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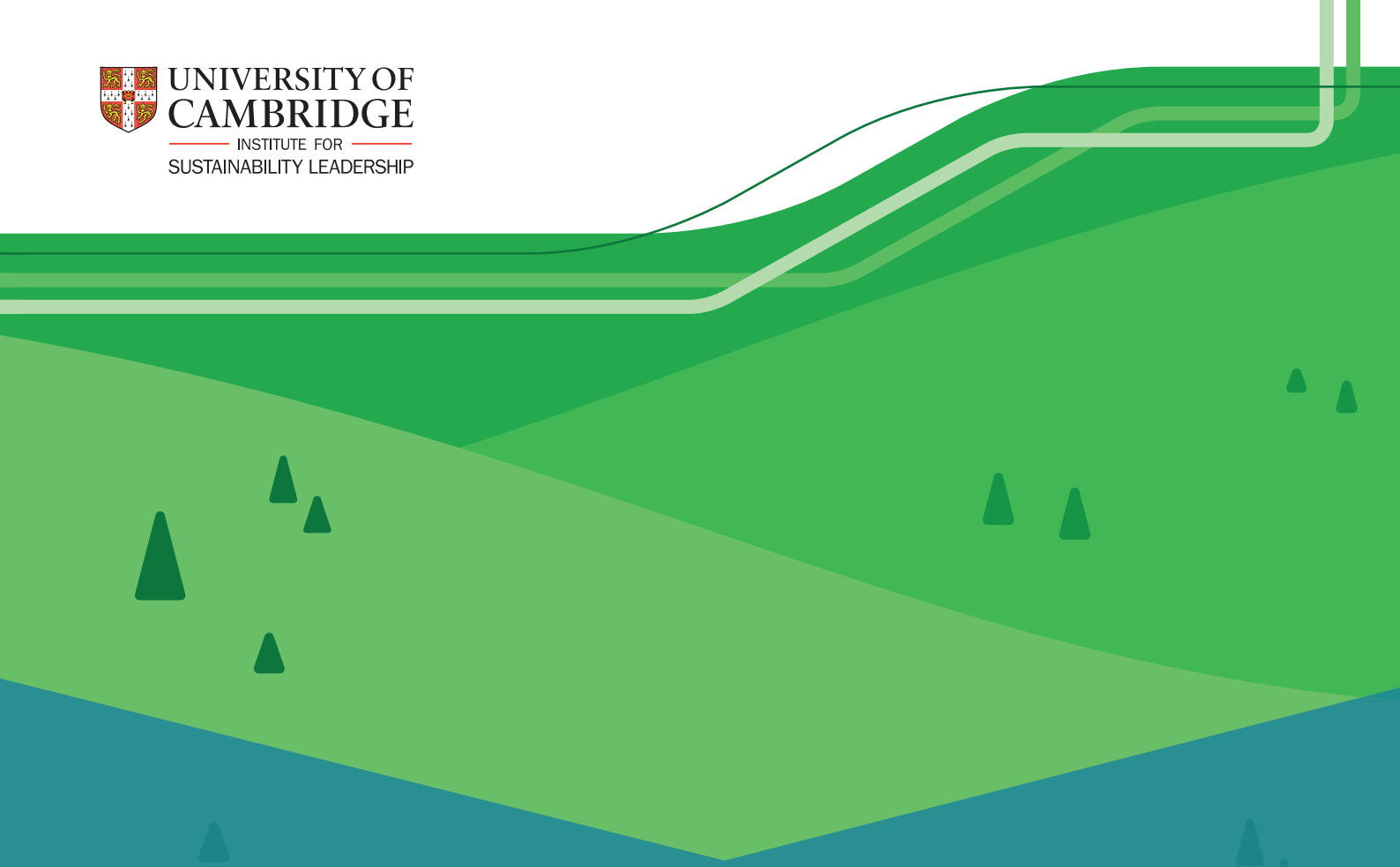
INSTITUTE FOR SUSTAINABILITY LEADERSHIP



Doing Business with Nature

Opportunities from natural capital

#RewireEconomy

Contents

Rewiring the Economy: Ten tasks, ten years, another future

Business thrives on a clear, long-term plan, yet the ability of the world's business leaders to plan for the future is undermined by a dramatic set of global challenges which remain unaddressed: inequality is rising, greenhouse gas emissions are rising, water and natural resources are becoming more scarce, and the responses to all of these are not yet clear. The global economy has proved its ability to drive innovation, but in key respects is unsustainable, its necessary reforms discussed but not delivered.

In 2015 – a year which sees the climax of a number of international discussions to agree new approaches to these global challenges – the University of Cambridge Institute for Sustainability Leadership is seeking to harness the power of its network and the lessons learned during its 26 year history to develop a new ten year, ten point plan to rewire the global economy. Designed for business, policy and financial leaders, the plan will identify the steps necessary to ensure capital flows into sustainable business models. In developing it, CISL will draw on the insights and achievements of its leadership groups including the Natural Capital Leaders Platform.

Acknowledgements

This report was written by Dr Gemma Cranston, Dr Jonathan Green and Hannah Tranter from the University of Cambridge Institute for Sustainability Leadership (CISL). CISL would like to thank the Natural Capital Leaders Platform member companies for their input into this collaborative report.

CISL's Natural Capital Leaders Platform convenes companies wishing to better understand and manage their impacts and dependencies on natural capital. By valuing these impacts and dependencies, our members are able to make better decisions, identify new business opportunities and contribute solutions to natural capital loss and ecosystem degradation.

Doing business with nature: opportunities from natural capital, led by the Natural Capital Leaders Platform, serves as a vehicle for engaging industry in a review of the global challenges around water, biodiversity and soil and for sharing business responses.

We are grateful for comments from colleagues: Bojana Bajzelj, Simone Cooper, Prof Doug Crawford-Brown, Dr Elizabeth Curmi, Dr Lynn Dicks, Dr Andreas Kontoleon, Dr Jagjit S. Srai, Dr Konstantina Stamati and Dr Bhaskar Vira. Our thanks extend to Prof Michael Samways (Mondi's Ecological Network Programme). Any errors that remain are our own.

Natural Capital Leaders Platform members

Foreword

A call for action and research

At the Cambridge Institute for Sustainability Leadership (CISL) we regularly see at first-hand the importance of both top-level leadership and collaboration for innovation and research-based sustainability. Now more than ever, tackling natural resource challenges, including the degradation of natural stocks and services, requires translating ideas and values into action.

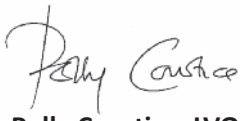
Climate change, increasing consumption and the degradation of natural resources including water, biodiversity and soil, are pushing companies to find appropriate ways to respond to these challenges. The effectiveness of the responses will define the future status and condition of our planet's most vital resources as well as determine the success of business operations across the globe. To address the scale of the challenge business leaders need to stretch beyond the current corporate responsibility agenda to embrace broader systemic change.

There is an urgent call for business to respond to the challenges generated by resource scarcity – and the associated policy ramifications – to secure their operations, supply chains and licences to operate; this in a world where reputation is increasingly a function of sustainability performance.

This *Doing business with nature* report highlights examples of the challenges around water, biodiversity and soil but more importantly showcases the business response from members of our Natural Capital Leaders Platform. They look to CISL to help them navigate this myriad of complexity, offering the latest science to inform their leadership decisions.

The relationship between business activity and loss of natural capital is understood by progressive companies. However, to embed natural capital into mainstream decisions companies now require evidence of the commercial advantages that securing and enhancing natural capital can deliver. This evidence must go beyond reputational gains and deliver the commercial logic to halting environmental degradation.

At this crucial point in time, joining the dots between natural capital challenges and business growth has never been so important. This will strengthen the case for business to invest in the sustainable management of water, biodiversity and soil to realise commercial gains. At CISL, we look forward to bringing together that body of evidence in partnership with a group of companies with the vision to deliver a new ambitious agenda for business growth that can be accommodated within our available natural capital.



Polly Courtice, LVO
Director,
University of Cambridge Institute for Sustainability Leadership (CISL)

Foreword

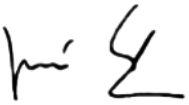
As the world's largest food and beverage company it is our responsibility at Nestlé to pave the way for other companies to appropriately address some of today's most pressing issues. These challenges are complex and stretch beyond our impact on the environment to our dependence on water, biodiversity, soil and our natural capital.

While communicating sustainability is of utmost importance for leading companies, Nestlé's sustainability story is not about how we talk about it, but how we make it happen. As the Chair for the Natural Capital Leaders Platform I consider natural capital and sustainability to be a direct operational matter which needs to be embedded across our different company functions.

In order to take action we need to be aware of both our dependence on natural capital and the associated challenges; such understanding can safeguard us from activities that might produce unintended consequences and go against our long-term interests. This *Doing business with nature* report clearly outlines the challenges and business responses to water, biodiversity and soil – three important elements that underpin natural capital. In Nestlé we need to be able to consistently assess where to prioritise our efforts on natural capital and this report provides the knowledge base that can inform our decisions.

The question I now pose is can we demonstrate the commercial benefit of tackling our natural capital challenges at scale? There is a real sense of urgency, to align profitability and sustainability, both of which form the basis for a successful business. We increasingly recognise that we cannot sacrifice the long-term dependencies of our business upon water, biodiversity and soil for short-term gains.

It is by developing science, and creating the much needed body of evidence which informs the commercial logic for natural capital interventions, that we can begin to prioritise our actions. No one company can do this alone and I am delighted to be part of a group of like-minded businesses, as Chair of CISL's Natural Capital Leaders Platform, in developing the means to align business targets with the management of natural capital.



José Lopez
Executive Vice President, Nestlé S.A.
Chair of the Natural Capital Leaders Platform

1 Setting the challenge

1.1 Natural capital is everybody's business

Doing business with nature: opportunities from natural capital aims to lay out the challenges and opportunities of companies whose future growth depends on a healthy and sustained supply of nature's goods and its services (natural capital). It breaks down key natural capital elements and supports businesses in beginning to build up the commercial logic that is needed to underpin appropriate business responses.

Natural capital impacts and dependencies directly affect the food and beverage, fuel, feed and fibre sectors. To manage their most significant impacts and dependencies on natural capital, companies need to focus upon the growing and production stages of supply chains. Securing the supply of their raw materials requires businesses to invest in the protection of water, biodiversity and soil.

This report guides businesses through water, biodiversity and soil issues whilst introducing a need for commercial evidence that links these broad issues with the day-to-day operational concerns of the business community.

> *"Natural capital is high on our agenda; having this report in our armoury to more effectively communicate with others on the subject will help to inform our debates and decisions in the future."*
>
> **Chris Brown**
> General Manager for Environmental Sustainability, Olam International Ltd

1.2 Challenging business as usual

The effectiveness of business as usual and current responses to water, biodiversity and soil challenges is questionable. This report challenges the status quo and invites businesses to reflect upon their natural capital strategies. At a time of increasing global pressures and declining trends of natural capital stocks, contemplating a shift from short-term actions, which offer temporary improvements, to longer-term natural capital investments is crucial[1].

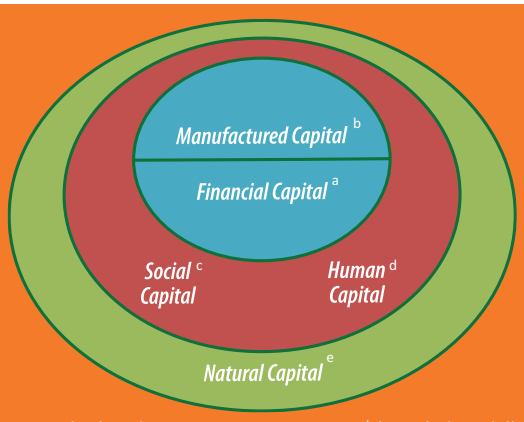
This report provides some practical, strategic and managerial responses to how companies are overcoming these challenges whilst also indicating business knowledge gaps and barriers to implementing solutions: best practice can have significant benefits if rolled out across businesses[2]. Tackling natural capital challenges requires collaboration between all stakeholders within a landscape to explicitly consider natural capital interdependencies and devise solutions based on the best available science.

Considerable opportunities and revenue growth can be generated if the challenges and business risks highlighted within the following chapters are addressed appropriately. This transformative shift can reverse trends that, if unchecked, could undermine a company's capacity to operate and grow in the future.

What is natural capital?

Capital is most often thought of as the wealth or assets of an individual, company or nation. 'Natural capital' is an economic characterisation of the limited stocks of physical and biological resources found on Earth. It refers to the limited capacity of ecosystems to provide services (i.e. the direct and indirect contributions of ecosystems to human well-being).

Natural capital underpins the four other capitals (financial, manufactured, human and social). This report highlights the goods and services that relate particularly to water, biodiversity and soil.



[a] money, stocks, bonds
[b] infrastructure, tools, roads
[c] families, communities, governance systems
[d] knowledge, skills, health
[e] water, biodiversity, soil, ecosystems, sea

Figure 1: Forum for the Future's Five Capital Model of the Economy

1.3 The business case

Businesses are increasingly aware of their dependencies upon natural capital and there is a growing interest in managing costs, reducing exposure to risk and creating commercial opportunities through strategies that enhance natural capital. However, this has tended to focus on water usage and carbon emissions, often neglecting other critical aspects of natural capital, such as biodiversity, soil and their interdependencies, essential to the production of raw materials. These challenges and business opportunities are outlined in the infographic designed by the Natural Capital Leaders Platform (Figure 2).

> *"Few businesses have made a real connection to natural capital and even fewer have an in depth understanding of how it affects their business and industry. As natural capital challenges become increasingly apparent, we need to develop a new way of thinking. We acknowledge the need for rigorous understanding of the water, biodiversity and soil impacts and dependencies of our industry and are eager to explore these through our work with the University of Cambridge."*
>
> **Andy Richardson**
> Head of Corporate Communications, Volac

1.4 Commercial drivers for managing natural capital dependencies

Why should businesses incorporate natural capital considerations into decision making processes? How do they impact growth and productivity? Recent work has shown that globally almost half of all studied water basins face severe water scarcity for at least one month per year[3]; extinction rates are on average one thousand times the natural background rate of extinction[4]; and globally only half of soil nutrients used by crops are replaced[5]. These trends will likely be exacerbated by changing consumption patterns and growing populations[6,7]. This threatens future cash flows and the stability of business by amplifying unmanaged risks in supply chains; this is particularly true at the growing phase of supply chains where the depletion and degradation of the world's resources is felt most strongly[8].

The commercial drivers for managing natural capital whilst operating in a world of constrained resources include (Figure 1):

- decreasing costs through reduced long term input costs
- reducing risks through sustainable supply chains
- enhancing brand and organisational reputation
- generating revenue growth

Examples of these drivers include maintaining a sustained supply of raw materials to prevent supply chain disruption and shield businesses from price volatility[8,9]; maintaining and securing new licenses to operate by meeting regulatory standards and managing natural resources sustainably[10]; and growing revenues through enhanced competitiveness and brand differentiation by communicating positive operations and investments in natural capital[10]. Considering natural capital interdependencies as well as the multitude of stakeholders involved in productive landscapes is pivotal for realising business opportunities and satisfying commercial drivers.

> *"Securing access and availability to certified fibre from sustainably managed forests is one of our greatest challenges. Safeguarding the natural capital that our fibre production depends upon is therefore a priority."*
>
> **Neil Burns**
> Head of Sustainable Development, Mondi Group

Business opportunities from natural capital challenges

NATURE'S GOODS AND ITS SERVICES

1 WWF (2014). Living Planet Report 2014: Species and spaces, people and places. Eds: R. McLellan, L. Iyengar, B. Jeffries, and N. Oerlemans . WWF, Gland, Switzerland.
2 PricewaterhouseCoopers (2010). Biodiversity and business risk: A Global Risks Network briefing. World Economic Forum Davos-Klosters Annual Meeting.
3 World Economic Forum (2012). What If the World's Soil Runs Out? Time Magazine, 14 December 2012.
4 WWDR (2014). Water and Energy: fact and figures. The United Nations World Water Development Report 2014.
5 Deloitte and Carbon Disclosure Project (2013). Moving beyond business as usual – a need for a step change in water risk management – CDP Global Water Report 2013. CDP, London.

Figure 2: Natural Capital Leaders Platform infographic outlining business opportunities from water, biodiversity and soil challenges.

2 Water challenges

As water is a necessary input for the production, manufacture, delivery and use of virtually all products and services[11], issues surrounding water scarcity and quality concern all industry sectors.

Water and its benefits

Definition: Water, in its liquid form, is the basic fluid of living organisms including agricultural crops[12]. Raw materials and produce are dependent on water sources including rainfall that infiltrates the soil and surface waters such as rivers and streams.

Interdependencies: Water is intricately linked to other natural capital dependencies, thereby reinforcing the need to address its extensive use in key operational decisions and when setting strategic objectives.

Benefits: Apart from the fundamental role of water in supporting life, hydrology affects the location and dispersal of biodiversity and freshwater bodies are home to 31 per cent of plant and vertebrate species[13]. Water enhances biomass production, enables flows of nitrogen and sulphur to soil, dissolves soil nutrients and, in industry and the built environment, it is used to regulate temperature and transport materials such as waste[14].

2.1 The business materiality of water

2.1.1 Business dependencies

Water is an economically strategic resource and a core element of natural capital underpinning many business activities[15]. Water risks cut across all industry sectors including energy and extractives, manufacturing, agriculture, tourism, pharmaceuticals, food and apparel[16]. In the recent World Economic Forum Global Risks 2014 report, Chief Executives said they regarded water-related issues as one of the top five global risks to business, this is a risk that is reinforced by concerns over failure of climate change mitigation/adaptation and by food crises, which are both also intricately linked to water[17].

More and more companies are recognising the fundamental value of water quantity and quality to their corporations and the potential material consequences that water scarcity can have. For example, the insurance industry has shown a clear interest in reducing the costs of flooding through mitigation measures; whilst farmers, food producers, water companies and energy suppliers are only too aware of the need to manage water appropriately and effectively to avoid operational disruptions[18].

2.1.2 Status of water and implications for business

One-fifth of the world's aquifers are being overexploited[19] and around 1.2 billion people live in areas of water scarcity where 75 per cent or more of river flow is withdrawn for industry, agriculture or domestic use[20]. Water shortages can limit production, disrupt supply chains, lead to conflict with other water users and harm corporate reputations[21]. Safeguarding water and ensuring its availability in sufficient quantity and quality is a subject of vital interest to business[22].

Much like agriculture and domestic households, industry depends on water as a raw material, solvent, coolant, transport agent and energy source. There is a clear need for companies to develop effective responses to sustain corporate activities and ensure resilience in the face of water risks[22]. Investors have a role to play in encouraging a step change within business contexts to protect natural assets from current and future water-related risks and from the subsequent impacts on financial performance[22].

> *"Analyses of product life cycles and supply chains have clearly highlighted the fundamental value of water, both as a global good and as a core local natural capital resource. When water becomes scarcer locally, it has knock-on consequences on the retail and other industries. Therefore, it is in food retailers' best interests to invest in adequate water stewardship to ensure the sustainability of product supply chains."*
>
> **Chris Brown**
> Sustainable Business Director, Asda

2.2 The business-water challenges

2.2.1 Business agricultural activities *impact* upon water:

through industrial and agricultural withdrawal

Seventy per cent of freshwater withdrawn annually for human use is for agricultural irrigation and 15 to 35 per cent of this withdrawal is estimated to exceed supply[23]. The misuse of surface and ground water displaces water flows and disrupts cycles[24]. Water is embedded within products that are transported across the globe from areas of varying water availability; business can therefore contribute to local water scarcity[25]. Overexploitation of water resources can decrease long term capacity and force operations to be displaced to more secure water areas. Misuse of surface and ground water sources may also spawn tensions between users and cause reputational damage as well as fuel questions around regulations and licences to operate.

through pollution of water ways

Pollution can occur as a result of businesses discharging substances into surface waters or groundwater without prior treatment. It can also occur inadvertently through chemical spills or leaks, trade effluent, silt accumulation or agrochemical runoff[26,27]. It is often an offence to pollute waterways as this disturbs aquatic ecosystems and decreases water quality for other users as well as for future business needs[28]. Polluting waterways can lead to reputational controversy, infringement of local legislation and increased water treatment costs.

through land use and infrastructure changes

While the distribution of water around the world is uneven, business activities and practices have further altered the distribution of water through land use and infrastructure changes. The removal of vegetation and deforestation for the expansion of business operations alters plant stem water flow, infiltration rate and evapotranspiration processes within local environments[29]. Damming and irrigation also displace water and alter natural processes within aquatic ecosystems[30]. Modifying hydrological cycles can, at a global level, lead to increased extreme weather events like storms and droughts[31]. At a local level, changing water flows can affect water availability and quality. This can have implications on input costs as water may need to be treated or diverted before use.

> *"Whilst companies need to be both more transparent in their disclosure of water use and continually improving their performance in water use, this will not be enough to guarantee success. It is important that companies engage with other water users and all stakeholders to find collaborative solutions around allocation and water stewardship."*
>
> **Duncan Pollard**
> AVP Stakeholders Engagement in Sustainability, Nestlé

2.2.2 Business activities are vulnerable as they *rely* upon water:

for ensuring the quantity of produce

The amount of water in lakes and rivers versus the amount available in soil differs across the globe and changes with time. Water is one of the factors that defines land suitability for agriculture and forestry and thereby impacts production[32,33]. Agricultural production depends upon rain water that is stored within soil or, when this is insufficient, irrigation from ground or surface waters for plant transpiration and growth[34]. Business bottom lines, their raw material production and the stability of their supply chains depend on a certain quantity of water.

for guaranteeing the quality of produce

Water quality is defined by its temperature, turbidity, clarity, pH, mineral content, nutrient and heavy metal presence and salinity[35]. Re-use schemes and infrastructure may alter water quality and make water sources unsuitable for certain uses thus impacting the production of high-quality raw materials[36]. The quality of produce defines corporate reputation and brand and also marketability.

2.2.3 Whilst external forces are also putting *pressure* on water resources:

as user demands are increasing and diversifying

As water gains recognition as a strategic natural resource and becomes scarcer in certain areas, demand for clean water will intensify[37]. Global population is projected to grow by two to three billion by 2050; clean drinking water will therefore be in greater demand as will water for additional food production, energy generation and other water intensive production systems[38]. Competing requirements pose a risk to businesses which have seen decreases in water allotments, more stringent regulations and higher costs of water[39]. Changing socioeconomic conditions are also causing dietary shifts from predominantly starch-based foods to meat and dairy and is expected to lead to a 70 per cent global increase in water demand by 2050[38].

> *"Needs for improved water quantity and quality are intensifying and we are increasingly looking for opportunities for the development of multi-sector resource management plans and an integrated approach to new water resource infrastructure."*
>
> **Andy Brown**
> Head of Sustainability, Anglian Water

as water supply infrastructure is becoming inadequate and outdated

Some water distribution systems are archaic and are no longer adequate for service[40]. Underinvestment in infrastructure further exacerbates water challenges and raises safety and quality concerns[40]. Damage to critical points in water systems can cause water shortages and degrade water quality thus resulting in decreased efficiency, increased operational costs and reputational detriment[41].

as climate change impacts water sources

The pressure on water supplies is further aggravated by the threat of global climate change as reported by the Intergovernmental Panel on Climate Change (IPCC)[42]. Increases in temperatures, changes in rainfall patterns (droughts and floods) and rising sea levels may impact the amount of available clean, fresh water[42]. In addition, natural disasters and floods can overwhelm water delivery and sewage services as well as mobilise pathogens, toxins, and other pollutants thereby contaminating drinking water supplies and leaving people without water services[42]. All of these impacts amplify the competing demands for clean water and subsequently endanger operational productivity and reputation.

In order to secure resilient supply of raw materials, businesses will need to develop strategies that reduce their impacts on water and secure its provision and quality in the face of external pressures.

2.3 Business responses to the top three water challenges

2.3.1 There is a wide variety of competing users

With increasing numbers and types of water users, there is a risk that responsibility and accountability for water risks becomes further fragmented and water resource management is put on hold. Of the world's 276 international river basins, 60 per cent lack cooperative management frameworks and yet, with increasing scarcity, water prices and conflicts over access to water are likely to increase[43,44].

> *"At Anglian Water we have explored the agricultural element of water use both through our work on CISL's Sink or Swim project and the subsequent implementation phase; we've been having discussions over the last few months around what action to pursue to bring together agricultural communities, retail communities and water users to innovatively challenge financial and regulatory barriers."*
>
> **Andy Brown**
> Head of Sustainability, Anglian Water

What can businesses do?

It has been established that two-thirds of UK businesses do not measure or monitor their water use and 85 per cent have set no reduction targets[45]. Businesses have the opportunity to lead the way as water stewards by, for example, promoting practices in their supply chains, such as rain water harvesting or more efficient irrigation. Stakeholders must work together to build management strategies that address increasing water demand and secure water dependencies. Businesses with a sound understanding of water risks can also demonstrate themselves as a more attractive investment[46]. Understanding different perspectives and needs as well as measuring the costs and risks for a variety of sectors can facilitate collaborative opportunities by identifying synergies and subsequent beneficial solutions[47].

> *"The global decrease in groundwater levels and our growing reliance on surface water fuels the debate around water use and stewardship and forces questions over who has the rights over it. Business has a role to play in defining these rights."*
>
> **Andy Richardson**
> Head of Corporate Communications, Volac

Anglian Water: a multi-sector approach to catchment management

Water availability is an issue of direct relevance to Anglian Water. However, Anglian Water only manages a portion of the water used in its region and for some time has believed that there needs to be a greater ownership of the challenges facing water companies in order to achieve favourable outcomes. This was tested in the Wissey Catchment, as part of the Sink or Swim collaboratory with CISL. The Wissey catchment is faced with increasing demand for water whilst at the same time suffering from decreasing water availability.

A practical example to resolve this challenge was explored; specifically a reservoir that meets the predicted customer demand with 75 per cent of its capacity and supports agriculture and the environment with the remaining 25 per cent. A successful system could benefit the water company as well as other sectors in the region by generating financial economies of scale, enabling efficient management of licences and permits, supporting protection of agricultural production and maintaining environmental quality.

The project took a multi-sector approach to innovate four models for cross-sector finance; it considered different ways of using the existing and new finance channels to address the water asset investment challenges in the UK. This case study opened the door for business to build coherent water investment and management strategies with government. Such a strategy generates a secure supply of water which will create resilience and reduce risks across multiple sectors.

2.3.2 Water quality and quantity needs are intensifying

Meeting basic human and ecological needs for water, improving water quality, eliminating overdraft of groundwater and reducing the risks of political conflict over shared water require fundamental changes in water management and use[37].

> *"The need to engage in dialogue with our communities has long been known in business, but the nature of that dialogue is expanding. We are increasingly seeing the need to discuss topics like water and biodiversity, and in many cases it is up to business to lead the way in bringing various stakeholders to the table."*
>
> **Brian Nash**
> Sustainability Director, Ingredion

What can businesses do?

New financial models are necessary to develop management solutions for water users and dependents on the ground; business cannot do this in isolation[15]. Supply network design needs to consider resources, such as water quality and availability, in making decisions over location and capacity[2]. Investment in water infrastructure and other interventions can help secure long-term productivity while safeguarding landscape-scale operations and maintaining reputation. Appropriate water management would secure water dependencies to ensure the long-term supply of resources that underpin the economy and profitability of business[48].

Ingredion: diverting waste water for increased income

Ingredion's multiple operations in Thailand convert locally grown cassava, also known as tapioca, into many different starch-based ingredients for use in food or industrial applications. The company's operations in Thailand all have facilities to treat the waste water generated from the manufacturing process. This waste-water treatment allows the company to meet or exceed the regulatory requirements for waste-water discharge. Nonetheless, the company continually explores alternative solutions to waste-water management. As part of this effort, one of the manufacturing sites in Thailand worked with local regulatory officials and a local ecologist to determine more beneficial applications for the site's waste-water effluent. This collaboration found that local Napier grass would be a viable outlet for the treated waste water. Napier grass, a protein source for local cattle, is typically grown only in the rainy season. Providing effluent water to Napier farmers enabled farmers to grow additional crops in the dry season, significantly increasing their income from the crop.

2.3.3 The impacts of climate change affect water resources throughout operations

Climate change has unprecedented impacts on the hydrological cycle and on water availability that vary with time and space. Climate change can affect water availability (both too much and too little), delay seasonal patterns and trends, intensify weather events and raise seawater levels[42]. This can influence business costs through the price of water inputs, the effect on crop harvests and the disruptions caused by more frequent extreme weather events.

What can businesses do?

Businesses need a comprehensive and grounded understanding of their landscapes and contexts for raw material sourcing. This can inform where water dependencies lie and how these interlink with other natural and social resources in order to anticipate and manage risks related to water quantity and quality. Investing in long-term climate change mitigation infrastructure and interventions must become a business priority. Climate change adaptation and mitigation measures to safeguard water dependencies, while being fundamental, must also consider landscapes and interdependencies between natural capital elements[42].

> *"We at Asda, just like other businesses, have to cope with the risks of more extreme weather in for example variable rainfall patterns. In fact, our recent study based on the IPCC guidelines has shown that only five per cent of our fresh produce supply chain is not at risk from climate change impacts. Impacts on sourcing, processing and logistics imply that there is £101.9 million, £163.9 million and £103.8 million (respectively) value at risk. For businesses, the events such as droughts and flooding reduce the resilience of supply chains and risk potential losses from commodity price hikes that follow sudden drops in agricultural production. There are tangible business incentives to urgently address these risks."*
>
> **Chris Brown**
> Sustainable Business Director, Asda

3 Biodiversity Challenges

Despite global efforts, rapid biodiversity loss and ecosystem degradation have continued at an alarming rate[1,5], potentially affecting almost all companies through impacts on their supply chains and growth objectives.

Biodiversity and its benefits

Definition: Biodiversity is the variety of all life on Earth, the ecological interactions they have and the habitats in which they live. In more technical terms, it is the variability among living organisms: the genetic variability between individuals, the variability among species and the variability of different ecosystems[49].

Interdependencies: Biodiversity and wild nature (hereafter "biodiversity") underpin key functions of ecosystem structures and processes that generate or enhance ecosystem services[50,51].

Benefits: Ecosystem services are the benefits provided by ecosystems to humans, such as nutrient cycling, pest regulation, carbon sequestration and pollination[23,52]. Biodiversity also regulates and detoxifies local water sources and increases soil fertility by enabling decomposition, energy flow and nutrient cycling[53]. Maintaining biodiversity and safeguarding plant varieties can also help adaptation to changing environmental conditions by for example, enhancing drought tolerance[54].

3.1 The business materiality of biodiversity

3.1.1 Business dependencies

Business dependence upon biodiversity is felt strongly within supply chains in agricultural production systems. Biodiversity fundamentally underpins the benefits that businesses derive from natural capital and supports the key ecosystem functions that ensure the delivery of business operations and productivity[52]. Businesses, including pharmaceutical companies, food and agri-businesses, forestry industries and construction and packaging sectors use genes, species and ecosystem services (see "Biodiversity and its benefits") as critical inputs into their production processes and depend on healthy ecosystems to treat and dissipate waste, maintain soil and water quality and help control air composition[51,52]. Considering these societal and industrial benefits as well as the associated values of these intact ecosystems is vital when exploring land use opportunities and conversion[55].

3.1.2 Status of biodiversity and implications for business

Extinctions are now occurring 1,000 times faster than the expected background rate and a recent global study reports that the abundance of over 10,000 monitored mammal, fish, bird, reptile and amphibian populations have, on average, more than halved between 1970 and 2010[1,4]. As biodiversity continues to deplete, businesses face challenges to safeguard raw material production and to comply with a greater number of national and international laws and agreements[56]. Biodiversity policies (e.g. mandatory offsetting) urge businesses to understand and begin to address their impacts on biodiversity. Financial institutions that have voluntarily adopted the Equator Principles (these institutions now cover 70 per cent of international Project Finance debt in emerging markets) are required to incorporate action on biodiversity in their lending terms[57], including the International Finance Corporation's Performance Standard 6 which requires a "no net loss" impact when operating in natural habitats and a net gain for operations in "critical habitats"[58].

Rather than allowing biodiversity risks to manifest themselves in mainstream business, business leaders can take early steps to secure biodiversity, and seize opportunities that enable them to remain at the forefront of their sector. The benefits of such action can include decreased costs from the reduced need of inputs to counter biodiversity degradation and brand enhancement from the implementation of conservation initiatives.

3.2 The business-biodiversity challenges

3.2.1 Business activities *impact* upon biodiversity:

through ecosystem disruption

Company operations and agricultural activities are impinging upon fragile ecosystems, some of which have high conservation value[59-62]. Over-abstraction of water, soil salinization from irrigation in arid regions, fertiliser run-off and industrial leaching of toxins contribute to biodiversity loss and ecosystem instabilities[59,61,63]. Ecosystem disruption from agricultural activities can harm brand reputation and lead to decreased marketability of products.

through the expansion of business operations which often depends on the use of abandoned and degraded land or on the conversion of natural and semi-natural habitats

While there are large areas of abandoned and degraded land available for business expansion, large amounts of high-quality land are often converted for agricultural, residential or industrial purposes; this results in losses of land availability or fragmentation of habitats and species[59,60,62]. The complexities of converting poor quality land into high-quality arable land are significant and would incur substantial business costs.

3.2.2 Business activities are vulnerable as they *rely* upon biodiversity:

for genetic diversity to provide system resilience to pest and climatic events

Homogenisation of agriculture has led to dependence on just a few crops and on a narrow gene pool, potentially resulting in the loss of genetic diversity[64-67]. The current industrial and domestic reliance on a small number of crops makes entire systems more vulnerable to emergent pests and diseases or changes in environmental conditions[64,65]. It is in businesses' interest to retain a diverse source of genetic resources through the conservation of crop diversity and of wild relatives of domesticated species to maintain plant breeding opportunities[68-70]. System resilience is key for supply chain security and sustainability and, when neglected, it can significantly disrupt business operations, increase costs through damage-control and generate risks.

for high quantity and quality crop harvests delivered by wild-pollination

Some farming techniques, such as the use of pesticides on seeds and plants, may impact pollinators as well as pests and can have subsequent negative impacts on crop harvests[71-73]. Wild pollination can increase the size and quality of crop harvests, which form the raw materials for many products[73,74]. Maintaining a diversity of pollinators within the landscape provides insurance against year to year variability in the abundance of particular pollinating species[75]. Access to pollinator abundance and diversity can reduce risks as well as costs of artificial inputs or manual pollination and is fundamental to business operations.

for enhanced ecosystem services from species diversity and abundance

Biodiversity contributes to services such as the supply of clean water through filtering and regulating processes provided by forest and grassland cover[76-78] and the removal of pollutants from water courses[79]. Soil microorganism biodiversity enables adequate and productive biogeochemical cycling of nutrients through different forms of nitrogen, sulphur and phosphorus and through the degradation of organic matter that controls the release of plant nutrients[80]. Biodiversity provides natural predators and parasites for improved pest control, particularly important in an emerging environment of increasingly regulated pesticide use and expanding demand for organic crops[71,81]. Ecosystem services, although often discounted, underline business operations; if they are tampered with it will cost a significant amount to find and access other means of providing similar services.

> *"We have long term predictions for climate change and for analysing the implications on our supply chains and business operations. It seems to us that the next step would be stress testing our supply chains in terms of biodiversity productivity. The complexities behind biodiversity make this hard to measure and monitor – but we need to start doing this now because it underpins many of our operations."*
>
> **Chris Brown**
> Sustainable Business Director, Asda

3.2.3 Whilst external forces are also putting *pressure* on water resources:

as competing user demands and interests increase

The world's more biodiverse regions tend to coincide with higher human population densities[82]. As biodiversity becomes scarcer, these areas could face competing interest from industry, agriculture and forestry, conservation and research[82]. This will impact upon land use policies and regulations for business operational expansions and brand enhancement.

as human populations rise and consumption trends change

Per capita consumption, particularly associated with wealth increases, and human populations are predicted to increase in concert, resulting in greater pressure on natural resources[83,84]. This subsequently increases competition over land and biodiversity resources and endangers corporate reputations and marketability of products.

as the consequences of climate change increase pressures on biodiversity stocks

Climate change can force species to shift their ranges and can disrupt ecological communities through changes in patterns of rainfall or weather events[85,86]. Elevated levels of atmospheric CO_2 and changes in temperature are expected to alter crop yields and also threaten corals through ocean acidification[62,87]. New initiatives and technologies aimed at mitigating climate change may also have negative effects on biodiversity and need to be appropriately planned and managed[88]. Although investing in climate change mitigation and adaptation to safeguard biodiversity may incur significant business costs, consequences of biodiversity loss may signify further costs as well as reputational harm.

> *"Our business and ecosystem services are inextricably linked: our business practices impact ecosystems and their regulatory and provisioning services whilst also fundamentally depending upon these ecosystems."*
>
> **Peter Gardiner**
> Natural Resources Manager, Mondi Group

Photo by: Samways/Pryke, Mondi Ecological Network Programme

In order to maintain licenses to operate and secure supply chains, businesses will need to develop strategies that reduce their impacts on biodiversity, address their dependencies on biodiversity and adapt to external pressures.

3.3 Business responses to the top three biodiversity challenges

3.3.1 Land tenure rights, governance and security are uncertain

Land governance and rights Issues over land governance and rights have been demonstrated both theoretically and empirically to be an important factor in unsustainable rates of deforestation and over-exploitation[89,90]. The lack of or absentee ownership of landscapes and ecosystem servicesmeans fragmented responsibility and undermines long-term visions, reducing opportunities to manage price volatility in the supply chain.

> *"Land tenure rights are definitely very important and more work needs to be done to understand the impact of land ownership on natural capital."*
>
> **Andy Richardson**
> Head of Corporate Communications, Volac

What can businesses do?

Businesses must engage and collaborate with other stakeholders within the landscape to avoid the abuse or overuse of nature and foster agreements on its utilisation and on the rights and responsibilities of local people. Assuming responsibility for biodiversity and ecosystems, and the valuable services they provide, is an essential part of corporate social responsibility.

Olam International: reconciling wild nature with large-scale plantations

Olam International has palm and rubber plantations in Gabon, Africa. With low agricultural and economic development and significant forest cover, Gabon's rich lands maintain high carbon stocks and extraordinary biodiversity reserves that contribute to the ecosystem's balance. When assessing the suitability of land allocated by the Government, Olam recognised the biodiversity and wildlife needs of the area and invested substantial time and resources in completing a high level agronomic, environmental and social due diligence prior to commencing plantation development. Such initiative builds on from the Roundtable on Sustainable Palm Oil New Planting Procedures and Gabon's national regulations.

Olam focused on biodiversity and its complex systems when proceeding with land selection and management. Olam worked closely with the Gabonese Government and the Ministry of National Parks, who are also strongly committed to conservation goals for their 'Green Gabon'. This partnership enabled Olam to ensure that the production of its commodities would not impinge the biodiverse landscape. Olam identified high conservation value areas, monitored social and environmental issues within the area, carried out LIDAR surveys, an Environmental & Social Impact Assessment, a High Conservation Value Assessment and a Prior and Informed Consent of communities before developing a management plan. This enabled concessions with vulnerable and fragile landscapes to be returned to the Government and to exclude any ecologically sensitive areas from development. A process of robust due diligence as well as making important links between the palm and rubber plantations and the local biodiversity and environment enabled Olam to both develop its production chain as well as secure biodiversity conservation; in face proposed land areas totalling 31,890 hectares have been ruled unsuitable for certified palm and they have been returned to the Government of Gabon. Olam's work around land has reduced the allocation of agronomically unsuitable, high conservation value or high carbon stock lands.

3.3.2 There is a lack of data demonstrating the links between biodiversity and certain commodities

Although biodiversity research and knowledge around species abundance and distribution is growing, much research is still needed around the interactions between biodiversity and wild nature and certain commodities. Clear linkages between nature conservation and profitability also need to be made.

> *"We need to turn it around for the corporate world, and make good practice around biodiversity credible. Business can bring a lot to bear to help fill in data gaps that can then be interpreted into decision making."*
>
> **Chris Brown**
> Sustainable Business Director, Asda

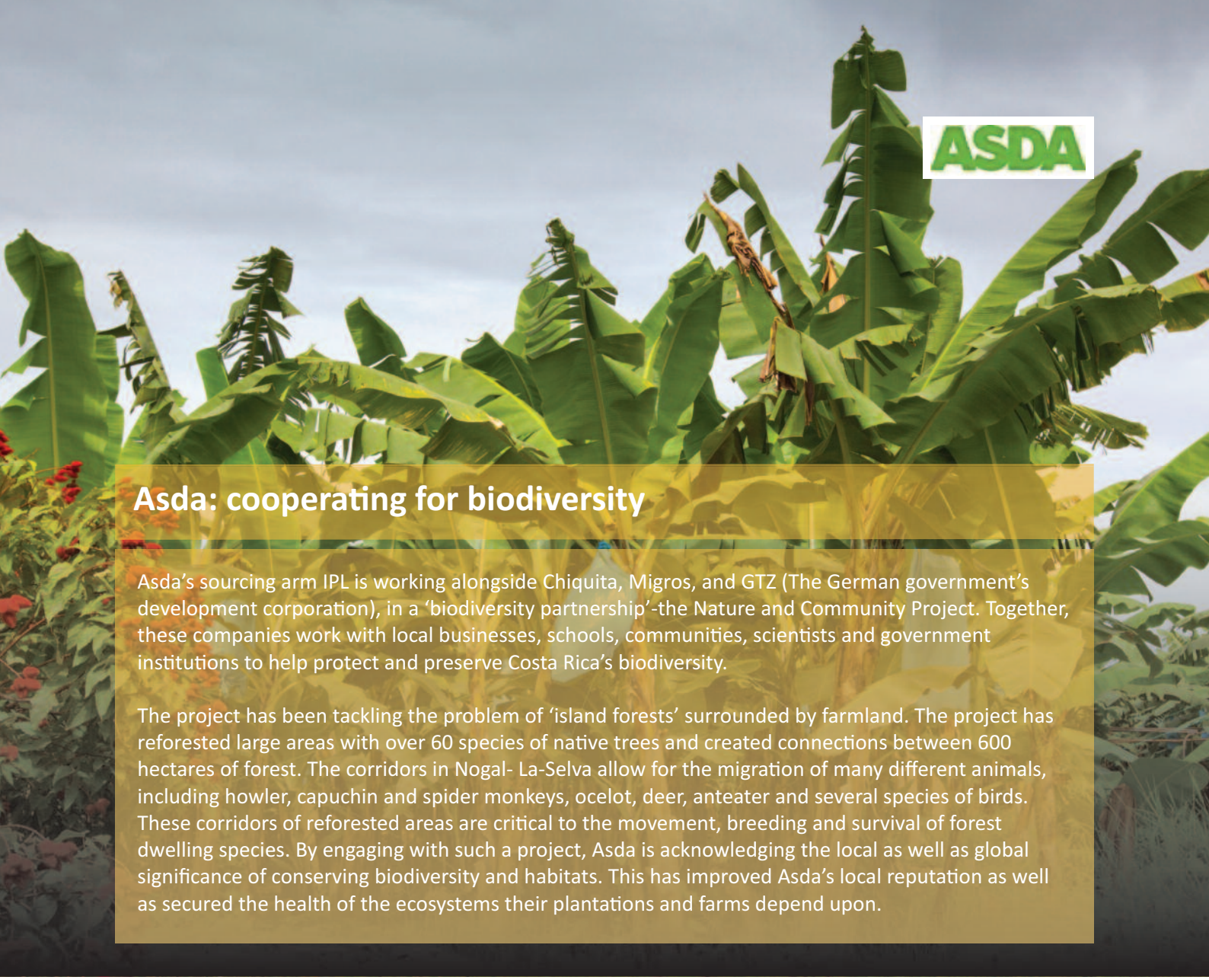
What can businesses do?

There remains much work to be done on the collection of empirical data, and this remains an area that would be helped by significant business investment. Businesses need to be confident in the value of investing in natural capital and need rigorous evidence that doing so will increase sustainability, profitability and brand.

Mondi: implementing mitigation measures in production landscapes

Commercial and subsistence agriculture, commercial forestry and other extensive forms of human development now dominate many landscapes. Even the best network of protected areas cannot ensure the survival of all species and their associated ecosystem services. This means that mitigation measures in production landscapes, especially those containing extensive agriculture and forestry plantations, are required. Ecological networks (ENs) are one mitigation solution that include quality set-aside land, mostly in the form of corridors within production landscapes and are aimed at extending the size of protected areas, maximizing on biodiversity conservation and maintaining of ecosystem processes. One of the great advantages of good quality ENs, including wetlands, is that they also maintain hydrological processes, and with them, the indigenous biota. ENs add considerable resilience to production landscapes in terms of maintaining biodiversity and all the complex associated processes in South African systems as well as in the face of El Niño Southern Oscillation events and global climate change.

Mondi is working with Professor Michael Samways and his research team at Stellenbosch University in South Africa to identify and manage ENs in their plantation forests. Approximately 25 per cent of Mondi's land holdings in South Africa are set aside land and would fall into the category of ENs of varying quality. When applied to the commercial forest sector in South Africa the total amount of land set aside for these ENs is approximately 0.5 million hectares, a substantial area of natural habitat for maintaining biodiversity and ecological processes. The research so far has shown that wide corridors combined with nodes of grasslands, wetlands and forest in ENs are equivalent in terms of biodiversity to that in neighbouring protected areas. The implementation of extensive ENs in South Africa continues to show good results and these ENs are playing a major role in conserving natural resources for future generations.



Asda: cooperating for biodiversity

Asda's sourcing arm IPL is working alongside Chiquita, Migros, and GTZ (The German government's development corporation), in a 'biodiversity partnership'-the Nature and Community Project. Together, these companies work with local businesses, schools, communities, scientists and government institutions to help protect and preserve Costa Rica's biodiversity.

The project has been tackling the problem of 'island forests' surrounded by farmland. The project has reforested large areas with over 60 species of native trees and created connections between 600 hectares of forest. The corridors in Nogal- La-Selva allow for the migration of many different animals, including howler, capuchin and spider monkeys, ocelot, deer, anteater and several species of birds. These corridors of reforested areas are critical to the movement, breeding and survival of forest dwelling species. By engaging with such a project, Asda is acknowledging the local as well as global significance of conserving biodiversity and habitats. This has improved Asda's local reputation as well as secured the health of the ecosystems their plantations and farms depend upon.

3.3.3 There is a lack of simplified biodiversity metrics

There is no shortage of targets and indicators that measure biodiversity that are being used or proposed. However, many of these are difficult for companies to apply at a local level or to aggregate over all of their operations and value chains. Businesses require metrics which are credible, practical to use, easy to understand and relevant to their industry. At the highest level, the key reference point for companies are the Aichi Biodiversity targets (2011-2020) as monitored by the Convention on Biological Diversity (CBD)[91].

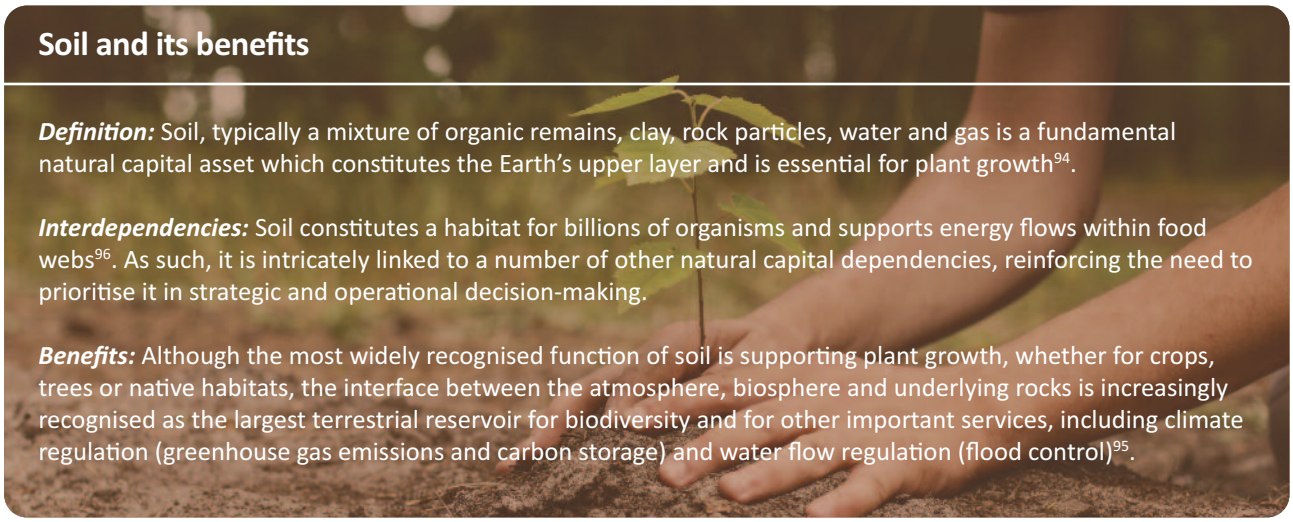
> *"The complexity behind biodiversity and its measurement has led to companies currently using 'land area' as a proxy for biodiversity. At Nestlé, we are keen to have simple metrics defined that better reflect the key elements of biodiversity."*
>
> **Duncan Pollard**
> AVP Stakeholders Engagement in Sustainability, Nestlé

What can businesses do?

Companies are encouraged to report against the Global Reporting Initiative (GRI) framework[92], which includes a number of biodiversity indicators. These are not all well designed to assess natural capital health for ecosystem service delivery on productive land. Where necessary, businesses must challenge existing metrics and communicate what they need and want of measurement tools. Biodiversity is complex, but businesses need to report upon their dependency, impact and responses in a simple way if they are to better incorporate biodiversity into their decision making.

4 Soil challenges

Soil management has increasingly come under the spotlight, yet soil degradation continues to limit agricultural and industrial productivity, affecting companies along value chains and their future profitability[93].



Soil and its benefits

Definition: Soil, typically a mixture of organic remains, clay, rock particles, water and gas is a fundamental natural capital asset which constitutes the Earth's upper layer and is essential for plant growth[94].

Interdependencies: Soil constitutes a habitat for billions of organisms and supports energy flows within food webs[96]. As such, it is intricately linked to a number of other natural capital dependencies, reinforcing the need to prioritise it in strategic and operational decision-making.

Benefits: Although the most widely recognised function of soil is supporting plant growth, whether for crops, trees or native habitats, the interface between the atmosphere, biosphere and underlying rocks is increasingly recognised as the largest terrestrial reservoir for biodiversity and for other important services, including climate regulation (greenhouse gas emissions and carbon storage) and water flow regulation (flood control)[95].

4.1 The business materiality of soil

4.1.1 Business dependencies

Fundamentally, soil underpins the value of the natural assets upon which businesses depend[97]. Soil quality has direct implications on the quantity and quality of raw material yields and it supports key functions that supply resources and commodities in the growing phase of the value chain[97]. Although not always obvious, understanding the links between soil and business can help companies to maximise their growth and productivity and minimise their risks. Businesses rely on soil directly as a substrate for growing crops, for water regulation and filtration and for the cycling of nutrients[95]. For businesses with a significant impact or dependency on other categories of natural capital, soil is likely to also be a key asset within those operations or supply chains. Understanding the vital provisioning and regulating services it delivers is therefore a matter of increasing urgency[95].

4.1.2 Status of soil and implications for business

Since 1960, one-third of the world's arable land has been eroded and degraded, and the rate continues at about ten million hectares per year[98]. For companies whose production does not directly rely on soil, it can be difficult to understand their indirect reliance (e.g. through their supply chains, as investors or energy suppliers) on soil quantity and quality. However, apart from the goal of securing supply chains, sustainable soil management is also important for regulatory, reputational and market reasons[95]. Demonstrating good soil practice, through appropriate management, can be essential to gaining access to land and resources as well as proving responsible performance to government, investors and other stakeholders[99]. Generating greater yields per unit of land at a higher profit by lowering unit production costs will only be possible by building and maintaining soil fertility and providing balanced nutrition to crops[100]. Improved understanding of the wide-ranging and far-reaching impacts of degraded soils combined with increasing human pressures have encouraged governments, lobbying groups and forward-thinking businesses to further investigate the sustainable management of soil.

4.2 The business-soil challenges

4.2.1 Business agricultural activities *impact* upon soil:

through increased soil salinization and acidity from pollution

Salts occur naturally in soil and in irrigation water and, if not removed from agricultural wastewater, they can build up over time, reducing the ability of crops to take up water and resulting in lower yields[101,102]. Two thousand hectares of land are lost per day due to damage caused by salt[103]. Pollutants, including mine tailings, acid rain, and fertiliser remnants, can lead to low pH soils[104,105]. Acidic soils cause significant losses in production and where the choice of crops is limited to acid-tolerant species and varieties, profitable market opportunities may be reduced[105]. The use of agrochemicals such as pesticides in business operations has helped increase yields, but their overuse can also cause chemical changes in soil composition and disrupt the microorganism communities in the soil[106]. Polluting soil resources has trickle down impacts on the production of raw materials needed for corporate supply chains and can lead to the increase of input costs essential for soil nutrition and structure.

through the alteration of the biogeochemical cycles of nitrogen and phosphorus

Nitrogen and phosphorus are both essential elements for plant growth and fertiliser is often applied to make up for shortages within the soil[107]. However, only a small fraction of the fertiliser generated for crop production is taken up by plants, whilst the rest is lost to the environment[108]. Although at least one third of humanity now relies on nitrogen fertiliser for adequate diets, an increasing level of this reactive nitrogen causes a series of negative effects such as acid rain, reduced groundwater quality, negative impacts on human health, soil and stream acidification, coastal eutrophication and nitrous oxide emissions[109]. Business impacts on the biogeochemical cycles of nitrogen and phosphorus have extensive effects on water sources and local community health which can subsequently impact raw material production and brand representation.

through the promotion of soil erosion, degradation and compaction

One third of the world's arable land has been degraded since 1960 and the rate continues at about ten million hectares per year[98]. As agricultural land becomes degraded, producers may be forced to convert more land to agriculture[110].

Livestock farming is one of the main activities responsible for soil erosion globally. While pasture itself may not result in annual soil erosion rates as high as from crop production, the initial conversion from, for example, forests to pasture can lead to extreme erosion with loss of topsoil and organic matter[111]. Soil is also damaged by compaction, which occurs when heavy machinery, the passage of humans or animals or a lack of water in the soil displaces air from pores between soil grains[112]. Degraded land masses and soil resources may force business operations to relocate, may disrupt supply chains, or may incur significant costs to manage existing soil resources. Business expansion may also be challenged by regulations and national land legislation.

> *"Soil quality is of extreme importance to our business, as the majority of our raw materials are agricultural in nature. While many of our farmer suppliers are very good stewards of the land, there are some sourcing regions that may have opportunity for improvement. It is important that businesses engage with those growers to help identify practice that will provide benefit for the land, the farmer, the broader community, and the company itself."*
>
> **Brian Nash**
> Sustainability Director, Ingredion

4.2.2 Yet business activities are vulnerable as they also *rely* upon soil:

as soil texture and structure define yield quantity and quality

The structure of soil is one of the parameters that defines land suitability for industrial or agricultural operations[113]. Soil structure affects water quality, water-holding capacity and vital chemical energy flows with spaces among soil particles providing oxygen to plant cells that can breakdown sugars and release energy necessary for growth[114]. Soil also insulates roots from temperature fluctuations[114]. Soil texture and structure are critical to maintain yield quantity and quality and to therefore uphold entire supply chains.

as soil nutrition is necessary for plentiful and high-quality harvests

Nutritious soils promote plant growth and dispersal by providing essential macro and micro nutrients to their roots[115]. Soil pH regulates the availability of nutrients while living soil organisms and decomposed organic matter are needed for biological nutrient cycling[116]. Soil moisture and minerals promote seed germination and seedling survival and vigour[117]. The quality and marketability of products depend upon nutritious soil, business supply chains can be significantly altered by soil nutrition characteristics in terms of the sourcing location of raw materials and quality of raw materials.

as soil biodiversity plays an important role in maintaining productivity

The number and variety of species in the soil, from micro-habitats to landscapes, play a multitude of critical roles including maintaining soil structure, regulating nutrient flows, detoxification and biological pest control[118]. Similarly to soil structure and soil nutrition, soil biodiversity demands business interest and concern as it can dictate soil productivity and therefore raw material production and supply chain security.

> *"To select and develop new land for operations, we need a landscape approach that considers managing biodiversity, soil and water simultaneously. We cannot address each in splendid isolation; these elements will naturally be prioritised depending on context but they need to be tackled together."*
>
> **Chris Brown**
> General Manager for Environmental Sustainability, Olam International Ltd

4.2.3 Whilst external forces are also putting *pressure* on soil resources:

as landscapes are shaped by natural forces

Landscapes and soil quality are shaped by natural forces including water and extreme weather events, and by industry, such as construction and infrastructure[119]. Degraded lands often have lower water capacity, which can worsen flooding, and extreme weather events are predicted to become more frequent under climate change scenarios[120]. Such events can have disastrous repercussions on business activities and supply chain security while costs to remedy damages to infrastructure and local communities can prove significant.

as population and consumer trends continuously evolve

Growing populations and changing demographics as well as a shift to meat-intensive diets have changed demand for suitable agricultural, industrial and urban land[121]. Global human trends have contributed to desertification, the loss of arable land and decreased soil quality[122]. These impacts are affecting business operational areas and increasing costs for maintaining raw material production and supply chains.

In order to build more resilience in their supply chains, companies will need to develop strategies to reduce their impacts on soil and secure their dependencies on soil whilst adapting to increasing shocks and pressures.

4.3 Business responses to the top three soil challenges

4.3.1 Businesses assert little control over on-the-ground soil related activities

With long and complex global supply chains (which can range from industrial farming to small scale traditional methods) businesses do not always control soil management activities and supply of their raw materials can be threatened[95].

> *"Many businesses are working on specific crop improvements and often in specific regions. Soil quality is already a consideration in these work streams. We need to find a way to scale the delivery and to better share our approach and progress."*
>
> **Adrian Greet**
> Global Sustainability Programme Director,
> Mars Incorporated

What can businesses do?

Businesses should analyse their supply chains to determine their most vulnerable operational areas. Businesses can further invest to improve soil management activities through capacity building, knowledge extension services and farmer engagement to promote practices such as Conservation Agriculture by minimising soil disturbance, providing continuous cover crops and rotating crops[123,124]. Companies can start by internally recognising the importance of soil and understanding that securing it as a natural capital dependency is a valuable strategic opportunity. Given the importance and value of soil as a natural capital asset, there is a surprising lack of awareness and investment from business[95]. Generating understanding of the insecurity of soil dependencies, alongside a vision for long-term productivity will promote soil conservation investments, and greater accountability for soil associated risks.

Ingredion: farming the land through capacity building

Working with farmers in Thailand, Ingredion is striving to ensure that high soil quality is maintained on its cassava producing farms. Cassava farming is done entirely by hand and, since rotting crop remains naturally provide nutrients to the land, cassava farming does not lend itself to the same soil issues that other crops may face. It is therefore a secure, low cost crop for farmers to grow and through its Thailand Model Farmer Programme, Ingredion is training farmings to share best practices. These farmers represent the optimal environmental stewards simply through their deeply rooted connection to their farming communities and natural landscapes. Their partnership with Ingredion enables them to stand economically but they nurture their soil, rivers and environment because of their ingrained relationship with the land.

Nestlé: ensuring the right fertiliser is applied to cocoa soils

Historically, the production of cocoa in Côte d'Ivoire has increased but this has been done primarily through forest encroachment rather than by promoting improved yields on existing land. There is therefore an growing need to focus on a fertiliser to regenerate soil fertility and avoid expanding cocoa plantations into forested land. For a number of years farmers have not invested in fertiliser and productivity has remained low. This has been a consequence of high input costs, poor understanding on what fertiliser to use on what soil and a difficulty in giving tailored advice to farmers. Today, Nestlé is working with the World Cocoa Foundation 'CocoaAction' strategy, which has a workstream led by IDH (Sustainable Trade Initiative) on understanding soil fertility and how to increase fertiliser usage to subsequently improve farmer income.

4.3.2 There is a lack of science regarding specific commodities and locations

Soils are highly variable due to differences in local geography, topography, climate vegetation and management[95]. Greater understanding is needed to fine tune practices relating to soil health and management. Soil requirements also differ according to the type of land use and crop specificities. The science surrounding this is either lacking or needs to be compiled and translated into business-digestible material.

What can businesses do?

Businesses should adopt a holistic way of considering soil related challenges through a natural capital lens as a first step towards acknowledging the importance of scientific research. Businesses need to work together to review existing data and coordinate new research to understand how their commodities impact upon natural capital and what interventions are most appropriate to their situation. Lack of an international governing body to support coordinated global action on the management of soils implies a low focus on soil policy[95].

> *"Farmers on the ground aren't always informed on climate change in a way that is digestible. The theme of communication is very much recurring and there is a need for evidence and a more efficient exchange of knowledge. We are well aware of climate change projections and possible future scenarios but the magnitude of the associated financial and societal impacts is yet to be fully calculated. There is a need to start considering and evaluating these impacts so as to influence decisions and strategic thinking."*
>
> **Andy Brown**
> Head of Sustainability, Anglian Water

4.3.3 Natural events and climate change impacts are accelerating soil degradation

Increased intensity of wind or rainfall may erode topsoil and remove nutrients which end up in watercourses and release more greenhouse gases into the atmosphere[120]. Less summer rainfall could increase drought risk thereby affecting soil stability and structure and increasing input costs[120].

What can businesses do?

Businesses can better their understanding of soil and investigate appropriate interventions to mitigate future changes, including reducing wind erosion by planting shelter belts and considering minimum tillage techniques[125]. In addition, good soil management can help regulate emissions of key greenhouse gases from agriculture whilst securing soil health.

Olam International: maintaining profitable yields despite water constraints

In 2013, almond yield from one of Olam's mature orchards in California declined by 15 per cent, prompting an enquiry into how efficiently these almond trees utilise water. Maintaining the flow of water, with a pH of 6.5, at a well-timed interval is essential to maximise almond yields, thereby highlighting the importance of both water availability and quality.

In 2014, the orchard only received 49 per cent of normal precipatiation levels and it is extremely likely that the drought will continue through 2015. Given the lack of precipitation and lack of available surface water, the orchard relies entirely on a groundwater pumping system to irrigate the almond trees. However, this can be insufficient: in 2014, groundwater pumping capacity decreased to 5,500 gallons per minute and the orchard fell short of its water demand. In addition to quantity, groundwater quality is a challenge as pH is often higher than that required for almond tree growth and can therefore affect the soil's health and water infiltration rates. The increased application of groundwater has also caused soil sodium levels to increase, and has subsequently impaired water infiltration and nutrient uptake by tree roots.

The variability of water quality and quantity impacts soil and plant health and subsequently affects both short-term and long-term yield potential for almonds. To deal with such challenges, Olam formed a collaborative team to develop a drought response action plan which included: more efficient and timely irrigation to build soil moisture profile; increased efficiency of existing wells by cleaning perforations; application of compost, organic acids and soluable calcium; acidification of the water to reduce the bicarbonate salts and lower the pH to 6.5 and a pipeline installation to flexibly transfer water to different parts of the orchard. Enhancing the water holding capacity and nutrition of soil has allowed Olam to turn away from its dependency on an ever more pressured water resource. Olam's work proved that there are in fact more cost-effective solutions to the drought issue than the long-term and costly process of deepening wells or treating poor- quality water and these involve a broader look at soil dynamics.

5 Integrated Solutions

5.1 Opportunities can be seized to reduce impacts on water, biodiversity and soil to secure business objectives

Interventions can be prioritised to collectively manage water, biodiversity and soil rather than tending to address one individual element of natural capital, a single environmental or particular social concern. Shifting the drivers for interventions from reputation management and short-term efficiency gains to productivity and long-term returns can ensure that supply-chains are secured as well as sustainable. Also vital to success is the sustainable management of natural capital and collaboration between stakeholders which can contribute to reducing business costs as well as supply chain risks.

5.2 Tangible business benefits can be gained when natural capital and its interactions are sustainably managed and prioritised

Businesses can determine the very best investments in natural capital, both for themselves and for society, by understanding the benefits and trade-offs of particular interventions and how different stakeholders are impacted. Effective natural capital management and appropriately informed solutions require thorough knowledge and data around the interdependencies of water, biodiversity and soil. For instance, wetland restoration may contribute to nitrogen and phosphorous retention, as well as increasing biodiversity value[126]. It may, however, also have slower or lesser effects on enhancing soil quality[127]. Another lesson comes from the Grain to Green Project in China, under which the planting of non-native trees on agricultural land appears to have decreased soil erosion and provided alternative livelihoods to minority groups, but in some areas has increased water scarcity and reduced native biodiversity[128-130].

5.3 The time is ripe for business to take action

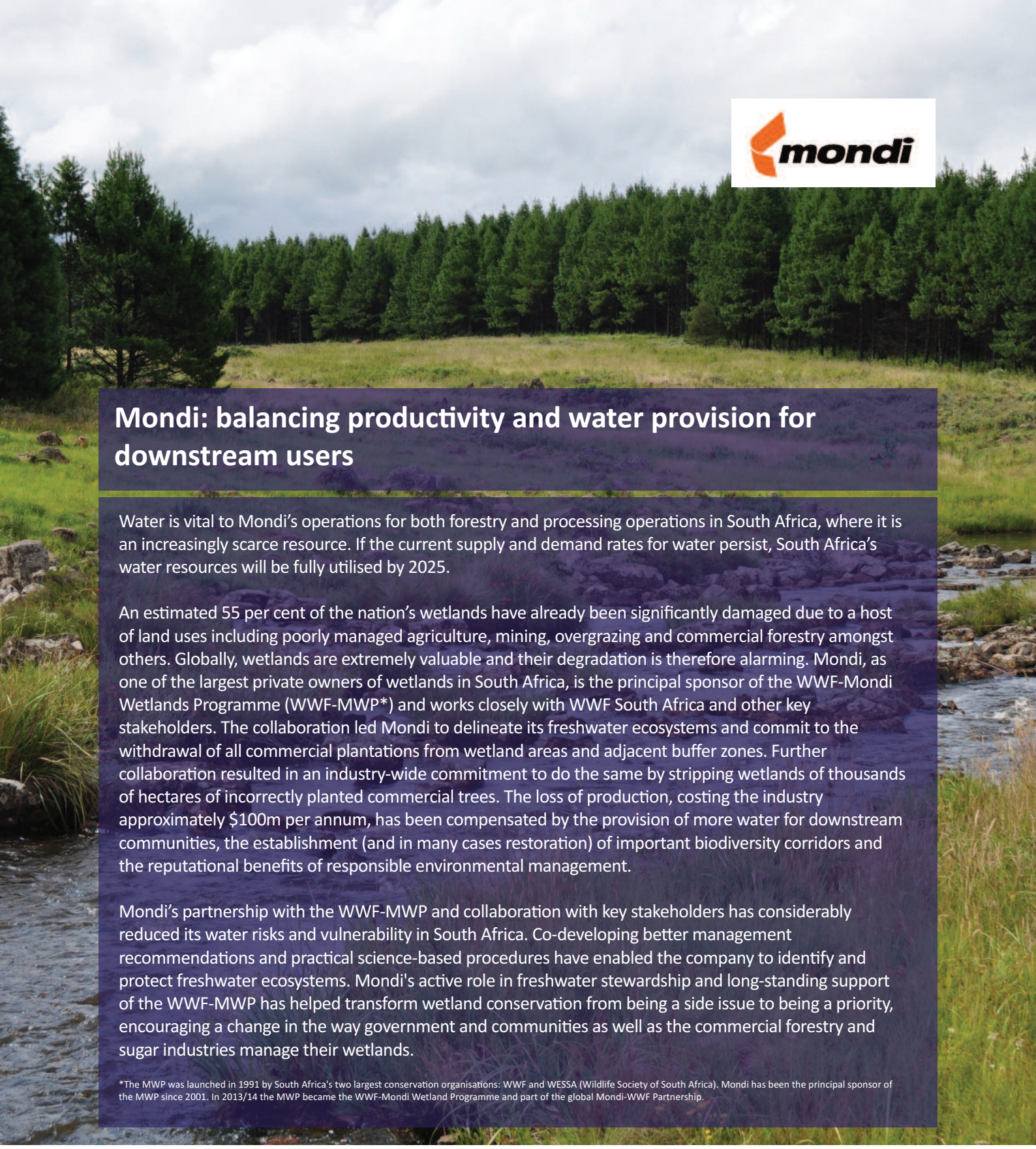
As pressure on natural capital increases, successful companies will identify the key management interventions that can improve aspects of water, biodiversity and soil, in the most dependent or priority landscapes from which they source raw materials. Business interventions and investments need to consider not only the consequences for natural capital but also the commercial benefits; these considerations include:

- Material natural capital dependencies and impacts
- Current impact and progress measures
- Commercial logic based upon evidenced business returns
- Areas and opportunities for greatest positive impact
- Mitigation and restoration

Integrated solutions, comprising a mix of interventions, should build on long-term resilience, the best scientific evidence, both environmental and social considerations and be as cost effective as possible.

Leading companies can identify their key natural capital dependencies now and make strategic decisions to secure them whilst options still exist in fragile landscapes. This will give them a competitive advantage as strategic options become more limited and more expensive thanks to increasing external pressures.

Business leaders in the Natural Capital Leaders Platform acknowledge that corporate profitability is threatened by diminishing natural capital reserves, including water, biodiversity and soil. Industry progress towards increased sustainability can vary depending on the structure or configuration of supply networks, the regulatory context, the relative influence of consumers and whether there are associated technology disruptions that drive more frugal and efficient supply chains[2,131]. Companies within the Natural Capital Leaders Platform are getting to the root of the problems around water, biodiversity and soil and are building on their current commercial drivers to achieve long-term productivity of both agricultural and natural landscapes.



Mondi: balancing productivity and water provision for downstream users

Water is vital to Mondi's operations for both forestry and processing operations in South Africa, where it is an increasingly scarce resource. If the current supply and demand rates for water persist, South Africa's water resources will be fully utilised by 2025.

An estimated 55 per cent of the nation's wetlands have already been significantly damaged due to a host of land uses including poorly managed agriculture, mining, overgrazing and commercial forestry amongst others. Globally, wetlands are extremely valuable and their degradation is therefore alarming. Mondi, as one of the largest private owners of wetlands in South Africa, is the principal sponsor of the WWF-Mondi Wetlands Programme (WWF-MWP*) and works closely with WWF South Africa and other key stakeholders. The collaboration led Mondi to delineate its freshwater ecosystems and commit to the withdrawal of all commercial plantations from wetland areas and adjacent buffer zones. Further collaboration resulted in an industry-wide commitment to do the same by stripping wetlands of thousands of hectares of incorrectly planted commercial trees. The loss of production, costing the industry approximately $100m per annum, has been compensated by the provision of more water for downstream communities, the establishment (and in many cases restoration) of important biodiversity corridors and the reputational benefits of responsible environmental management.

Mondi's partnership with the WWF-MWP and collaboration with key stakeholders has considerably reduced its water risks and vulnerability in South Africa. Co-developing better management recommendations and practical science-based procedures have enabled the company to identify and protect freshwater ecosystems. Mondi's active role in freshwater stewardship and long-standing support of the WWF-MWP has helped transform wetland conservation from being a side issue to being a priority, encouraging a change in the way government and communities as well as the commercial forestry and sugar industries manage their wetlands.

*The MWP was launched in 1991 by South Africa's two largest conservation organisations: WWF and WESSA (Wildlife Society of South Africa). Mondi has been the principal sponsor of the MWP since 2001. In 2013/14 the MWP became the WWF-Mondi Wetland Programme and part of the global Mondi-WWF Partnership.

> *"Operating in a world of constrained resources in which scarce natural capital is continually being depleted or eroded, we are faced with environmental and social challenges which are both global in scale and local in nature. These challenges affect our business as well as the stakeholders and communities we work with and the way business responds and leads the way is key to future sustainability."*
>
> **Peter Gardiner**
> Natural Resources Manager, Mondi Group

6 Call to Action

Dr Jake Reynolds, Director Business Platforms, CISL

The opportunities and the challenges are clear: the test now is how business will act

A key enabler of future business productivity is the securing of natural capital. Ensuring natural capital is considered and managed within supply chains will, for many businesses, help to sustain growth. However, the robust commercial logic for business to substantially address environmental degradation and secure natural capital remains under-developed. A comprehensive body of evidence that connects environmental enhancement to business gains and links strategic investment in natural capital to positive business returns is required to shift mainstream business practice.

There is an urgent need for trusted data and research that enables companies to make commercially interesting arguments for investing in natural capital, at scale. Members of the Natural Capital Leaders Platform recognise this and are working with CISL to build up a body of evidence placing real commercial situations at its core.

The Platform is exploring the key themes of water, biodiversity and soil through a series of Action Research Collaboratories (ARCs). We at CISL invite businesses concerned with the questions and challenges posed in this report, and with an interest in identifying the commercial benefits of investing in natural capital, to partner with us in this important research.

Action Research Collaboratories

Business needs to find the most appropriate solutions that have a natural capital focus, can solve the underlying environmental degradation problem and are business relevant. Many current approaches are resource intensive, costly and time-consuming, and do not adequately address the spectrum of natural capital challenges associated with water, biodiversity and soil. The Action Research Collaboratories explore these approaches, identify the gaps in addressing core natural capital challenges and determine where business is best placed to focus its investments. These collaboratories inform the decisions necessary to secure the natural resource supplies that underpin business practice.

For more information on the CISL ARC process please visit **www.cisl.cam.ac.uk/natcap** or email **hannah.tranter@cisl.cam.ac.uk**

References

[1]World Wildlife Fund. (2014). *Living Planet Report 2014: species and spaces, people and places.* McLellan, R., Iyengar, L., Jeffries, B., & Oerlemans, N. (Eds.). Retrieved from http://bit.ly/1ssxx5m

[2]Srai, J. S., Alinaghian, L. S., & Kirkwood, D. A. (2013). Understanding sustainable supply network capabilities of multinationals: A capability maturity model approach. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufactur*e, 227(4), 595-615. doi:10.1177/0954405412470597

[3]Hoekstra, A. Y., Mekonnen, M.M., Chapagain, A.K., Mathews, R.E., & Richter, B.D. (2012). Global Monthly Water Scarcity: Blue Water Footprints versus Blue Water Availability. *PLoS ONE*, 7(2), e32688. doi:10.1371/journal.pone.0032688

[4]de Vos, J.M., Joppa, L.N., Gittleman, J.L., Stephens, P.R., & Pimm, S. L. (2014). Estimating the Normal Background Rate of Species Extinction. *Conservation Biology.* doi:10.1111/cobi.12380

[5]Food and Agriculture Organisation of the United Nations. (2011). *The State of the World's Land and Water Resources for Food and Agriculture: Managing systems at risk*. Retrieved from http://www.fao.org/nr/solaw/solaw-home/en/

[6]Alexandratos, N., & Bruinsma, J. (2012) *World agriculture towards 2030/2050: the 2012 revision.* ESA Working paper No. 12-03. Food and Agriculture Organization of the United Nations and Earthscan. Retrieved from www.fao.org/docrep/016/ap106e/ap106e.pdf

[7]Bajželj, B., Richards, K.S., Allwood, J.M., Smith, P., Dennis, J.S., Curmi, E. & Gilligan, C. A. (2014). Importance of food-demand management for climate mitigation. *Nature Climate Change,* 4(10), 924-929. doi:10.1038/NCLIMATE2353

[8]Lee, B., Preston, F., Kooroshy, J., Bailey, R., & Lahn, G. (2012). *Resources Futures: A Chatham House Report.* Retrieved from http://www.chathamhouse.org/publications/papers/view/187947

[9]University of Cambridge Programme for Sustainability Leadership. (2012). *The Leadership Compact: Committing to Natural Capital.* Cambridge, UK: CISL. Retrieved from http://www.cisl.cam.ac.uk/Business-Platforms/Natural-Capital-Leaders-Platform/Natural-Capital-Leadership-Compact.aspx

[10]ACCA, Flora & Fauna International & KPMG. (2012). I*s natural capital a material issue? An evaluation of the relevance of biodiversity and ecosystem services to accountancy professionals and the private sector.* Retrieved from http://www.accaglobal.com/content/dam/acca/global/PDF-technical/environmental-publications/natural-capital.pdf

[11]Cosgrove, W.J., & Rijsberman, F.R. (2014). World Water Vision: Making Water Everybody's Business. New York, NY: Earthscan.

[12]Zumdahl, S.S. (2014, July 9). Water. Encyclopædia Britannica. Retrieved from http://www.britannica.com/EBchecked/topic/636754/water

[13]Wetlands International. (2010). *Biodiversity loss and the global water crisis: A fact book on the links between biodiversity and water security.* Wageningen, The Netherlands: Wetlands International.

[14]Bot, A., & Benites, J. (2005). *The importance of soil organic matter: key to drought-resistant soil and sustained food production*. FAO Soil Bulletin 80. Rome, Italy: FAO.

[15]Ya He, J., Cranston, G. (2014). *Sink or Swim: A multi-sector collaboration on water asset investment.* Cambridge, UK: CISL. Retrieved from http://www.cisl.cam.ac.uk/Resources/Resource-Security/Publications-and-Videos.aspx

[16]International Energy Agency. (2012). Chapter 17. Water for Energy: is energy becoming a thirstier resource? In International Energy Agency, *World Energy Outlook* 2012 (pp. 1-31). Paris, France: OECD/IEA.

[17]World Economic Forum. (2014). *Insight Report: Global Risks 2014 Ninth Edition.* Retrieved from www3.weforum.org/docs/WEF_GlobalRisks_Report_2014.pdf

[18]Kron, W. (2009). Flood insurance: from clients to global financial markets. *Journal of Flood Risk Management*, 2(1), 68-75. doi:10.1111/j.1753-318X.2008.01015.x

[19]World Water Assessment Programme. (2014). *The United Nations World Water Development Report 2014: Water and Energy.* Retrieved from www.unwater.org/worldwaterday/world-water-development-report/en/

[20]Molden, D., Frenken, K., Barker, R., de Fraiture, C., Mati, B., Svendsen, M., Sadoff, C., & Max Finlayson, C. (2007). Chapter 2: Trends in water and agricultural development. In D. Molden (Ed.), *Water for food, water for life: a comprehensive assessment of water management in agriculture* (pp.57 -89). London, UK: Earthscan.

[21]Sanni, W. (2011). *Corporate Water Strategies.* London, UK: Earthscan.

[22]Deloitte & Carbon Disclosure Project. (2013). *Moving beyond business as usual – a need for a step change in water risk management – CDP Global Water Report 2013*. Retrieved from https://www.cdp.net/CDPResults/CDP-Global-Water-Report-2013.pdf

[23]Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis.* Retrieved from www.millenniumassessment.org/documents/document.356.aspx.pdf

[24]Gerbens-Leenes, P., & Hoekstra, A. (2008). *Business water footprint accounting: A tool to assess how production of goods and services impacts on freshwater resources worldwide.* Value of Water Research Report Series No. 27. Retrieved from http://www.waterfootprint.org/Reports/Report27-BusinessWaterFootprint.pdf

[25]Hoekstra, A., & Hung, P. (2005). Globalization of water resources: international virtual water flows in relation to crop trade. *Global Environmental Change*, 15(1), 45-56. doi:10.1016/j.gloenvcha.2004.06.004

[26]Hoekstra, A. (2008). *Water neutral: reducing and offsetting the impacts of water footprints.* Value of Water Research Report Series No. 28. Retrieved from http://www.waterfootprint.org/Reports/Report28-WaterNeutral.pdf

[27]Ongley, E. (1996). *Control of water pollution from agriculture.* FAO irrigation and drainage paper 55. Rome, Italy: FAO.

[28]Gunningham, N., Kagan, R., & Thornton, D. (2004). Social license and environmental protection: why businesses go beyond compliance. *Law and Social Inquiry*, 29(2), 307-341. Retrieved from http://scholarship.law.berkeley.edu/facpubs/675

[29]van Dijk, A.I.J.M., & Keenan, R.J. (2007). Planted Forests and Water in perspective. *Forest Ecology and Management,* 251(1-2), 1-9. doi:10.1016/j.foreco.2007.06.010

[30]Rosenberg, D.M., McCully, P., & Pringle, C.M. (2000). Global-Scale Environmental Effects of Hydrological Alterations: Introduction. *BioScience*, 50(9), 749-751. doi:10.1641/0006-3568(2000)050[0746:GSEEOH]2.0.CO;2

[31]Oki, T., & Kanae, S. (2006). Global hydrological cycles and world water resources. *Science,* 313(5790), 1068-1072. doi:10.1126/science.1128845

[32]Ramankutty, N., Foley, J.A., Norman, J., & McSweeney, K. (2002). The global distribution of cultivable lands: current patterns and sensitivity to possible climate change. *Global Ecology and Biogeography,* 11(5), 377-392. doi:10.1046/j.1466-822x.2002.00294.x

[33]Vörösmarty, C., Fekete, B., Meybeck, M., & Lammers, R. (2000). Global system of rivers: its role in organizing continental land mass and defining land to ocean linkages. *Global Biogeochemical Cycles,* 14(2), 599-621. doi:10.1029/1999GB900092

[34]Allen, R., Pereira, L., Raes, D., & Smith, M. (1998). *Crop evapotranspiration: Guidelines for computing crop water requirements.* FAO irrigation and drainage paper 56. Rome, Italy: FAO.

[35]Shibata, T., Solo-Gabriele, H.M., Fleming, L.E., & Elmir, S. (2004). Monitoring marine recreational water quality using multiple microbial indicators in an urban tropical environment. *Water Research,* 38(13), 3119-3131. doi:10.1016/j.watres.2004.04.044

[36]Toze, S. (2006). Reuse of effluent water –benefits and risks. *Agricultural Water Management,* 80(1-3), 147-159. doi:10.1016/j.agwat.2005.07.010

[37]Gleick, P.H. (2003). Global Freshwater Resources: Soft-Path Solutions for the 21st Century. *Science,* 302(5650), 1524-1528. doi:10.1126/science.1089967

[38]Hill, Y., & Clucas, N. (2012). *Water means Business: Corporate Perspectives on Water.* Report by Corporate Citizenship. Retrieved from http://corporate-citizenship.com/wp-content/uploads/Corporate-Citizenship-Water-means-business.pdf

[39]DeFraiture, C., & Wichelns, D. (2010). Satisfying future demands for agriculture. *Agricultural Water Management,* 97(4), 502-511. doi:10.1016/j.agwat.2009.08.008

[40]Morrison, J., Schulte, P., Koopman, L., Teear, N., Lamb, C., de Souza, K., Norton, M., Shiao, T., & Reig, P. (2014). *The CEO Water Mandate. Corporate Water Disclosure Guidelines: Toward a Common Approach to Reporting Water Issues.* Retrieved from http://ceowatermandate.org/files/Disclosure2014.pdf

[41]Donnelly, K., Ha, M., Cooley, H., & Morrison, J. (2012). *The CEO Water Mandate. Water as a Casualty of Conflict: Threats to Business and Society in High-Risk Areas.* Retrieved from http://ceowatermandate.org/files/high-risk_full_report.pdf

[42]Jiménez Cisneros, B.E., Oki, T., Arnell, N.W., Benito, G., Cogley, J.G., Döll, P., Jiang, T., & Mwakalila, S.S. (2014). Freshwater resources. In C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M.Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken,P.R. Mastrandrea & L.L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 229-269). Cambridge, UK & New York, NY: Cambridge University Press.

[43]World Water Assessment Programme. (2012). *The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk.* Retrieved from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWDR4%20Volume%201-Managing%20Water%20under% 20 Uncertainty %20 and%20 Risk.pdf

[44]Pacific Institute. (2008). *The world's water: water conflict chronology.* Retrieved from http://www2.worldwater.org/chronology.html

[45] UK businesses could save around £10 million per day. (2010, April 16). *Energy and Environment management.* Retrieved from http://www.eaem.co.uk/news/

[46]Olson, E.G. (2009). Business as environmental steward: the growth of greening. *Journal of Business Strategy,* 30(5), 4-13. doi:10.1108/02756660910987563

[47]Greenwood, R., Willis, R., Hoenig, M., Strategic, R., & Farrington, R. (2012). *The CEO Water Mandate: Guide to water-related collective action.* Retrieved from http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/wrca_full_report3.pdf

[48]WBCSD & IUCN. (2010). *Water for Business: Initiatives guiding sustainable water management in the private sector. Version 2.* Retrieved from http://www.wbcsd.org/waterforbusiness3.aspx

[49]United Nations. (1992). *Convention on biological diversity.* Retrieved from https://www.cbd.int/doc/legal/cbd-en.pdf

[50]Millennium Ecosystem Assessment. (2005). Millennium Ecosystem Assessment: Objectives, Focus, and Approach. In R. Hassan, R. Scholes & N. Ash (Eds.), *Ecosystems and Human Well-being: Current State and Trends, Volume 1.* Washington, DC: The Island Press.

[51]Hooper, D.U., Adair, E.C., Cardinale, B.J., Byrnes, J.E.K., Hungate, B.A.M.K.L., Gonzalez, A., Duffy, J.E., Gamfeldt, L., & O'Connor, M.I. (2012). A global synthesis reveals biodiversity loss as a major driver of ecosystem change. *Nature,* 486, 105-108. doi:10.1038/nature11118

[52]TEEB. (2012). *The Economics of Ecosystems and Biodiversity in Business and Enterprise.* London, UK & New York, NY: Earthscan.

[53]de Groot, R., Fisher, B., Christie, M., Aronson, J., Braat, L., Gowdy, J., Haines-Young, R., Maltby, E., Neuville, A., Polasky, S., Portela, R., & Ring, I. (2010). Chapter 1. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. In P. Kumar (Ed.), *The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations* (pp. 1-33). London, UK & New York, NY: Earthscan.

[54]Ford-Lloyd, B., Schmidt, M., Armstrong, S., Barazani, O., Engels, J., Hadas, R., Hammer, K., Kell, S., Kang, D., Khoshbakht, K., Li, Y., Long, C., Lu, B.-R., Ma, K., Nguyen, V.T., Qiu, L., Ge, S., Wei, W., Zhang, Z., & Maxted, N. (2011). Crop Wild Relatives—Undervalued, Underutilized and Under Threat? *BioScience,* 61(7), 559-565. doi:10.1525/bio.2011.61.7.10

[55]Balmford, A., Bruner, A., Cooper, P., Costanza, R., Farber, S., Green, R.E, Jenkins, M., Jefferiss, P., Jessamy, V., Madden, J., Munro, K., Myers, N., Naeem, S., Paavola, J., Rayment, M., Rosendo, S., Roughgarden, J., Trumper, K., & Turner, R.K. (2002). Economic Reasons for Conserving Wild Nature. *Science,* 297(5583), 950-953. doi:10.1126/science.1073947

[56]Vogel, D. (1997). *Trading Up: Consumer and Environmental Regulation in a Global Economy* (2nd ed.). USA: Harvard University Press.

[57]Equator Principles. (2013). *The Equator Principles, June 2013: A financial industry benchmark for determining, assessing and managing environmental and social risk in projects.* Retrieved from http://www.equator-principles.com/resources/equator_principles_III.pdf

[58]International Finance Corporation. (2012). *IFC Performance Standards on Environmental and Social Sustainability.* Retrieved from http://www.ifc.org/wps/wcm/connect/c8f524004a73daeca09afdf998895a12/IFC_Performance_Standards.pdf?MOD=AJPERES

[59]Brinson, M.M., & Malvarez, A.I. (2002). Temperate freshwater wetlands: types, status, and threats. *Environmental Conservation,* 29(2), 115-133. doi:10.1017/S0376892902000085

[60]Geist, H. J., & Lambin, E.F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *BioScience,* 52(2), 143-150. doi:10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2

[61]Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J.A. (2009). A safe operating space for humanity. *Nature,* 461, 472-475. doi:10.1038/461472a

[62]Rockström, J., Steffen, W., Noone, K., Persson, Å., Chaplin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J.A. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society,* 14(2), 32. Retrieved from http://www.ecologyandsociety.org/vol14/iss2/art32/

[63]Erisman, J. W., Galloway, J.N., Seitzinger, S., Bleeker, A., Dise, N.B., Petrescu, A.M.R., Leach, A.M., & de Vries, W. (2013). Consequences of human modification of the global nitrogen cycle. *Philosophical Transactions of the Royal Society B*, 368, 20130116. doi:10.1098/rstb.2013.0116

[64]Fadda, C., Jarvis, D., & de Santis, P. (2011). Damage, Diversity and Genetic Vulnerability: the Role of Crop Genetic Diversity in Agricultural Production Systems. In D.I. Jarvis, C. Fadda, P. de Santis & J. Thompson, *Damage, diversity and genetic vulnerability: The role of crop genetic diversity in the agricultural production system to reduce pest and disease damage. Proceedings of an International Symposium 15-17 February 2011, Rabat, Morocco*. Rome, Italy: Biodiversity International.

[65]Frison, E. A., Cherfas, J., & Hodgkin, T. (2011). Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. *Sustainability,* 3, 238-253. doi:10.3390/su3010238

[66]Bonneuil, C., Goffaux, R., Bonnin, I., Montalent, P., Hamond, C., Balfourier, F., & Goldringer, I. (2012). A new integrative indicator to assess crop genetic diversity. *Ecological Indicators,* 23, 280-289. doi:10.1016/j.ecolind.2012.04.002

[67]Vellve, R. (2009). *Saving the Seed: Genetic Diversity and European Agriculture.* London, UK: Earthscan.

[68]Khush, G. S. (1989). Multiple disease and insect resistance for increased yield stability in rice. In International Rice Research Institute, *Progress in Irrigated Rice Research: Selected papers and abstracts from the International Rice Research Conference 21 - 25 September 1987, Hangzhou, China* (pp. 79-92). Manila, Philippines: International Rice Research Institute.

[69]Jacobsen, S.-E., Sørensen, M., Pedersen, S.M., & Weiner, J. (2013). Feeding the world: genetically modified crops versus agricultural biodiversity. *Agronomy for Sustainable Development,* 33, 651-662. doi:10.1007/s13593-013-0138-9

[70]Stolton, S., Maxted, N., Ford-Lloyd, B., Kell, S., & Dudley, N. (2006). *Food Stores: Using protected areas to secure crop genetic diversity.* A research report by WWF, Equilibrium and University of Birmingham, UK. Retrieved from http://d2ouvy59p0dg6k.cloudfront.net/downloads/food_stores.pdf

[71]Power, A.G. (2010). Ecosystem services and agriculture: tradeoffs and synergies. *Philosophical Transactions of the Royal Society B*, 365, 2959-2971. doi: 10.1098/rstb.2010.0143

[72]Vanbergen, A. J., & the Insect Pollinators Initiative. (2013). Threats to an ecosystem service: pressures on pollinators. *Frontiers in Ecology and the Environment,* 11(5), 251–259. doi:10.1890/120126

[73]Potts, S. G., Biesmeijer, J.C., Kremen, C., Neumann, P., Schweiger, O., & Kunin, W.E. (2010). Global pollinator declines: trends, impacts and drivers. *Trends in Ecology and Evolution,* 25(6), 345-353. doi:10.1016/j.tree.2010.01.007

[74]Gallai, N., Salles, J-M., Settele, J., & Vaissière, B.E. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, 68, 810-821. doi:10.1016/j.ecolecon.2008.06.014

[75]Balmford, A., Rodrigues, A.S.L., Walpole, M., ten Brink, P., Kettunen, M., Braat, L., & de Groot, R. (2008). *The Economics of Biodiversity and Ecosystems: Scoping the Science.* Cambridge, UK: European Commission (contract: ENV/070307/2007/486089/ETU/B2).

[76]Calder, I., Hofer, T., Vermont, S., & Warren, P. (2007). Towards a new understanding of forests and water. *Unasylva,* 58(229). Rome, Italy: FAO.

[77]Hönigová, I., Vačkář, D., Lorencová, E., Melichar, J., Götzl, M., Sonderegger, G., Ouškova, V., Hošek, M., & Chobot, K. (2012). Survey on grassland ecosystem services: *Report of the European Topic Centre on Biological Diversity.* Prague, Czech Republic: Nature Conservation Agency of the Czech Republic.

[78]Smith, P., Ashmore, M., Black, H., Burgess, P., Evans, E., Hails, R., Potts, S.G., Quine, T., Thomson, A. (2011). Chapter 14: Regulating Services. In UK National Ecosystem Assessment, *The UK National Ecosystem Assessment Technical Report* (pp. 535-596). Cambridge, UK: UNEP-WCMC.

[79]Cardinale, B. J. (2011). Biodiversity improves water quality through niche partitioning. *Nature*, 472, 86-91. doi:10.1038/nature09904

[80]Torsvik, V., & Øvreås, L. (2002). Microbial diversity and function in soil: from genes to ecosystems. *Current Opinion in Microbiology,* 5(3), 240-245. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12057676

[81]Vandermeer, J., Perfecto, I., & Philpott, S. (2010). Ecological Complexity and Pest Control in Organic Coffee Production: Uncovering an Autonomous Ecosystem Service. *BioScience*, 60(7), 527-537. doi:10.1525/bio.2010.60.7.8

[82]Luck, G. W. (2007). A review of the relationships between human population density and biodiversity. *Biological Reviews of the Cambridge Philosophical Society.*, 82, 607-645. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17944620

[83]Gerbens-Leenes, P., Nonhebel, S., & Krol, M. (2010). Food consumption patterns and economic growth. Increasing affluence and the use of natural resources. *Appetite,* 55, 597-608. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20854862

[84]Gerbens-Leenes, P., & Nonhebel, S. (2002). Consumption patterns and their effects on land required for food. *Ecological Economics,* 42, 185-199. doi:10.1016/S0921-8009(02)00049-6

[85]Walther, G.R. (2010). Community and ecosystem responses to recent climate change. *Philosophical Transactions of the Royal Society B*, 365, 2019-2024. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20513710

[86]Doney, S. C., Ruckelshaus, M., Duffy, J.E., Barry, J.P., Chan, F., English, C.A., Galindo, H.M., Grebmeier, J.M., Hollowed, A.B., Knowlton, N., Polovina, J., Rabalais, N.N., Sydeman, W.J., & Talley, L.D. (2012). Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science,* 4, 11-37. doi:10.1146/annurev-marine-041911-111611

[87]Wang, D., Heckathorn, S.A., Wang, X., & Philpott, S.M. (2012). A meta-analysis of plant physiological and growth responses to temperature and elevated CO_2. *Oecologia,* 169, 1-13. doi:10.1007/s00442-011-2172-0

[88]Sutherland, W. J., Bailey, M.J., Bainbridge, I.P., Brereton, T., Dick, J.T.A., Drewitt, J., Dulvy, N. K., Dusic, N. R., Freckleton, R.P., Gaston, K.J., Gilder, P.M., Green, R.E., Heathwaite, A.L., Johnson, S.M., Macdonald, D.W., Mitchell, R., Osborn, D., Owen, R.P., Pretty, J., Prior, S.V., Prosser, H., Pullin, A.S., Rose, P., Stott, A., Tew, T., Thomas, C.D., Thompson, D.B.A., Vickery, J.A., Walker, M., Walmsley, C., Warrington, S., Watkinson, A.R., Williams, R.J., Woodroffe, R., & Woodroof, H.J. (2008). Future novel threats and opportunities facing UK biodiversity identified by horizon scanning. *Journal of Applied Ecology,* 45(3), 821-833. doi:10.1111/j.1365-2664.2008.01474.x

[89]Robinson, B. E., Holland, M.B., & Naughton-Treves, L. (2014). Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change,* 29, 281-293. doi:10.1016/j.gloenvcha.2013.05.012

[90]Barbier, E., & Burgess, J. (2001). Tropical Deforestation, Tenure Insecurity, and Unsustainability. *Forest Science,* 47(4), 497-509. Retrieved from http://www.researchgate.net/publication/233625750_Tropical_Deforestation_Tenure_Insecurity_and_Unsustainability

[91]*Aichi Biodiversity Targets.* (n.d.). Retrieved October 7, 2014, from Convention on Biological Diversity website, http://www.cbd.int/sp/targets/

[92]*G4 Sustainability Reporting Guidelines*.(n.d.). Retrieved October 26, 2014, from Global Reporting Initiative website, https://www.globalreporting.org/reporting/g4/Pages/default.aspx

[93]Lal, R. (2003). Soil erosion and the global carbon budget. *Environment International,* 29(4), 437-450. doi:10.1016/S0160-4120(02)00192-7

[94]White, R.E. (2006). *Principles and Practice of Soil Science: the Soil as a Natural Resource* (4th ed.). Malden, UK: Wiley- Blackwell Science.

[95]Bridge, J., & Banwart, S. (2013). S*ecuring soils for sustainable agriculture: a science-led strategy.* London, UK: The Royal Society of Chemistry. Retrieved from http://www.rsc.org/globalassets/04-campaigning-outreach/realising-potential-of-scientists/research-policy/global-challenges/securing-soils-for-sustainable-agriculture.pdf

[96]Brussaard, L. (1997). Biodiversity and Ecosystem Functioning in Soil. *Ambio*, 26(8), 563-570. Retrieved from http://www.jstor.org/stable/4314670

[97]Bezdicek, D., Papendick, R., & Lal, R. (1996). Importance of soil quality to health and sustainable land management. In J.W. Doran & A.J. Jones (Eds.), *Methods for assessing soil quality* (pp. 1-8). Madison, USA: Soil Science Society of America.

[98]Clay, J. (2004). *World Agriculture and the Environment: A Commodity-By-Commodity Guide to Impacts and Practices.* Washington, USA: Island Press.

[99]Williamson, I. (2001). Land administration "best practice" providing the infrastructure for land policy implementation. *Land Use Policy,* 18(4), 297-307. Retrieved from http://hdl.handle.net/11343/33980

[100]Darst, B., & Fixen, R. (2000). High Yields, High Profits, and High Soil Fertility. *Better Crops,* 84(1), 4-8. Retrieved from http://www.ipni.net/publication/bettercrops.nsf/0/A62E38A13592A1A7852579800081FDE2/$FILE/Better%20Crops%202000-1%20p04.pdf

[101]Qadir, M., Ghafoor, A., & Murtaza, G. (2000). Amelioration strategies for saline soils: a review. *Land Degradation & Development,* 11(6), 501-521. doi:10.1002/1099-145X(200011/12)11:6<501::AID-LDR405>3.0.CO;2-S

[102]Rozema, J., & Flowers, T. (2008). Crops for a salinized world. *Science,* 322(5907), 1478-1480. doi:10.1126/science.1168572x

[103]Qadir, M., Quillérou, E., Nangia, V., Murtaza, G., Singh, M., Thomas, R., Dreschsel, P., & Noble, A. (2014). Economics of salt-induced land degradation and restoration. Natural Resources Forum. Retrieved from http://www.unccd.int/en/programmes/Capacity-building/CBW/Resources/Pages/Publication-Page.aspx?ItemID=112

[104]Lawrence, G. B., Shortle, W.C., David, M.B., Smith, K.T., Warby, R.A., & Lapenis, A.G. (2012). Early Indications of Soil Recovery from Acidic Deposition in U.S. Red Spruce Forests. *Soil Science Society of America Journal,* 76, 1407–1417. Retrieved from http://www.nrs.fs.fed.us/pubs/41143

[105]Hue, N.V., Craddock, G.R., & Adams, F. (1988). Effect of Organic Acids on Aluminum Toxicity in Subsoils. *Soil Science Society of America Journal,* 50(1), 28-34. doi:10.2136/sssaj1986.03615995005000010006x

[106]Carvalho, F. (2006). Agriculture, pesticides, food security and food safety. *Environmental Science & Policy,* 9(7-8), 685-692. doi:10.1016/j.envsci.2006.08.002

[107]Tilman, D., Cassman, K., Matson, P., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature,* 418, 571-677. doi:10.1038/nature01014

[108]Matson, P., McDowell, W., Townsend, A., & Vitousek, P. (1999). The globalization of N deposition: ecosystem consequences in tropical environments. *Biogeochemistry,* 46(1-3), 67-83. Retrieved from http://link.springer.com/article/10.1007%2FBF01007574

[109]Galloway, J., Townsend, A., Erisman, J., Bekunda, M., Cai, Z., Freney, J., Martinellis, L., Seitzinger, S., & Sutton, M. (2008). Transformation of the Nitrogen Cycle: Recent Trends, Questions, and Potential Solutions. *Science,* 320(5878), 889-892. doi:10.1126/science.1136674

[110]MacDonald, D., Crabtree, J.R., Wiesinger, G., Dax, T., Stamou, N., Fleury, P., Gutierrez Lazpita, J., & Gibon, A. (2000). Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response. *Journal of Environmental Management,* 59(1), 47-69. doi:10.1006/jema.1999.0335

[111]Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., & de Haan, C. (2006). *Livestock's long shadow.* Rome, Italy: FAO. Retrieved from ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e00.pdf

[112]Bilotta, G., Brazier, R., & Haygarth, P. (2007). The Impacts of Grazing Animals on the Quality of Soils, Vegetation, and Surface Water in Intensively Managed Grasslands. *Advances in Agronomy,* 94, 237-280. doi:10.1016/S0065-2113(06)94006-1

[113]Doran, J. W., & Parkin, T.B. (1994). Defining and Assessing Soil Quality. In J.W. Doran, D.C. Coleman, D.F. Bezdicek & B.A. Steward (Eds.), *Defining Soil Quality for a Sustainable Environment.* Madison, USA: Soil Science Society of America.

[114]Linn, D.M., & Doran, J. (1984). Effect of Water-Filled Pore Space on Carbon Dioxide and Nitrous Oxide Production in Tilled and Nontilled Soils. *Soil Science Society of America Journal*, 48(6), 1267-1272. doi:10.2136/sssaj1984.03615995004800060013x

[115]Havlin, J., Beaton, J., Tisdale, S., & Nelson, W. (1999). Soil Fertility and Fertilizers, *An introduction to Nutrient Management* (6th ed.). New Jersey, USA: Prentice Hall.

[116]Hoorman, J., & Islam, R. (2010). *Understanding Soil Microbes and Nutrient Recycling: Agriculture and Natural Resources Fact Sheet.* Ohio, USA: The Ohio State University. Retrieved from http://ohioline.osu.edu/sag-fact/pdf/0016.pdf

[117]Abedi, M., Bartelheimer, M., & Poschlod, P. (2014). Effects of substrate type, moisture and its interactions on soil seed survival of three Rumex species. *Plant and Soil,* 374(1-2), 485–495. doi:10.1007/s11104-013-1903-x

[118]Altieri, M. (1999). The ecological role of biodiversity in agroecosystems. *Agriculture, Ecosystems & Environment,* 74(1-3), 19-31. doi:10.1016/S0167-8809(99)00028-6

[119]Martínez-Casasnovas, J., Ramos, M., & Ribes-Dasi, M. (2002). Soil erosion caused by extreme rainfall events: mapping and quantification in agricultural plots from very detailed digital elevation models. *Geoderma,* 105(1-2), 125-140. doi:10.1016/S0016-7061(01)00096-9

[120]Smith, P., & Bustamante, M. (2014). Agriculture, Forestry and Other Land Use (AFOLU). In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel & J.C. Minx (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 811-922). Cambridge, UK & New York, NY: Cambridge University Press.

[121]OECD & Food and Agriculture Organization of the United Nations. (2014). OECD-FAO *Agricultural Outlook 2014-2023*. Retrieved from http://dx.doi.org/10.1787/agr_outlook-2014-en

[122]Meyer, W.B., & Turner, B.L. (1992). Human Population Growth and Global Land-Use/Cover Change. *Annual Review of Ecology and Systematics,* 23, 39-61. Retrieved from http://www.jstor.org/stable/2097281

[123]Chambers, B., Goulding, K., & Leake, A.R. (2011). *Simply Sustainable Soils: Six Simple Steps for Your Soil to Help Improve the Performance, Health and Long-term Sustainability of Your Land.* Stoneleigh Park, UK: Asda and LEAF (Linking Environment and Farming).

[124]Kassam, A., & Brammer, H. (2013). Combining sustainable agricultural production with economic and environmental benefits. *The Geographical Journal,* 179(1), 11–18. doi:10.1111/j.1475-4959.2012.00465.x

[125]Rosenzweig, C., & Hillel, D. (2000). Soils and global climate change: challenges and opportunities. *Soil Science,* 165(1), 47-56. Retrieved from http://journals.lww.com/soilsci/Abstract/2000/01000/SOILS_AND_GLOBAL_CLIMATE_CHANGE__CHALLENGES_AND.7.aspx

[126]Hansson, L-A., Brönmark, C., Nilsson, P.A., & Abjörnsson, K. (2005). Conflicting demands on wetland ecosystem services: nutrient retention, biodiversity or both? *Freshwater Biology,* 50(4), 705–714. doi:10.1111/j.1365-2427.2005.01352.x

[127]Ballantine, K., & Schneider, R. (2009). Fifty-five years of soil development in restored freshwater depressional wetlands. *Ecological Applications,* 19(6), 1467–1480. doi:10.1890/07-0588.1

[128]Tallis, H., Kareiva, P., Marvier, M., & Chang, A. (2008). An ecosystem services framework to support both practical conservation and economic development. *PNAS,* 105(28), 9457–9464. doi:10.1073/pnas.0705797105

[129]Cao, S., Chen, L., & Yu, X. (2009). Impact of China's Grain for Green Project on the landscape of vulnerable arid and semi-arid agricultural regions: a case study in northern Shaanxi Province. *Journal of Applied Ecology,* 46(3), 536–543. doi: 10.1111/j.1365-2664.2008.01605.x

[130]Bullock, J.M., Aronson, J., Newton, A.C., Pywell, R.F., & Rey-Benayas, J.M. (2011). Restoration of ecosystem services and biodiversity: conflicts and opportunities. *Trends in Ecology and Evolution,* 26(10), 541-549. doi:10.1016/j.tree.2011.06.011

[131]Srai, J. S., & Gregory, M. A. (2008). A supply network configuration perspective on international supply chain development. *International Journal of Operations & Production Management,* 28(5), 386-411. doi:10.1108/01443570810867178

[132]Borucke, M., Moore, D., Cranston, G., Gracey, K., Katsunori, I., Larson, J., Lazarus, E., Morales, J.C., Wackernagel, M., & Galli, A. (2013). Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecological Indicators,* 24, 518–533. doi:10.1016/j.ecolind.2012.08.005

[133]UN Water & FAO. (2007). *Coping with water scarcity: challenge of the twenty-first century.* Retrieved from: http://www.fao.org/nr/water/docs/escarcity.pdf

[134]Karr, J., & Dudley, D. (1981). Ecological Perspective on water quality goals. *Environmental management,* 5(1), 55-68. doi:10.1007/BF01866609

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