity security of supply. It is intended to provide a hotspot analysis, flagging areas of concern with regard to sustainability that could come to impact commodity security of supply. The results can either be used to identify areas that require further analysis, or to identify areas which should be the target of policy. It has also been designed to be flexible to both data-poor and data-rich assessments, where the results can be read as being either indicative or predictive, depending on the strength and reliability of the inputs used in the application of the methodology.

This methodology draws together four elements related to supply risk—economic importance, vulnerability, the supply country environment and sustainability issues. Economic importance and vulnerability relate to the demand-side, while supply country environment and sustainability issues relate to the supply-side. Hazards on the supply-side related to the country environment or to sustainability issues can impact importing countries or enterprises in two ways—either by negatively impacting the quantity of supply available, or via value at risk, i.e. negative reputational impacts and the like. This methodology considers both of these types of impact, since they are both key ways by which supply-side hazards can affect those on the demand-side.

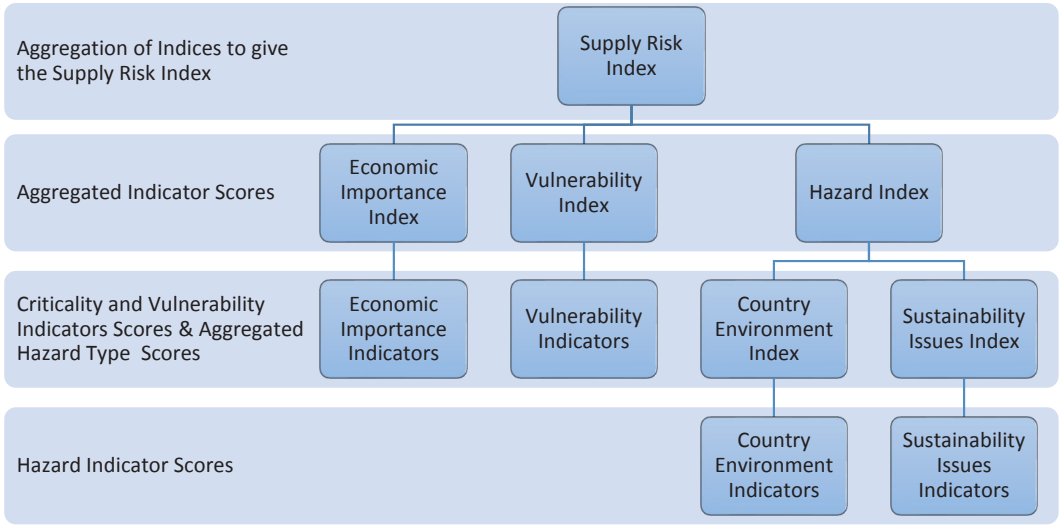

FIGURE 4. ASSESSMENT METHODOLOGY FRAMEWORK

Sustainable development related risks are different than other types of commodity-supply risks because they can affect commodity security of supply either directly, or through indirect external effects. They can correlate with one another and even with other types of commodity-supply risk, and they can have cumulative effects as different types of sustainable development related hazards interact with one another and become more pronounced over time, exacerbating risk. Supply-side and demand-side are distinguished in the methodology and considered as separate entities, but in practice this conceptualization may be more complex, where long-standing relationships may mean that

the two parties interact closely and even make decisions together, or where partial or full ownership of the resource may exist, in effect making a given entity its own supplier.

As stated above, four factors combine to affect the quantity of supply risk experienced for strategically important commodities: the economic importance of a commodity in the importing country, the country's vulnerability to supply hazards, and the presence and scale of hazards on the supply-side with respect to both sustainability issues and the country environment. Economic importance relates to the importance of the commodity in the national economy or enterprise production, vulnerability relates to the affordability (price) of the commodity and its availability (quantity), and hazards relate to impacts on the accessibility (physical supply) and acceptability (value at risk) of commodity supplies being driven by country environment factors or sustainability issues.

The commodity supply risk framework developed for this methodology contains an inventory of indicators that are used to understand economic importance, vulnerability and hazards. Loss exposures to given sustainable development related hazards are individually assessed, depending on factors relevant to each commodity. Hazard loss exposures are assessed by looking at a number of constituent components—the hazard's relevance to the sector, the share of supply impacted by the hazard, the prospective impact of the hazard, and its likelihood of occurrence.

This hazard loss exposure is then evaluated in the context of the economic importance of the resource and the vulnerability to supply disruptions on the demand-side at the national and enterprise levels. The overall risk level is calculated as follows:

Supply Risk Level = Average (Hazard Loss Exposure, Vulnerability and Economic Importance Score)

Economic importance and vulnerability are assessed with respect to the specific commodity and loss exposure is assessed with respect to the specific hazard. Assessments of the importance of the various elements are conducted on a scale of 0 to 3 representing low (0), medium (1), high (2), or very high (3). This approach keeps the assessment straightforward and accommodative of both qualitative (data-light) and quantitative (data-heavy) evaluations, with qualitative findings fitted to this scale or quantitative indicators indexed to it.

Hazards are assessed individually for both the national and enterprise levels and are done in light of the country or enterprise's unique supply mix. This means that for a given hazard, the assessment is carried out with respect to the country or enterprise's main suppliers, not the main global suppliers. Supply-side national and enterprise level hazards are distinguished, and evaluated individually in terms of their impact on the demand-side national and enterprise levels. For each hazard, a number of different elements are scored: the relevance of the hazard to the commodity being analyzed; the share of supply that could be affected by the hazard; and both the likelihood of the hazard having an impact and the anticipated size of the impact, for both the national and enterprise levels. These assessments of likelihood and impact are then combined to produce an assessment of the loss exposure that the hazard represents at both national and enterprise levels. As with economic importance and vulnerability, these are each evaluated on a 0 to 3 scale. The hazard loss exposure, for both the national and enterprise levels, is then calculated by taking the average of the scores assigned to the hazard's relevance, share of supply impacted, and prospective impact and likelihood.

Hazard Loss Exposure = Average (Relevance, Share of Supply, Prospective Impact, Likelihood)

These assessments of loss exposure are then themselves combined to produce an assessment of the overall level of hazard loss exposure that exists in the commodity supply chain. Assessments of economic importance and vulnerability

follow, and are input into the formula above to produce an overall assessment of sustainable development related supply risk for the commodity as it relates to both the national and enterprise levels on the supply-side.

The overall methodological procedure is therefore as follows:

1. **Assess hazards** by:
    a. For a given country or enterprise scoring the relevance of the hazard to the commodity sector, the share of supply to which the hazard applies, the prospective impacts on the national or enterprise entity as a result of this hazard, and the probabilities of these impacts occurring.
    b. Combining these assessments into a hazard loss exposure score.
    c. Averaging the various hazard loss exposures to arrive at country and producer level aggregate hazard loss exposure.
2. **Assess economic importance** of the commodity to the importing country or enterprise.
3. **Assess vulnerability** of the importing country or enterprise with respect to availability (quantity) and affordability (price).
4. **Assess these loss exposures** *in the context of economic importance and vulnerability* to estimate the risk level.

The individual assessments of the risk represented by the hazards in the framework can be used as an index to identify the hazards that are particularly relevant to commodity supply disruption and brand and reputational impacts at the national and enterprise levels. The result provides a traffic light style hotspot analysis, which allows for the flagging of particular risk types for further analysis. Further, these risk levels, when aggregated to come up with an overall supply risk at the national and enterprise levels for the given commodity, can be used for comparison across commodities of interest and to identify commodities where the greatest risk is present. The outputs of the methodology can also be used to understand which enterprise level risks are significant and could come to translate into national level risks, and thereby where it might be necessary to intervene with policy.

2.1 Developing the Framework

The supply risk framework was developed in line with our multi-level view of supply risk, and the deconstruction of risk into economic importance, vulnerability and hazards. In order to populate the framework, literature reviews were undertaken to identify the economic importance, vulnerability and hazard factors across the demand-side macro (national) and micro (enterprise) and supply-side macro (country) and micro (producer) levels.

For each of the enterprise level, vulnerability and hazard elements are underlying indicators that were gleaned from literature. Appendix 1 lists these indicators. The main sources for these indicators are also listed in the Appendix. Namely, a study by Sovacool and Mukherjee (2011), which provides a synthesized, workable framework for analyzing national energy security policies and performance, was helpful. Composed of 320 simple indicators and 53 complex indicators, this framework was developed for policy-makers and scholars wanting to analyze, measure, track, and compare national performance on energy security, but many of the indicators are also applicable to a wide range of strategically important non-energy commodities. These indicators were compiled by Sovacool and Mukherjee through 68 semi-structured research interviews over the course of February 2009 to November 2010, including visits to the International Energy Agency, U.S. Department of Energy, United Nations Environment Program, Energy Information Administration, World Bank Group, Nuclear Energy Agency, and International Atomic Energy Agency. Other indicators

were taken from Society of Investment Professionals in Germany (DVFA) and The European Federation of Financial Analysts Societies (EFFAS) (2010)'s version 3 report on environmental, social and governance (ESG) key performance indicators, the Global Reporting Initiative's (2011) Sustainability Reporting Guidelines, and emerging market ESG indices (S&P Dow Jones Indices, 2011). Where needed, these indicators were adapted for our context and complemented with our own indicators as well.

This framework is outlined in Appendix 2.

2.2 Applying the Framework

The application of the supply risk assessment method to copper and palm oil pilot studies is composed of three main levels of analysis:

- The Global Commodity Context level assesses the commodity's global security of supply conditions.
- The National Security of Supply level assesses the economic importance of the commodity for the domestic economy and society, and the vulnerability of the economy and society to supply disruptions.
- The China Global Commodity Supply Chains level assesses the foreign (supply-side) country and producer hazards broadly in terms of their prospective impacts, the likelihood of these impacts, and the resulting hazard loss exposure on supply-side micro and macro-levels (Chinese enterprises and China as a country).

The application of the framework in the assessment of supply risks in copper and palm oil is restricted by the availability of data. Therefore, we employed a multi-criteria indicator selection approach that allows us to choose indicators on the basis of the feasibility of obtaining adequate information, the importance of the indicator in understanding supply risks, and its relevance to the sustainable development and security of supply intersection.

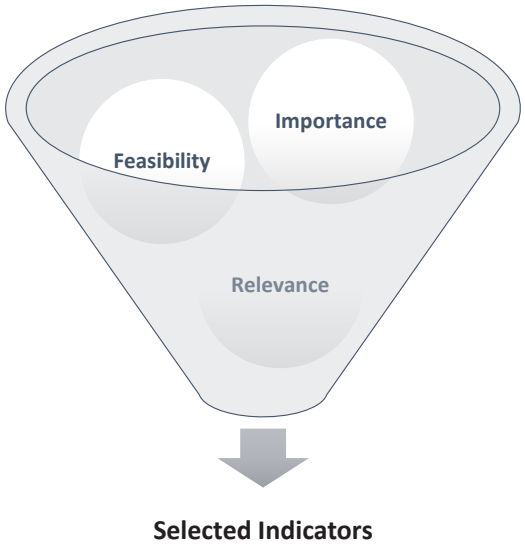

FIGURE 5. MULTI-CRITERIA INDICATOR SELECTION

At the China national level, the economic importance of the resource and the vulnerability to supply disruptions is assessed quantitatively because the availability of relevant data from databases like FAOSTAT, UN Comtrade and others makes such assessments feasible. At the enterprise level, we have little information to be able to quantitatively assess economic importance and vulnerability, and restrict our discussion of these elements to a conceptual and qualitative level, which we try to adapt to the context of Chinese enterprises where possible.

On the supply-side, at the foreign country and producer levels, we developed a framework that allows the analyst to glean evidence from literature regarding the following characteristics of hazards: their relevance to the commodity sector, the prospective impact of the hazard on the China or Chinese enterprise levels, the probability of those impacts occurring, and the share of supply to which the hazard applies. All of these analyses are combined for each hazard into a hazard loss exposure, a single indicator that assesses the extent of prospective losses at the China and Chinese enterprise-levels due to the presence and magnitude of these hazards. Individual loss exposures at the China and Chinese enterprise levels are aggregated into overall loss exposures in the commodity supply chain for these entities. The China national and Chinese enterprise hazard loss exposure assessments indicate the level of prospective losses that are associated with the presence of these hazards, assuming that the China national or enterprise entity is fully vulnerable to these hazards, and the commodity is particularly critical and strategically important.[1]

In the final stage of the supply risk assessment, hazard loss exposures are assessed in the context of economic importance and vulnerability for China and Chinese enterprises. This final assessment gives way to a conclusion regarding supply risk in the specific China or Chinese enterprise context.

The overall methodological procedure is therefore as follows:

1. **Assess economic importance** of the commodity to the importing country or enterprise.
2. **Assess vulnerability** of the importing country or enterprise with respect to availability (quantity) and affordability (price).
3. **Assess hazards:**
    a. For a given country or enterprise scoring the relevance of the hazard to the commodity sector, the share of global supply to which the hazard applies, the prospective impacts on the national or enterprise entity as a result of this hazard, and the probabilities of these impacts occurring.
    b. By combining these assessments into a hazard loss exposure score.
    c. By summing the various hazard loss exposures to arrive at country and producer level aggregate hazard loss exposures.
4. **Assessing these loss exposures** *in* **the context of economic importance and vulnerability** to estimate the risk level.

[1] For example, assuming high levels of economic importance and vulnerability, what are the China national and Chinese enterprise loss exposures due to the following hazards: at the country level, a natural disaster damaging crops, thus destroying mining facilities and equipment or other critical infrastructure (e.g. transportation or energy infrastructure), and a government deciding to increase trade barriers in favor of domestic industries, while at the producer level, sustainability issues like environmental degradation or the unfair treatment of workers and local communities giving rise to opposition and conflicts, or poor maintenance and safety records causing operations to be shut down such as in the cases of a mining collapse?

Enterprise supply risk is a construct that assesses hazard loss exposures in the context of the economic importance of the commodity and the vulnerability of the enterprise to both supply disruption and brand and reputational effects. Supply disruptions occur when country or producer supply hazards have implications for the productivity or efficiency of operations, potentially constraining the quantity and reliability of supplies, or reducing the enterprises' accessibility to these resources and their affordability. Brand and reputation is also a factor in enterprise supply risk by way of acceptability considerations. Where environmental, social and governance factors at the producer or country level do not comply with either the normative standards of the public or the sourcing policies of the enterprise, there may be negative brand and reputational repercussions or the imposition of voluntary supply constraints.

National supply risk is a construct that assesses hazard loss exposures in the context of the economic importance of the commodity and the vulnerability of China to a secure (affordable and stable) supply. Supply disruptions or increases in the level and volatility of prices may occur due to either generalized or China-specific conditions and events:

- Generalized effects are those that disrupt supply effectively irrespective of its intended destination, which could be China national or Chinese enterprise levels. These effects occur at the country level of supply, and include accessibility hazards like resource nationalism or environmental disasters. Generalized disruptions occur across all or at least a material portion of supply options, and can arise because of a highly concentrated supply that makes generalized and source specific the same, or the systemic nature of the hazard. A hazard that is systemic to the particular commodity production sector affects a cross section of producers, making the entire production system's ability to supply dependent upon the maintenance of certain conditions.
- China-specific effects are those where supply to China more specifically is impacted, and could be either producer level if only limited capacity to supply exists (in this case producer level supply hazards are also transferred to the country level) or if only the disrupted producers are able or willing to supply China, Additionally, China-specific effects might be national level, for example, if there is a political standoff between China and the sourcing country.

In addition, Chinese enterprise level supply risks can produce supply risks at the national level by way of China's influence on the supply chain's transactional activities. Due to China's influence on Chinese enterprises' procurement policies, a portion of transactional supply is actually structural in nature. China may also be impacted by way of its ownership of commodity producers in foreign countries. Finally, the competitive implications of Chinese enterprises' commodity sourcing can also translate into national-level competitiveness. All of these issues that are particularly relevant in the Chinese context have particular applications for policy-makers wishing to influence responsible and sustainable collective action.

References

A.T. Kearney. (2011). *Raw Material Strategy—Volatility Is Here to Stay: A four-pronged approach to raw material management*. Chicago, USA.: A.T. Kearney, Inc.

Amiruddin, M. N. (2003). Palm Oil Products Exports, Prices and Export Duties: Malaysia and Indonesia Compared. *Oil Palm Industry Economic Journal , 3* (2), 15-20.

Cardona, O.-D., van Aalst, M. K., Birkmann, J., Fordha, M., McGregor, G., Perez, R., et al. (2012). Determinants of Risk: Exposure and Vulnerability. In C. B. V. Barros, T. F. Stocker, D. Qin, D. J.

Dokken, K. L. Ebi, M. D. Mastrandrea, et al., *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (pp. 65-108). Cambridge, UK: Cambridge University Press.

DEFRA. (2012). *Resource Security Action Plan: Making the most of valuable resources*. London: Department for Environment, Food and Rural Affairs.

DNV. (n.d.). *Supply Chain Risk Management - Turning Environmental, Social and Governance Risks into Rewards*. DET NORSKE VERITAS.

DVFA and EFFAS. (2010). *KPIs for ESG: A Guideline for the Integration of ESG into Financial Analysis and Corporate Valuation*. Frankfurt: DVFA Society of Investment Professionals in Germany in conjunction with EFFAS European Federation of Financial Analysts Societies.

FAO. (2003). *World agriculture: Towards 2015/2030*. (J. Bruinsma, Ed.) London and Rome: Earthscan Publications Ltd.

GRI. (2011). *Sustainability Reporting Guidelines*. Global Reporting Initiative.

Koehler, D. A., & Hespenheide, E. J. (2013). Finding the Value in Environmental, Social, and Governance Performance. *Deloitte Review* (12), 98-111.

Maplecroft. (2013 9 January). Maplecroft's Political Risk Atlas 2013 Forecasts Global Risk Hotspots. From http://maplecroft.com/about/news/pra_2013.htm

S&P Dow Jones Indices. (2011). *S&P ESG India Index Methodology*. The McGraw-Hill Companies, Inc.

Simchi-Levi, D. (2010). *Operations Rules: Delivering Customer Value through Flexible Operations*. Cambridge: Massachusets Institute of Technology.

Smith, P. G. (2010). Competition for land. *Philosophical Transactions of the Royal Society B, London, 365*, 2941-2957.

Sovacool, B. K., & Mukherjee, I. (2011). Conceptualizing and measuring energy security: A synthesized approach. *Energy , 36*, 5343-5355.

Appendix 1: Indicators framework

		Macro level assessment (national)	Micro level assessment (enterprise)
Domestic (Demand-side)	Economic importance	**Existing indicators:** • Commodity imports per capita • Commodity imports per GDP **Potential additional indicators:** • Direct employment in key commodity consuming sectors • Induced employment in key commodity consuming sectors • Technical expertise in key commodity consuming sectors (number of engineers or energy employees) • Unemployment in these sectors (%) • Expenditures on financial support mechanisms to these sectors • Net capital investment in related infrastructure • Total amount of stranded costs or sunk costs • Planned production expansion in these sectors • Average rate of return on investments in these sectors • Commodity intensity (amount needed for USD $1,000 of GDP) • Commodity intensity in key sectors (amount needed for USD $1,000 of GDP in key sectors)	**(Existing: none used, currently relies on macro indicators)** **Potential additional indicators:** • Commodity importance to product value • Investment and employment • Efficiency and intensity • Innovation and research • Supply chain integration • Ownership of commodity supply base • Planned new key commodity consuming sector projects including construction status of approved projects • Commodity intensity (amount needed for USD $1,000 of EBITDA) • Commodity intensity in key sectors (amount needed for USD $1,000 of EBITDA)
	Vulnerability	**Existing indicators:** • Imports as share of global production • Imports as share of global imports • Import dependence • Concentration of foreign supply Diversification **Potential additional indicators:** • Total commodity reserves • Total commodity reserves per capita • Proven recoverable commodity reserves • Proven recoverable commodity reserves per capita • Average commodity reserve-to-production ratio • Average commodity reserve-to-consumption ratio • Self-sufficiency (%) of demand met by domestic production • Total commodity supply per capita • Total commodity supply per GDP • Peak commodity demand (eg. peak load electricity demand) • Base commodity demand (eg. base load electricity demand) • Refining capacity (as percentage of consumption) • Refining capacity (volume refined per year) • Annual amount of commodity production • Growth in commodity production per year • Annual commodity consumption per capita • Net commodity imports • Ratio of commodity exports and imports to consumption • Total commodity imports • Balance of payments related to commodity or commodity group imports • Diversification in commodity sourcing (number of countries, companies, etc.) • ShannoneWiener Index • Herfindahl-Hirschman Index (HHI) Index • Commodity capacity margins (maximum supply versus maximum demand) • Volume of commodity in reserves • Percentage of commodity capacity actually utilized • Peak demand vs. base demand (eg. baseload demand) ratio • Consumption profiles summer/ winter • Production profiles summer/ winter • Emergency stockpiles (number of days to meet average demand) • Emergency stockpiles (as % of imports)	**(Existing: none used, currently relies on macro indicators)** **Potential additional indicators:** • Total number of suppliers • Percentage of sourcing from three biggest external suppliers • Turnover of suppliers in per cent • ESG compliance systems • Cost of interruptions
Foreign (Supply-side)	Producer sustainability	**Existing indicators:** • Level of land use • Level of water use • GHG intensity • Pollution concerns • Biodiversity impacts • Energy intensity • Labour and human rights concerns • Concerns in relation to competing claims on resources • Safety risks • Corruption concerns in relation to the industry • Litigation and compliance risks in the industry Concern over lack of transparency **Potential additional indicators:** • New issues	**Existing indicators:** • Level of land use • Level of water use • GHG intensity • Pollution concerns • Biodiversity impacts • Energy intensity • Labour and human rights concerns • Concerns in relation to competing claims on resources • Safety risks • Corruption concerns in relation to the industry • Litigation and compliance risks in the industry Concern over lack of transparency **Potential additional indicators:** • New issues
	Country environment	**Existing indicators:** • Lack of strong climate policy • Resource nationalism • Exposure to natural hazards • Lack of commitment to trade openness • Poor record on governance • Poor rating on market competition and infrastructure • Risk of lack of inadequate information by producers **Potential additional indicators:** • New issues	**Existing indicators:** • Lack of strong climate policy • Resource nationalism • Exposure to natural hazards • Lack of commitment to trade openness • Poor record on governance • Poor rating on market competition and infrastructure • Risk of lack of inadequate information by producers **Potential additional indicators:** • New issues

Authoring Team

Jason Potts, International Lead

Jason Potts manages the Sustainable Markets and Responsible Trade (SMART) Program at the IISD. Prior to joining IISD, Mr. Potts worked with the Trade, Employment and Competitiveness Program at the International Development Research Centre, as well as the North American Commission for Environmental Cooperation's Trade and Environment Branch on issues at the nexus of trade, environment and international development.

potts.jason@gmail.com

Gabriel A. Huppé, Project Researcher

Gabriel Huppé works across the IISD with the Natural and Social Capital program, the Sustainable Finance program, the Trade and Investment program, and the Impact Network. His work focuses on governance and policy innovations, international food production and trade system, and the role of the private sector in sustainable development.

ghuppe@iisd.ca

Jason Dion, Project Researcher

Jason Dion's work at IISD focuses on Greenhouse Gas mitigation, environmental impact analysis, the green economy, and Nationally Appropriate Mitigation Actions (NAMAs). He is a graduate of York University focusing on ecological economics, and holds a certificate from Laval University's Partnership for Economic Policy (PEP) in development policy modeling using Computable General Equilibrium (CGE) economic models.

jdion@iisd.ca

Vivek Voora, Project Researcher

Vivek Voora works with the Natural and Social Capital Program, Trade and Investment Program and Water Innovation Centre at IISD. He works broadly on projects related to natural capital, ecosystem services, sustainable agriculture and water management as well as ecosystem markets, greening supply chains and sustainability standards.

vvoora@iisd.ca

Maya Forstater, Lead Writer

Maya Forstater is a researcher and writer with 15 years experience in the field of sustainable development and business, leading research with multilateral institutions, multi-sector collaborations, major corporations in the energy, ICT, apparel, mining and minerals and mobility sectors, and has written extensively on a range of issues related to sustainability and business.

maya@zadek.net

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International Institute for Sustainable Development
Head Office
161 Portage Avenue East, 6th Floor, Winnipeg, Manitoba, Canada R3B 0Y4
Tel: +1 (204) 958-7700 | Fax: +1 (204) 958-7710 | Website: www.iisd.org