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Special Issue on Sustainable Development Goals (SDGs)

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Sustainable Development Goals (SDGs)
Editorial Introduction

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Sustainable Development (SD) is a concept that became popular thanks to the Brundtland Commission Report also known as Our Common Future. The Rio Conference of 1992 resulted in sustainable development being accepted as a desirable objective in development policy and planning. Yet sustainable development has been defined and interpreted in many ways and its integration in the policy discourse has not been without problems. Having said that one should also agree that sustainable development has been used as an idea by the civil society, particularly the environmental and conservation groups, to contest the dominant policy paradigm that focuses on more economic goals like increasing GDP without taking into account the real costs of economic growth. Scientists have called the attention to the planetary limits to growth and this has rekindled the debate on limits to growth in a different way. But the challenge lies in dealing with the trade-offs and choices and how best the conflicting objectives and interests in relation to the environment can be addressed (Vira 2015).

In fact, we have come a long way since the days of 'Our Common Future' to the 'Future We Want'. The Brundtland Commission Report provided the background for the Rio Conference of 1992 while the Rio+20 conference paved the way for post-2015 agenda and Sustainable Development Goals (SDGs) are part of the global discourse of sustainable development.

But ever since the Stockholm Conference of 1972 the global debates on environment and development have also been debates that have often pitted the North against the South. According to Delyse and Redclift

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(2015), "However, since UNCED, the balance of power has shifted. While the struggle at that and earlier fora can be seen as being between 'North' and 'South', the gap today is also between the poorest countries, with no resources to attract investment, the developed countries, and the new 'rapidly developing' economies. Notable among these is the BRICS, which may symbolise a shift in global economic power away from the G8 towards the developing world. In the meantime, dominant discourses and the interests they reflect and defend guarantee that the EU and developed world countries, as well as rapidly developing countries such as China, will make adjustments to deal with the crises of debt in developed nations such as Greece, but fail to respond to similar needs of resource-poor developing countries in Africa and South America".

The nature of the challenges today is such that they have to be addressed collectively and equity should be a key principle in addressing them. Although there are doubts and skepticism about SDGs, today they provide humankind the options and hope to pursue sustainable development in the real sense of the term. SDGs are successors to the Millennium Development Goals (MDGs). The achievements under MDGs are impressive and setting up of MDGs spurred action and investment in key sectors like health and education.[1] Although not all countries did well in meeting the MDGs, but this atleast enabled the global community to realise the tasks on hand in terms of meeting the aspirations and demands of the poor and needy in the world. The SDGs will guide the global development agenda for the next 15 years and SDG targets will be the benchmark for countries. While SDGs *per se* are acceptable and non-controversial harmonising them with national priorities and policy timescales is important.[2] At the same time managing the transition from MDGs to SDGs remains a major challenge and a report of the Secretary General of UN called for policy integration and coherence across actors and sectors.

In some sectors like Health while objectives like Universal Health Coverage (UHC) may seem to be acceptable to all but questions have been raised whether a narrow focus on UHC is desirable at all as that could priortise expansion of access to health services over equitable health outcomes across all relevant sectors. According to Schmidt, Gostin and Emanuel (2015), "But UHC is a means, not an end in itself. The ultimate goal

must be the improvement of health. Unfortunately, most population-level health targets do not include policy vehicles that can help to accomplish them."

This question is not unique to health-related SDGs. Rather in case of many SDGs the policy vechiles may not be strong enough to match the objectives or there is a conflict between SDGs and national priorities. Besides SDGs, many countries have agreed to different targets/goals under various international plans of action or as a commitment to international conventions and treaties. Balancing them with SDGs is a tough challenge given the multiple demands on available resources. SDGs are not owned by UN or by the governments and civil society and other stakeholders have a major role to play in achieving SDGs. While sustainable development has been talked about for more than a quarter century there is still skepticism about the concept and translating that in practice and also on SDG. These skepticisms and critiques emanate from sections of civil society and academics who are disappointed with the way sustainable development has been put to practice and they consider that SDGs will not make much difference to the people or planet or are of the view that ideas like degrowth are more relevant than sustainable development or SDGs (Kothari, Demaria and Acosta 2015). Such views need not be dismissed as mere critiques and the critical perspectives can be used to improve the discourse and policy measures on SD and SDG.

The negotiations on the Post-2015 Development Agenda are now over and the General Assembly has adopted the document entitled, 'Transforming our World: The 2030 Agenda for Sustainable Development' with this the stage is now set for cooperation and implementation across agencies and national governments. The focus now would be on goals and targets for carrying the agenda forward. There are 17 goals and 169 targets that would be a crucial component for the implementation of SDGs. The context this time would be very different from the one that was there with MDGs. This is for the first time that the United Nation's platform for SDGs and for that matter biodiversity finds an extremely important spot. In fact, the idea of sustainable development is being viewed as a step in the direction of poverty alleviation.

The SDGs goals related to biodiversity has reflected in Goal 15 which talks about protecting and restoring sustainable use of terrestrial ecosystems, sustainably manage forests along with conserving and sustainably use the oceans, seas and marine resources (Goal 14). The idea of combat climate change (Goal 12) and making our cities sustainable and reliable (Goal 11) along with sustainable industrialization and foster innovation (Goal 9) are some of the areas which are addressed for evolving a wider and purposeful approach.

Even Goal 6 with emphasis on sustainable management of water resources and Goal 7 with affordable and reliable sources of energy are extremely important. As has emerged through this long-list of goals, an effort has been made to provide a direction to the national governments, societies and communities to make definitive choice which mankind needs to make a tryst with destiny for ensuring future sustenance.

Science and Technology and Innovation and policies associated to them would have a major impact for implementing the agenda. Issues of conflict between multilateral trade agreements and the agreements specific to environment and biodiversity. First instance, the Sanitary and Phyto-sanitary Measures of WTO (SPS Agreement) and Cartagena Biosafety Protocol (CBP) are yet to be conclusively close. Not much has happened in technology transfer, under Article 66.2 of The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Similarly, access to technology is yet to be effectively addressed though Paragraph 123 of the Addis Abba Action Agenda (AAAA) called for establishing a Technology Facilitation Mechanism (TFM). However, operationalisation of TFM and its working is yet to be clearly spelled out. The mechanism would comprise UN's Inter-Agency Task Team on Science Technology and Innovation for SDGs and the collaborative effort comprising multilateral stakeholder consultation and an online platform as a gateway for existing Science, Technology and Innovation initiatives. It is important that TFM leads the creation of incentives for innovation and technology transfer and while doing so identify the most needed technologies in the context of sustainable development. There may also be a facilitating role for TFM for establishing joint R&D mechanisms creating centres for adopting technologies and encouraging capacity building. Under the TFM, therefore,

prioritising innovation needs and contextualising STI system for sustainable development should be the first goal. The IPR related issues should be leveraged as a building block and not as a hindrance.

RIS has initiated a programme on SDGs and this special issue of the ABDR is part of the RIS activities and publications on SDGs, which is supported by UNDP and other institutions. A key component of the programme is to facilitate reflections on themes and objectives indicated in the SDGs and how the objectives can be realised with the cooperation of all stakeholders. In this Special Issue, there are six articles of which, five discuss various themes and issues related to SDGs. The contributions are leading policy researchers in the realm of global issues and sustainable development frameworks.

Biodiversity gets prominence in the SDGs and this indicates that its importance is getting better recognised. Pointing this out Balakrishna Pisupati provides a review of key issues and tasks ahead in meeting the goals of two key Biodiversity Goals accepted by the countries and suggests how they can be met. Access to justice and sustainable development are linked in more than one way. Elizabeth Maruma Mrema and Matthias Häntschel indicate the importance of Environmental Access Rights (EARs) as an important legal means to enhance citizen involvement in environmental issues and trace the relationship between access to justice, citizen participation in international environmental law. They point out that as ultimately citizens' well-being should be the core objective of sustainable development, EARs can play an important role in achieving sustainable development. The article by Maria Julia Olivia discusses how Ethical Biotrade can contribute to the conservation and sustainable use of biodiversity. She explores the nexus between use, equitable access and benefit sharing and how this can enable different stakeholders involved in use and conservation of genetic resources. Applying the concept of Ecological Footprint to countries in the ASEAN region and the region, Katsunori Iha *et al.* discuss the linkages between economic growth, use of resources and challenges in promoting sustainable development in the region in the context of multiple challenges and demands on natural resources. Pooran Chandra Pandey shows how business can contribute to achieving SDGs and shares the results from studies and surveys on the role and perception of the business community

in achieving SDG. Bioeconomy as a concept has gained attention in the recent years. Kathleen D'Hondt, Gerardo Jiménez-Sánchez and Jim Philp explore how Asia can benefit from biotechnology in different sectors and how biotechnology can contribute to the Asian Bioeconomy in a big way.

We hope that the Special Issue will be found interesting and useful by the readers of this journal. Your suggestions and comments are welcomed.

Endnotes

1 See UN (2015) for details on achievements under MDGs.

2 See Scott and Lucci and Berliner (2015) for details.

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Dealing with Biodiversity Related Goals within the Sustainable Development Goals (SGDs)

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Abstract: The 70th Session of United Nations General Assembly (UNGA) is expected to adopt the Post 2015 Development Agenda that includes a set of Sustainable Development Goals (SDGs) in September 2015. For the first time, biodiversity finds a prominent spot amongst the draft SDGs which is seen as a signal from the member states that they have recognized the important role of ecosystems and biodiversity in achieving sustainable development. This paper provides an overview of key issues and challenges related to the two biodiversity Goals besides suggesting a series of actions at national and global levels to achieve these Goals.

Keywords: Sustainable development, Sustainable Development Goals (SDGs), Millennium Development Goals (MDGs), UNGA, biodiversity, ecosystems, achieving SDGs.

1. Introduction

The UN General Assembly Resolution (A/69/L.46) calls for the adoption of Post 2015 Development Agenda as decided during the UN Conference on Sustainable Development (UNCSD, 2012) that comprises four components– a Declaration, a set of Sustainable Development Goals (SDGs) and targets, their means of implementation and a global partnership for development as well as a framework for follow up and review of implementation.

Based on this, a set of 17 SDGs and 169 targets were drafted by an Open Working Group (OWG) in July 2014. Intergovernmental negotiations are being held until 31 July, 2015 for agreeing on the components that is expected to be adopted during the Special Summit scheduled to take place from 25-27 September at UN Headquarters, New York.

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The Open Working Group (OWG) on Sustainable Development Goals (SDGs), through a series of informal discussions prepared the Zero Draft of the suggested SDGs. During the 13th meeting of the OWG, participants have agreed to further discuss consolidation of the suggested Goals. Currently, there are two Goals related to biodiversity with a set of targets[1] to achieve the Goals. The two Goals currently under discussion, with specific focus on biodiversity are:

Goal 14, Conserve and sustainably use the oceans, seas and marine resources for sustainable development,' that has 11 targets.

Goal 15, 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss,' with 11 targets that address threatened species, conservation and sustainable use, restoration, forests and mountain ecosystems, land degradation, poaching and trafficking of endangered species, invasive alien species, fair and equitable sharing of benefits and free prior and informed consent (FPIC), among other issues

Chairs of the OWG suggested to merge the above two Goals but this was not agreed to by the delegations, who wished to maintain the two Goals. The primary objection to combining Goals 14 and 15 is due to the fact that marine issues do not receive requisite attention compared to terrestrial issues of conservation and sustainable use.[2]

In addition to the discussions related to combining Goals 14 and 15, many delegations are also considering to explore the possibility of mainstreaming issues related to biodiversity across other Goals. This paper focuses on the options available for realising the biodiversity goals of the draft SDGs and identify various challenges that countries could face in implementation of actions. It also provides options to link the Goals with the Aichi biodiversity targets and related decisions under the Convention on Biological Diversity (CBD).

2. Experiences from Achieving the MDGs Relevant to Biodiversity

Unlike the current debates in designing the SDGs, development of MDGs has been a quick and simple process with limited opportunities for stakeholders to provide substantial inputs in designing the Goals and Targets.

Target 7 on environmental sustainability has been a weak one with three targets until 2005 when a new, fourth target 7 B was introduced. Table 1 provides details of the Goal, targets and related indicators currently being used to assess progress in realising the Goal.

Table 1: Goal, Targets and Indicators for Monitoring Progress

Goal 7 : Ensure Environmental Sustainability[3] **Targets**	**Indicators for Monitoring Progress**
Target 7.A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	7.1 Proportion of land area covered by forest 7.2 CO_2 emissions, total, per capita and per $1 GDP (PPP) 7.3 Consumption of ozone-depleting substances 7.4 Proportion of fish stocks within safe biological limits 7.5 Proportion of total water resources used
Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss	7.6 Proportion of terrestrial and marine areas protected 7.7 Proportion of species threatened with extinction
Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	7.8 Proportion of population using an improved drinking water source 7.9 Proportion of population using an improved sanitation facility
Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	7.10 Proportion of urban population living in slums

It is evident from Table 1 that both the kind and nature of targets and indicators used to measure progress are neither comprehensive nor complete. However, measurability has been the key criterion in selecting the indicators. The result of this is reflected in the progress reports submitted by countries of regions in achieving Target 7 where information related to Targets 7 A and 7 B has been very limited except for figures related to protected area coverage and number of species in the threatened category list of IUCN.

The Report on Progress in Achieving the MDGs for Africa in 2013 indicates that progress towards achieving the MDGs is mixed with many Goals and Targets not achieved 12 years after the adoption of the MDGs.[4] For example, this report prepared by the United Nations Economic and Social Council Economic Commission for Africa does not even mention Target 7 B of the MDGs that focus on reducing rate of loss of biodiversity. India's Report on achieving the MDGs in 2014, similarly, does not indicate any action related to Target 7 B and merely mentions that the Ministry of Environment and Forests is responsible for MDG 7 on issues of national afforestation[5] while the World Bank reports that there has been 58 per cent increase in protected areas since 1990.[6] The Millennium Development Goals Report 2014 of the United Nations indicates that species decline continues in groups such as pollinators, birds and mammals.

This is a clear indication that Targets 7 A and 7 B of MDGs have not been met so far and progress made has not been reported appropriately. Such a conclusion was also drawn by the third Global Biodiversity Outlook that was launched in 2010 by the Convention on Biological Diversity (CBD). The United Nations Development Group (UNDG) in its thematic report published in 2010 indicated that fragmentation, lack of political support, unclear overarching mandate with regard to biodiversity have all contributed to this failure of member states to achieve Target 7 B. Lucas *et al.,* (2014) conclude that one of the key reasons on the failure to achieve Target 7 of MDGs is the nature of the Goal being exclusive and suggest integrating environmental sustainability and biodiversity across all relevant Goals.

3. Linking CBD 2010 Targets and MDGs: Learning from the Past

Through Decision VI/26 of CBD COP 6, Parties to the CBD agreed as follows,

"Parties commit themselves to a more effective and coherent implementation of the three objectives of the Convention, to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global,regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth.

Pisupati and Rubian (2008) assessed the issues and options to link the Convention on Biological Diversity (CBD) 2010 targets on biodiversity and the MDGs and concluded as follows:

1. The inclusion of biodiversity related sub-target into the MDGs was delayed;[7]
2. The nature of targets used to measure environmental sustainability is incomplete and weak;
3. The indicators used to measure progress towards Goal 7 and its Targets are limited making assessment of overall progress made on environmental sustainability weak;
4. There is lack of coordination in generating data and information between agencies and departments focusing on environmental management and those preparing assessment reports on MDGs as well as those developing implementation plans;
5. There is uneven focus on using indicators, at national level, to measure progress on MDG 7 since most of the indicators used are result based indicators than those based on pressure, response and process; and
6. Lack of focus on socio-economic pressures in achieving this Goal in light of progress made with respect to other MDGs impacted the overall achievement of other MDGs.

Further, assessment of progress towards the success in achieving the overarching objective of reducing the rate of loss of biodiversity in a manner it contributes to poverty reduction has been limited.[8]

Therefore, there is enhanced focus, now, to ensure that the SDGs are more inclusive, comprehensive and achievable in a manner sectoral issues such as environment and biodiversity are appropriately mainstreamed and addressed across the SDGs currently under development.[9]

4. The Aichi Biodiversity Targets (2011-2020) and Sustainable Development

The Strategic Plan for Biodiversity 2011-2020 and its 20 Aichi Biodiversity Targets were adopted during the 10th meeting of Conference of Parties to the CBD in 2010. These Targets are endorsed by other biodiversity related Multilateral Environmental Agreements (MEAs)[10] while the Environment Management Group (EMG)[11] has also endorsed the Targets

as the overarching global framework to deal with biodiversity issues in a manner that contributes to development. Governments at Rio+20 affirmed the importance of the CBD Strategic Plan and the Aichi Biodiversity Targets while the UN General Assembly encouraged consideration of the Strategic Plan and the Targets in the elaboration of the post 2015 UN development agenda, taking into account the three dimensions of sustainable development.[12]

The Report of the High Level Panel of Eminent Persons on the Post 2015 Development Agenda (HLP)[13], the Global Thematic Consultation on Environmental Sustainability[14] and others[15], [16] have widely analysed the role and importance of using the objectives of CBD Strategic Plan and the Aichi Biodiversity Targets in further developing the SDGs.

Discussions under the OWG of post 2015 development agenda was able to consider a majority of the issues and suggestions made thus far and have now come up with two Goals (Goals 14 and 15)[17] specific for biodiversity while considerations were also made for linking biodiversity and ecosystem based issues across other Goals.

5. Key Challenges to Realising the SDGs: Biodiversity Perspectives

5.1 Data Needs

One of the key challenges for countries to deal with monitoring actions in achieving the biodiversity related SDGs relate to data sourcing, presentation and analyses. Getting ready to monitor the SDGs will require a 'data revolution,' as called for by the High Level Panel of Eminent Persons on the Post-2015 Development Agenda (2013) and many others. The term 'data revolution' has different meanings to different people – some emphasise citizen accountability, others new forms of social and geophysical data, new ways of sharing data, and many other facets.[18] Recognising that there is a critical need to strengthen data collection capacity, as well as data quality, the UN Secretary-General launched the Independent Experts Advisory Group on the Data Revolution (IEAG) to advise on how the data revolution can be implemented. Their report – A World That Counts released in November 2014 calls for significant improvements needed for data coverage and quality.

With specific reference to biodiversity data and information, it has to be noted that in spite of countries submitting their National Reports to the CBD since 1996, the quality and consistency of data and information related to biodiversity and ecosystems has been uneven and inconsistent.

The Sustainable Development Solutions Network (SDSN) in their report of 2014 present a set of options for indicators and sources of data for SDGs 14 and 15 related to biodiversity. For the terrestrial biodiversity, the suggested potential indicators include annual change in forest area and land under cultivation (modified MDG Indicator), area of forest under sustainable forest management as a percentage of forest area, red list index, protected area overlay with biodiversity. For ocean biodiversity, the potential indicators include, ocean health (index), percentage of fish stock within safe biological limits.

The report indicates that more than 50% of the countries may not have enough data and/or information on majority of indicators to assess progress and review implementation of national actions related to the SDGs on biodiversity.

Thus, countries will have a challenging time to deal with the indicators related to measuring the progress towards achieving the targets and Goals. With challenges in deploying expertise and resources to deal with implementing the decisions under various biodiversity MEAs, it has to be seen on how countries will allocate resources to develop appropriate national level datasets related to monitoring actions towards achieving the biodiversity SDGs. The current need for countries will be to streamline and validate the data that will be used to measure progress of implementation.

5.2 Mainstreaming and Synergies

It certainly is laudable that biodiversity and ecosystem's contributions to sustainable development have received significant attention during the discussions to develop the SDGs. With two specific Goals related to biodiversity and several other targets focusing on biodiversity, countries have an uncommon opportunity to mainstream biodiversity and ecosystem services in development planning and actions to secure livelihoods for people living in both urban and rural areas.

However, at national level there is still considerable challenge to mainstream biodiversity and development. Though this agenda has been discussed through various Decisions at CBD Conference of Parties, impactful action is yet to be seen.

During a recently held workshop to enhance synergies amongst biodiversity related MEAs, organised by UNEP, it was discussed that mainstreaming and synergies are important to effectively deliver the SDGs using the options of revising and implementing the new generation of National Biodiversity Strategies and Action Plans (NBSAPs), improving the efficiency of national reporting and monitoring actions, strengthening the science-policy interface, improving Information management and awareness raising and enhancing institutional collaboration.

The UNEP should lead efforts not only to mainstream and synergise actions to deliver the mandates of biodiverity related MEAs but should begin developing mechanisms to monitor effective realisation of the Aichi Biodiversity targets as well as align the development of post 2020 biodiversity targets that are in sync with the Post 2015 Development Agenda.

5.3 Financing

During the CBD COP 11 held in 2012, Parties to the CBD decided to develop specific and targeted national financing strategies to achieve the Aichi biodiversity targets by 2020 and submit the national financing strategies by 2015. However, a recent interim review of the post 2010 National Biodiversity Strategy and Action Plans (NBSAPs) indicates that both developed and developing countries are yet to develop such strategies (Pisupati and Prip 2014).

The Third meeting on Financing for Development (FfD 3) is scheduled to be held in July 2015 that is intended to provide the roadmap to deal with options for achieving the Post 2015 Development Agenda at various levels and by different stakeholders, both public and private. The draft summary of Addis Ababa Accord has been subject to intense negotiations between March and June 2015 with an intention to adopt the same at FfD 3 in Addis Ababa.

Key elements of this draft Accord include a global framework for financing sustainable development, mobilizing the means to implement the post 2015 Development Agenda and an Addis Ababa Action Agenda

that focuses on domestic public finance, domestic and international private business and finance, international public finance, international trade for sustainable development and debt and debt sustainability.[19]

Though the Addis Ababa Accord may not specifically focus on issues of realising SDGs 14 and 15, there is a responsibility of member states to the CBD to ensure that the outcome document from FfD 3 be seen as the over-arching guidance to secure sustainable financing to deliver the 2020 Aichi biodiversity targets and beyond.

Lack of interest from Parties to the CBD to come up with a financing strategy to achieve the 2020 Aichi targets needs to be remedied urgently. Though there are a series of initiatives to deal with financing, such as the BIOFIN project of UNDP, it is unclear on the impact to ensure countries will deliver on their CBD COP decision (XI/4).[20]

Unless the discussions and decisions related to financing development and financing Aichi biodiversity targets are linked and actions taken synergistically at national level, the issue of financial resources for conservation and development will not be able to deliver.

6. Conclusion

With less than 2 months before the Post 2015 Development Agenda adoption by the UN General Assembly (September 2015), it is time for member states to UN recongise their commitments to other multilateral processes such as the MEAs.

Current indications from several countries on their preparedness to deal with realising the SDGs are still a cause of concern owing to limitations in genrating and using data and informaiton, ensuring value of resources spent and invested in development and conservation and securing finances and capacities to deliver on the development agenda (Pisupati 2015).

Though premature to assess the full preparation to realise the Aichi biodiversity targets, preliminary indications are that countries could potentially miss delivering the targets by 2020. This will be a serious blow to the credibility for conservation and development, especially since the conservation community has worked over-time to secure the appropriate political and related mileage in including two biodiversity related Goals under the SDGs.

Similarly, any uneven realisation of the Aichi biodiversity targets will impact the ability for delivering the sustsinable development agenda, not only in relation to SGDs 14 and 15, but also those related to poverty reduction, food security, climate resliience and the related.

Time has come for countries to act on the intent of being effective and efficient in securing the dual goals of conservaiton and development. For this to be achieved, the SDG framework could potentially become the over-arching agenda for conservation community that needs to address issues of mainstreaming and synergies.

Endnotes

1 http://uncsd.iisd.org/news/owg (accessed 22 July 2014).

2 http://www.iisd.ca/sdg/owg12/ (accessed on 24 June 2014).

3 http://unstats.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm

4 E/ECA/COE/32/3 AU/CAMEF/EXP/3(VIII).

5 Ministry of Statistics and Programme Implementation (2013).

6 http://www.worldbank.org/mdgs/environment.html (accessed on 10 July 2014)

7 The sub-target 7 B on biodiversity was only included in the MDGs in 2005.

8 CBD (2012).

9 http://sustainabledevelopment.un.org/content/documents/2401TST%20Issues%20Brief%20Biodiversity_FINAL.pdf

10 Biodiversity related MEAs include the Convention on Biological Diversity (CBD), Convention on the Conservation of Migratory Species of Wild Animals (CMS), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the Convention on Wetlands of International Importance (Ramsar Convention), the World Heritage Convention (WHC) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

11 The Environment Management Group (EMG) is a United Nations (UN) System-wide coordination body on environment and human settlements.

12 UN General Assembly Resolution 67/212 (A/Res/67/212).

13 http://www.post2015hlp.org/wp-content/uploads/2013/05/UN-Report.pdf

14 http://www.iisd.ca/download/pdf/sd/crsvol208num7e.pdf

15 http://unsdsn.org/wp-content/uploads/2014/02/TG10-Final-Report.pdf

16 http://www.cbd.int/sbstta/doc/trondheim-full-paper-2-sdgs-en.pdf

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20 https://www.cbd.int/decisions/cop/?m=cop-11 (accessed on 10 June 2015).

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Access to Justice and Sustainable Development – How Can Environmental Access Rights Achieve Sustainable Development for All?

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Abstract: Today's vast range of environmental crises represents an alarming reality for citizens from rich or poor countries. Worldwide social inequalities are widening because of the increasing environmental pressure put on the fragile ecological equilibrium of our planet. The fact that the planetary boundaries have to be respected is now known as well as the necessity to fully endorse the concept of sustainable development. Sustainability is key to overcome the challenges of our time, but can only be achieved with the involvement of the whole society. In that regard, giving citizens the right tools to this achievement is crucial and delivering environmental justice is essential. Environmental access rights represent these tools and have the potential to place the global agenda on a sustainable trajectory, as demonstrated by various examples around the world. Access to information, public participation and access to justice have, therefore, the potential to make sustainable development a reality. Notwithstanding, if environmental democracy for all is to be achieved, then sustainable development still needs to be universally achieved.

Keywords: Environmental access rights, access to information, public participation, access to justice, sustainable development, environmental justice, environmental democracy

1. Introduction

Access to justice is a crucial means to handle environmental issues as it enhances the public's ability to enforce the right to participate, to be informed and to correct environmental harm. Access to justice is able to strengthen social cohesion and assert the citizens' right to be included in environmental

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matters. It has been acknowledged as being essential to consolidate democratic values and foster the maintenance of peaceful societies, as well as been particularly promoted by the international community for its pivotal role in the achievement of environmental sustainability.[1] Principle 10 of the Rio Declaration[2] paved the way for a better access to justice by highlighting the necessity of having effective access to judicial and administrative proceedings in environmental cases. Following the lead, Agenda 21[3] and the Johannesburg Plan of Implementation[4] have seen governments commit to a better access to justice, reinforcing the fact that access rights have been considered by many as being critical to functioning democracies and effective environmental protection.[5] It happened principally through the universal adoption of the concept of sustainable development that the necessity of facilitating access rights has been met with response on the part of national governments.

Acting against the persistent reluctance of states and national courts to dispense justice in cases pertaining to the environment was in fact what the international community was calling for, considering that preventing judicial recourses for environmental claims or imposing barriers was common practice across the globe (Foti *et al.* 2008). Adhering to this call, progress in meeting people's environmental concerns and dispensing environmental justice was, therefore, made nationally and regionally, yet progress needed to be realised universally in the face of global environmental threats (Sachs 2012).

Today's environmental threats triggered by a vast range of ecological crises being whether climate change, biodiversity loss, water scarcity, air and water pollution or soil degradation, represent an alarming reality citizens from rich or poor countries have to face. At present, humanity in its entirety is sensing that the unprecedented stress put on the earth's ecosystems can have devastating consequences on the entire ecological equilibrium and far reaching social and economic repercussions (Sachs 2012). In facing these repercussions, leaving people without the possibility of redress or remedy appears neither in compliance with the spirit of the sustainability discourse, nor in line with the efforts towards an improved access to justice. The increasing environmental pressures being both global and local and impinging dramatically on the social dimension by widening social inequalities have pointed out the need for environmental

justice and the need for urgent, high profile and change-producing goals towards sustainable development for all (Sachs 2012). Universal, ambitious and action-oriented goals are, therefore, required, taking into account the global nature of today's environmental challenges and making allowance for access rights.

Based on this statement, this paper will expose the link between access rights and sustainable development goals and demonstrate how the associated access to justice can contribute to the success of sustainable development. Within the post-2015 agenda and its recently proposed seventeen sustainable goals, a strong emphasis has been placed on social inclusion, hence, on the people's right to be informed of and participate in environmental matters. Social inclusiveness and its enforcement have a key role to play towards the achievement of a sustainable world as both are intrinsically linked to each other. Illustrating this interlinkage on the basis of the best practices of access to environmental justice around the world will, therefore, represent the leitmotif of this paper.

2. Justice In Its Environmental Context: Its Significance and Its Evolution Over Time

2.1 Access to Justice as Part of Environmental Access Rights

Access to justice in the environmental context can be defined as the "ability of groups and individuals to be able to bring an alleged […] violation [of environmental rights] to the attention of a court and to have that court adjudicate the claim in a fair and impartial fashion on the basis of the evidence and according to the applicable rules of law" (Baumgartner 2011). Rooted in human rights this ability serves the purpose of empowering people to advance the fulfilment of substantive rights (Redgwell 2007) – fundamental rights necessary to ensure human dignity such as the right to life, health, food and safe drinking water. However, in order to fulfil these basic rights people still need access to the information upon which decisions rest, and the opportunity to voice opinions and to influence choice among possible outcomes. In turn, actions on the part of governments and courts are also still necessary as the operationalisation of these rights lies in their sphere of competence (Foti *et al.* 2008). Access to justice can, therefore, not be considered without the right to information and the right to public

participation, both constituting part and parcel of the latter, and is to be regarded as a whole set of rights conducing to the scope of environmental justice. This set of rights is the key to more transparent, inclusive and accountable decision-making in matters affecting the environment – what has been called as environmental democracy – and irremissible constituent of sustainable development. Inherent purpose of these rights is to ensure that people everywhere can enjoy the right to understand the 'development' happening around them and the right to shape their own future (Mandela 2006).

Citizens' knowledge of potentially altering environmental conditions represents therefore the foundation of these access rights as only well-informed persons may be able to engage more effectively in the complexity of environmental issues. Environmental issues being coined by trade-offs and interconnectedness, striking the right balance between the different concerns at stake often appears as a complex matter necessitating the empowerment of all stakeholders, and especially concerned citizens. Hence, equipping citizens with the adequate informational tools in order for them to meaningfully participate in decision-making processes represents the indispensable cornerstone of environmental sustainability.

3. Environmental Access Rights and Their Historical Background

Whether constrained to run after the fast-growing advancement of technology and industry or shaped by the increasingly need for protection from environmental degradation, Environmental Access Rights (EARs) have evolved over time and developed at a different pace across countries. In developed countries, EARs rooted in the US with the release of the United States National Environmental Policy Act (NEPA 1970) – the first modern practice of public involvement in decisions affecting the environment – and the subsequent enactment of various environmental acts. Through the environmental justice movement launched by disadvantaged and poor communities seeking for distributive justice, EARs then came for the first time to the attention of local and national authorities (Pedersen 2010). This epoch in the US history considered once as ground-breaking in terms of environmental laws, seeing citizens perceiving environmental harms as unjust and the widening of standing to sue on behalf of the environment,[6] set

the framework for the administration of environmental justice elsewhere and inspired other countries with the adoption and innovation on environmental rights.

Learning from the US experience, governments in Australia, Canada and New Zealand, for example, adopted environmental impact assessments (EIAs) – meaningful and effective environmental management tools that mandate public participation – while Canada's law went even further by setting aside funds to ensure the participation of individuals and organisations in the public review process (Wood 1997). The European Commission for its part investigated the EIA process in Europe and found that many countries already had elements of the process in their respective legislations. This resulted in a harmonisation of standards for EIAs within the EC (now European Union) and led some countries to create special administrative courts to deal with conflicts arising from EIA process (Wood 1997). But after watching the proliferation of lawsuits in the US, European environmental rights experienced a backlash in standing requirements weakening the position of plaintiffs to challenge poor EIAs, and consequently weakening EARs (Foti *et al.* 2008 and Pedersen 2010). In developed countries the broad picture of EARs was, therefore, still contrasted, torn between a genuine will to strengthen environmental democracy and a fear for litigation explosion and court congestion.

In the developing world the implementation of EARs has varied, illustrating the plurality of experience and relative openness of many countries and regions. Broadly speaking many developing countries introduced tools for environmental management through legal reforms in the 1970s and 1980s accounting for environmental democracy, but many lacked enforceability or strong provisions for access (Redgwell 2007). External actors, acting without significant government involvement or oversight, have driven – and continue to drive – adoption of many of these tools, although domestic constituencies have increasingly pled for inclusion of information, participation and justice as core principles (Brinkerhoff and Crosby 2002). Arguably, adoption of many environmental tools came as early in the developing world as in developed countries.

The 1954 Equatorial Nile Project in Sudan, for instance, is likely the earliest EIAs carried out in the developing world, while Colombia, the

Philippines, Thailand or China also adopted some form of EIA process in an early stage. In substance, however, enforceable provisions for public participation and access to information have rarely been established which resulted in the weakness of these legal means. This weakness of access rights mainly bore on a lack of strong domestic demand for participatory process and contributed to the slowness of the reform process in most countries, or even to failures in some others.

Whether in developed or developing countries, the fate of EARs has, therefore, been determined by a variety of factors with the predominant ones being political will and public demand, and both leading to some disparities. However, despite these differences in terms of development, a common feature still arose out of the comparison: the transboundary recognition of the importance of EARs.

4. The Transboundary Recognition of the Importance of Environmental Access Rights

4.1 Environmental Access Rights are Human Rights

The recognition of the importance of EARs has not been restricted to a particular locality, nation or region, but has in fact occurred globally. Worldwide different nations with different state of development and different resources have all come to the conclusion that EARs were of significant importance, hence, took steps for their improvement. Access rights being largely procedural human rights in nature, their fate in an environmental context does not diverge from the one of substantive human rights. Hence, the international commitment to respect, protect and fulfil human rights prevails for them as well, constraining Member States to abide by the relevant obligations to realise access rights.[7] Realising the entitlement of all people to the fundamental civil, political, economic, social and cultural conditions necessary to ensure human dignity ranks among these obligations and has, therefore, to be achieved likewise the operationalisation of EARs. Both are inextricably tied and benefitting from each other. EARs are, for instance, able to advance economic, social and cultural rights such as the right to an adequate standard of living by drawing attention to and press for improvement in environmental and social conditions.[8]

They can advance civil and political rights such as the right to exercise freedom of expression and association or the right to take part in the conduct of public affairs,[9] by pushing for the disclosure of government-held environmental information, taking the example of a Chilean Civil Society Organisation (CSO).[10] Furthermore, they have the potential to further promote the acceptance of the right to a clean and healthy environment by emphasising on its importance towards sustainability. Increasing access can therefore advance the fulfilment of all these internationally and nationally well-established norms and contribute to the overall betterment of public policies. Public policies being shaped by a dynamic of governmental supply and public demand, hence by a genuine democratic disequilibrium, including rights accounting for environmental democracy and being able to maintain a dynamic balance is, therefore, essential.

4.2 Good Governance to Generate Public Benefits

Adequate public policies on their own are not be able to confer substantial public goods in favour of governments and communities. In fact to deliver these goods and further contribute to environmental justice, public policies require accountable, transparent and responsive authorities to implement them and a governance strategy to frame the latter. The transition between theoretical good policy and practical effective implementation is, therefore, crucial and highlights the necessity of "good governance." "We must learn to govern better", Kofi A. Annan (2008) with his call for a sustainable future has stated it. Sustainable development cannot succeed without governance strategies that are participatory, consensus-oriented, effective and efficient, equitable, inclusive and following the rule of law – governance including the essence of EARs. Good governance can benefit governments themselves in their role as regulator. And as an informed public, they can represent an essential ally to incentivise-regulated entities to police themselves. Furthermore, governments can benefit from open governance, as participatory processes such as public hearings, for instance, raise awareness of and can build support for government initiatives.

In fact, good governance, which increases access to information, public participation and access to justice, has been identified as raising the quality of decisions in multiple ways, namely: (i) Participation by all interested parties in a decision process builds legitimacy and "buy-in" for the resulting

decision, even in cases where there are winners and losers, the ownership built through the participatory process can lessen opposition and conflict when the decision is implemented; (ii) The involved stakeholders gain skills and knowledge through the participatory process, they can build relationships with one another, deepen their community's democratic culture, and foster trust and social cohesion - a form of social capital; (iii) Decisions made in a participatory manner are more likely to be fully implemented and sustained, in part because of enhanced legitimacy and reduced opposition, and may also be cost savings, especially in cases where stakeholder ownership of the decision extends to the sharing of labour or other resources in the implementation phase; (iv) the resulting decision will reflect the specialised knowledge and variety of perspectives that participants bring to the table, which raises the substantive quality of the decision relative to its intended outcomes; and (v) the resulting decision is more likely to reflect public values and interests than if it were top-down (Foti *et al.* 2008).

4.3 Environmental Access Rights Facing Hurdles

Decisions made in due consideration of access rights appear, therefore, legitimate, reflecting public values and interests, and not predispositioned to conflicts – features essential to the maintenance of peaceful and democratic societies. Inclusive and cohesive societies are best positioned to achieve sustainable development and face the global environmental challenges of our time, as the adaptive measures needed to mitigate environmental harm may be more easily taken or at least not encounter opposition (Millner 2011). However, although this statement might appear as a matter of course, hurdles to enhancing EARs are still persistent, compromising significantly environmental democracy wherever they are placed. Resistance to greater transparency constitutes one of them and appears particularly powerful as it limits public knowledge of the relevant issue at its core. The reasons for this resistance lie mostly in a fear for loss of power and loss of decisional influence and a will to control information about extraction of natural resources, pollution of surrounding areas or compliance with regulation.[11] Claims of commercial and security-based confidentiality may also impede access to information, as well as weaknesses on the part of authorities

in terms of publicity, including weak collection and dissemination of information (Foti *et al.* 2008).

In fact, hindrances to information access are not isolated cases, as public participation and access to justice are likewise affected. Public participation, for instance, is often hindered by insufficient lead time, unavailable project documents or overall unconsidered public consultation, and access to justice often prevented by hardly satisfiable procedural prerequisites or cumbersome external factors, such as affordability and geographical accessibility (Petkowa *et al.* 2002). Hurdles to access rights are, therefore, widespread and compromising environmental rights in every aspect and every part of the world. These hurdles being in some countries tenaciously remaining, they consequently pose a threat to environmental and social development nationally and have the potential to prejudice sustainable development globally. To achieve a sustainable world overcoming these hurdles are, therefore, crucial, and fostering a culture of openness indispensable – two objective intrinsically linked to environmental justice and democracy. In fact, whether regionally through commitments to Multilateral Environmental Agreements or nationally through the enactment of substantive and procedural rights some states have taken significant actions to achieve these two objectives. In contrast to above mentioned unsustainable practices, delivering justice in environmental matters is becoming a reality in some part of the world.

5. The Best Practices of Environmental Access Rights Crucial to the Achievement of Sustainable Development

Since the 1992 Rio Declaration, EARs are indeed receiving an augmented recognition around the world and the administration of environmental justice is substantially experiencing a revival of interest. Internationally the release in 2010 by the United Nations Environmental Programme Governing Council of "the Bali Guidelines,"[12] on how governments should develop national laws in relation to access rights, indicates that a will on the part of the international community to revive the access issue has still been present. Regionally the efforts of the UN Economic Commission for Europe (UNECE) have gone further than a mere will by succeeding in placing ratifying nations under a series of important obligations, including

assessing the environmental impact of major projects in an early stage and notifying potential transborder effect – obligations under the Espoo EIA Convention[13] – and collecting information held by private bodies and requiring public bodies to affirmatively make information publicly available – obligations of the Aarhus Convention.[14] In addition to these obligations a follow-up instrument of the latter, the Kiev Protocol on Pollutant Release and Transfer Registers,[15] has also been adopted, holding corporation accountable for disclosing information on the toxins they release into the environment.

Whether with the implementation of Principle 10, in the case of the Aarhus Convention and the Kiev Protocol, or Principles 17 and 19 in the case of the Espoo EIA Convention, these three international agreements embody the fruits of the 1992 Rio Declaration and demonstrate that states and international institutions have effectively brought environmental democracy forward. The Latin American countries are moving forward in the same direction as they are currently negotiating a regional instrument for the implementation of Principle 10. But while these advancements have still been confined to Europe and Central Asia, remarkable development in terms of EARs has also been made in the rest of the world. In fact, a widespread number of countries have enacted laws and statutes regarding access to information, public participation and access to justice, many of them being considered as best practices within their scope of application.

5.1 Access to Information: A Matter in Constant Evolution

It has been stated, access to information lies at the core of access rights as without information participation remains meaningless and justice insubstantial. Transparency and openness facilitate this right and have been acknowledged as being able to reduce corruption and arbitrariness, and discrimination in decision-making.[16] Since the 1992 Rio Earth Summit a dramatic increase in recognition of the importance of access to information has been revealed, as over 90 countries around the world have adopted framework laws or regulations for access to information and over80 countries have seen the right to information enshrined in their constitutions (Banisar 2006). Many others have adopted specific environmental information access statutes or provisions in general environmental protection laws such as in Brazil, which has followed the relatively same roadmap as the Aarhus Convention.[17] Most access to information laws (AILs) focuses on the

executive and administrative bodies that make up the modern bureaucratic state, but less often apply to the courts or legislature. In this respect, the best practice of AIL is to provide in the law a broad definition of public bodies to include any body that is exercising government functions, such as in the Portuguese Access to Administrative Documents Act. The latter applying to "organs of either the State or the autonomous regions that perform administrative functions, …, as well as other entities that exercise public authority according to the law" does hence not exclude any public entities potentially dealing with sensitive information and ensures a maximal scope of application and a non-restricted access.

The South African Promotion of Access to Information Act and the Freedom of Information Act 2001 of Antigua and Barbuda for their part allow individuals and government bodies to demand information from private entities to enforce other rights if necessary, allowing for the increasing necessity to call the private sector to account. Combining the essence of all these acts, Mexico has set an example for the world with one of the strongest AILs. By embracing the use of an electronic system for filing requests and disclosure Mexico with its first Freedom of Information Act (2002) has established a government agency devoted to freedom of information – the National Federal Institute for Access to Public Information (INAI in Spanish) – and enabled citizens, academic institutions, business, media and government agencies to file request with this autonomous institute for the release of information held by any federal body and provided the opportunity to appeal against federal agency decisions to withhold information – including environmental information. In keeping with its commitment to pay full tribute to the principle of openness, the INAI proceeds within its appeal mechanism in a public and transparent fashion and even broadcasts them on the web.[18] Through this modern way of doing Mexico's access to information right and the work of the INAI has transformed democratic politics and government decision-making, marking a great advancement in terms of access to environmental information (Rangel 2007 and Leon 2007) likewise practices in Turkey, Poland and Estonia (Banisar 2006). At international level, UNEP adopted its Environmental Access to information Policy in June 2014 as requested by it's Governing Council at its 27th Session to ensure its documents and materials can easily be made available to the public in an open and transparent manner when requested through a

stipulated procedure. As it was agreed with its member States to review its implementation after a year to further strengthen it, the Policy is currently undergoing review in consultation with its constituencies and stakeholders.

5.2 Public Participation: A Democratic Means at its Pace

Fair and effective public participation in decision-making process includes a range of stakeholder voices that have to be listened to and, to the great extent possible, responded to. A stakeholder's influence over the decision depends on the ability to access the decisional realm and to have his or her voice heard by the decision-maker (Uphoff 2005). Hearing stakeholder's voices and making public-participation an integral part of decision-making are two concerns that many countries have successfully met through the elaboration of EIA processes. EIA representing an adequate tool to strike a sustainable balance between economic, social and environmental concerns, the adoption of over 120 countries of legal provisions on EIA appears as a matter of course considering imperatives towards sustainable development.

Ghana, for instance, illustrates greatly how legal reforms in transparency have been able to feed the participatory process and improving availability of environmental information. Ghanaian Federal law[19] requires that EIA processes are to be announced ahead of time in a variety of way, including newspaper ads, announcement on the national radio and television stations, and members of the local community, including farmer's organisation and NGOs, and have to be given them time to air their opinions. After public participation, an independent panel must collate comments and officially submit findings of the public hearing to the Environmental Protection Agency (Appah Sampong 2004 and 2007).

This EIA practice has been successful in a number of outcomes and affected many decisions, including the size of a shopping mall, the setting of an oil company service station and the resettlement of six gold mining projects (Appah Sampong 2004 and 2007). The success of public participation and EIA-based decision-making has seen Ghana being ranked among the top three countries surveyed (behind South Africa and Tunisia) with "functional and relatively robust systems" and has then spilled over into a Strategic Environmental Assessment (SEA) integrated into the Ghana Poverty Reduction Strategy.[20] SEAs being mechanisms incorporating

environmental consideration into policies, plans and programmes, their impacts in preventing environmental problems is hoped to advance environmental protection to an even greater extent.

Beyond the African continent, the strengths of SEAs, including a greater steering force towards environmentally sustainable decisions, a better consultation of the public and a proactive nature to anticipate environmental issues, have also been recognised by other states and resulted, for instance, in the adoption of an EU directive on SEA.[21] A number of countries in Latin America and Southeast Asia, including China, the Philippines, Thailand and Vietnam, took the same approach and incorporated SEAs within national legislation (Banisar *et al.* 2012) - inspired or not by the New Zealand and Canadian SEA best practices both concretely elaborated for the achievement of sustainability.

5.3 Access to Justice: Environmental Adjudication Towards Sustainable Development?

If environmental decision-makers are to be held accountable, people need access to procedures and institutions that provide redress and remedy when the government's decisions are incorrect or unlawful. The public needs mechanisms to ensure that their government fulfils the right of access to information and the right to participate (Foti *et al.* 2008). Comprehensive mechanisms for access to justice provide procedural justice through fair and efficient means of conflict resolution, but depend on a number of factors. The first is the right to bring cases to court, or "legal standing." In this respect, India shows worthwhile reforming practice of rules of the courts initiated by the Indian Supreme Court (Silva 1999).

By broadening legal standings to admit public interest litigation and allowing groups and any citizen acting in good faith to sue for a cleaner environment, the Supreme Court dramatically changed the fate of environmental law for the whole country, and these seeds sowed in New Delhi took then root all over the Indian subcontinent. The Supreme courts of Bangladesh, Nepal, Pakistan and Sri Lanka inspired by the Indian environmental progress established rulings recognising a constitutional right to the environment and pressed for decisions enforcing such rights, following the Indian highest court which decided that the constitutional right to life

included a right to a healthy environment (Silva 1999).

But while legal standing to sue represents an irremissible prerequisite with regards to EARs, having courts being able to adequately and effectively deal with environmental matters appears as another obvious fundament necessary to advance environmental justice. In that regard, the call for sustainability sent at the 1992 Earth Summit appears again fruitful as stated by the proliferation of more than 600 specialised environmental courts and other tribunals around the world (Robinson 2014). In nations where environmental degradation has become acute, such as China, courts have been entrusted with the duty to guarantee achieving ecological progress by securing judicial environmental law (Robinson 2014). Thanks to the revised law for environmental protection in China which entered into force in January 2015, whereby China courts can with certainty hear claims made by NGOs thus allowing what is internationally and widely known as "citizen suit".[22]

With the establishment of a special fund for environmental public interest litigations China goes even further in its attempt to reverse the trend of ecological deterioration, by taking the practices of the environmental courts of New South Wales in Australian and of New Zealand as example. In all matters, Chinese courts are to determine the relevant party's burden of proof, which opens the door to introducing concepts such as *in dubio pro natura*, as observed in Brazilian courts (Robinson 2014). In addition, the courts are to consider continuous supervision, such as the structural injunction in American practice or the "continuing mandamus" in the Philippines practice in order to strengthen the hearing of cases on failing to perform duties.[23] The example of China in terms of access to justice is, therefore, instructive, as it typifies due to its recentness a case study, which is clearly representative of the current necessity of universal judicial cooperation between states.

In fact, to restore environmental quality and ecological integrity China has to learn from the best practices of other jurisdiction – a requirement that China has met by inviting courts of New Zealand Australia and elsewhere to share judicial experiences. But considering the vast scale of the country and its demographical boom much more is still needed in terms of environmental adjudication, as the needs of a growing human population

may put incremental stress on natural systems, giving rise in turn, to a larger volume of environmental conflicts. Resolving these environmental conflicts and enforcing environmental safeguards can effectively be done by courts and tribunals, as demonstrated, for instance, by the practice of South Asian courts, which have been leaders in designing effective remedies that resolve mismanagement of waste, abate urban pollution, or safeguard natural areas (Robinson 2014).

Environmental courts have the potential to restore and sustain ecological conditions and, therefore, effectively serve the objective of sustainable development – an objective that many jurisdictions are already striving for through their practices. In the Philippines, for instance, environmental adjudication by the Supreme Court has promulgated rules of procedure for the extraordinary Writ of Nature, which shifts the burden of proof onto the party alleged to be damaging the environment to prove that it is in compliance with all applicable environmental laws.[24] Similarly, the rule of *in dubio pro natura* is now in use in several South American nations and has been usefully refined and has found application for the precautionary principle, while the *Suo Moto* jurisprudence has been employed for environment conservation ends by the courts of Pakistan. Courts' rulings in Canada have created innovative rules to place corporations on probation in criminal cases, to ensure that they reform their operations and obey environmental law in the future (Robinson 2012).

In New Zealand legal rights have been granted to a river accommodating its preservation and marking the new trend of rights of nature, which will assuredly benefit environmental protection[25] – a trend shared with Ecuador, which has at the constitutional level proclaimed a right of nature (Boyld 2012). All these examples do in fact demonstrate that without such adjudication environmental protection is lost, the quality of the environment deteriorated and the public and nature harmed (Robinson 2012).

5.4 Good Practices in Need of Universality

Spread across the continents, good practices in terms of EARs can benefit local communities and national citizens, and through their influential power benefit other countries. Evidences show that existing practices demonstrating beneficial effects on the society in one state tend to be

adopted in another, due to public pressure or political necessity (Cheema 2000). But while in the past this "practice buy-out" used to be confined to a particular region or state alliance, today's recognition of the urgency of sustainable development for the entire planet brought a new dimension to this phenomenon: the requirement for universality. Initiated by the Rio-Agenda universality in terms of sustainable development is necessary if global challenges are to be overcome. Global environmental challenges such as climate change, the depletion of our oceans and the degradation of ecosystems can only be met with global response and global consensus as the impacts affect societies of the whole world.[26]

Environmental issues being best handled with the involvement of all,[27] environmental democracy and the adjudication of environmental justice appear as a fundamental prerequisite to tackle issues that threat the entire planet. In this regard, the adoption of the Aarhus Convention represents a good example of how states animated by the same will to advance environmental democracy have collectively agreed upon shared principles and standards to conjointly address environmental issues and advance EARs. With its Compliance Committee, the Aarhus Convention has been armed with an effective mechanism to further foster environmental democracy and justice, and combat environmental threats. Hence, learning from this example and applying its essence to the whole world appear as an adequate way of addressing environmental threats, while advancing international judicial cooperation in terms of environmental adjudication still represent another imperative.[28] All of earth's natural systems are interlinked within the biosphere, and if one nation fails to protect the environment within its territory, inescapably the environment in other nations will be impaired (Robinson 2012).

Facing environmental threats can only be done through an adequate integrated approach towards sustainable development combining environmental protection, social inclusion and economic development in a just and effective manner (Sachs 2012). In this regard, the inclusion of the society into environmental matters, hence the importance of EARs, has been recognised as one of the main characteristics of post-2015 sustainable development agenda - given the intrinsic interconnection between human and nature, yet the menace posed by human activity to vital ecosystem functions (Sachs 2012).

Equitably establishing optimal synergy between these two dimensions and eventually realising environmental democracy is, therefore, what the post-2015 agenda has to focus on, as it will thus contribute to the administration of environmental justice around the globe. Failure to do so may lead to environmentally damaging, developmentally unsustainable and socially unjust outcomes (Banisar et al. 2012), the allowance for EARs on a sustainable trajectory which embraces as its core components of intergenerational equity, respect of the planetary boundaries and the explicit commitment to a sound and healthy environment has, therefore, to be established. Planet earth and its ecosystems are home to humans and their healthiness indispensable to human well-being.[29] Using democratic means and mechanisms to respect and realise this statement represent, therefore, the best way to succeed in the achievement of peaceful and inclusive societies and in the overall achievement of a sustainable future for all.

6. Conclusion

EARs represent great legal means in a variety of ways as they are able to influence the development of the three dimensions of sustainable development. By advancing the cause of human rights, as well as the importance of environmental sustainability, EARs tangibly account for the importance of environmental democracy, and pay a great tribute to the necessity of placing citizens' well-being at the heart of sustainable development. The citizens' potential to achieve a sustainable future is of tremendous nature as it is able to accurately point out unsustainable practices and legitimately oppose them. In that regard, access to information and public participation represent the engine of this potential and the drivers towards environmental justice. Delivering justice in environmental matters can namely correct environmentally harmful practices and, therefore, confer validity to this citizens' potential. Tapping into the latter appears essential for the success of sustainable development and its recently proposed goals, as it is one of the main way, if not the only one, to initiate universal mobilisation for a sustainable world. Universality is the key in this respect and can only be reached through environmental democracy.

Endnotes

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19 See 1994 Environmental Protectin Agency Act and 1999 Environmental Assessment Regulations.

20 United Nations Economic Commission for Africa 2005.

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22 See Article 58 of the Environmental Protection Law of the People's Republic of China.

[23] See e.g, Metro. Manila Dev. Authc v. Concerned Citizens of Manila Bay, G.R. 171947-48 case examples for nation-wide forest protection or abating pollution in Manila Bay (S.C. Dec 18, 2008) (Phil.)

[24] Writ of Kalikasan, Supreme Court of the Philippines, A.M. No 09-6-8-SC.

[25] See The New Zealand Maori Council v. The Waikato River and Dams Claims Trust, SC 98/2012 2013 NZSC 6.

[26] See Open Working Group proposal for Sustainable Development Goals at https://sustainabledevelopment.un.org/sdgsproposal

[27] Principle 10, Rio Declaration on Environmental and Development.

[28] Ebbenson (2011); Fitzmaurice (2010); Dellinger (2012); and Verschuuren (2004).

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Ethical BioTrade, Biodiversity and Sustainable Development

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Abstract: Since 2007, the Union for Ethical BioTrade (UEBT) promotes the 'Sourcing with Respect' of ingredients that come from biodiversity. Through its Ethical BioTrade Standard, UEBT defines practices for the sourcing, research and development of natural ingredients that advance sustainable business growth, local development and biodiversity conservation. It provides a platform for the exchange of experiences, including on issues such as approaches for access to genetic resources and the fair and equitable sharing of benefits derived from their utilization. Its experiences demonstrate that biodiversity is a fundamental part of the Sustainable Development Goals and that all stakeholders, including business, can make important contributions to these goals.

Keywords: Biodiversity, business, biotrade, ethical sourcing, access and benefit sharing.

1. Introduction

On 22 May 2015, the world celebrated the International Day for Biological Diversity.[1] This year, the emphasis was on the role of biodiversity in achieving sustainable development.[2] Events around the globe called attention to the contribution that conserving, enhancing and using biodiversity sustainably makes to poverty eradication, food security and green consumption. The Executive Secretary of the Convention on Biological Diversity, Braulio F. de Souza Dias, made a call for action on biodiversity to governments, business, civil society, indigenous peoples, and individuals.[3]

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Yet during the International Day for Biological Diversity, the challenge of mainstreaming biodiversity – not only across governmental policies but also in broader societal practices – was also acknowledged. In particular, much work remains to be done in promoting action among business, which both impacts and depends on biodiversity.[4] Biodiversity directly supports major economic activity in such diverse sectors as agriculture, fisheries, forestry, construction and biotechnology. It is also an important source of innovation. New food, cosmetic, and pharmaceutical products are launched each month using ingredients derived from, or inspired by, biodiversity.[5] Unlike business action climate change, which is noteworthy, biodiversity is still not a priority for many companies. Lack of awareness, limited guidance, and an unclear "business case" for biodiversity are difficulties in promoting business action on biodiversity.[6] These issues also represent opportunities for change.

Ethical BioTrade is an example of an approach through which awareness raising, technical support and networking opportunities are used to promote business engagement on biodiversity. The Union for Ethical BioTrade (UEBT) is an association of companies involved in biodiversity-based innovation and sourcing – that is, developing and using natural ingredients in the food, cosmetics and pharmaceutical sectors.[7] UEBT membership supports companies in adopting sourcing approaches that respond to increasing consumer attention for sustainability and fair trade practices and evolving legislation on biodiversity-based research and development. In committing to the internationally-recognised Ethical BioTrade Standard, companies work towards aligning their operations and supply chains with the principles of the Convention on Biological Diversity (CBD) – and now the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation (ABS).

This paper describes how Ethical BioTrade is increasing business engagement on biodiversity and thus contributing to internationally agreed goals for using biodiversity sustainably and equitably. First, this paper describes the Ethical BioTrade approach, including the UEBT background, approach and main tools. Then, it focuses on some of the practical experiences of UEBT members in putting in practice the Ethical BioTrade Standard, including examples of sustainable use and fair and equitable

benefit sharing. Finally, the paper concludes with some lessons learnt for other initiatives supporting the Aichi Biodiversity Targets and the CBD Strategic Plan for Biodiversity – and thus the Sustainable Development Goals.

2. Ethical BioTrade: The "Sourcing with Respect" of Biodiversity

2.1 The Term "Ethical BioTrade"

The term "BioTrade" comes from the United Nations Conference on Trade and Development (UNCTAD), which in 1996 launched an initiative to promote trade and investment in biodiversity-based products and services in line with the objectives and principles of the CBD.[8] In UNCTAD, BioTrade is defined to include activities related to the collection or production, transformation, and commercialisation of goods and services derived from native biodiversity that meet certain environmental, social and economic stipulations. These stipulations, called the BioTrade Principles and Criteria, aim to advance implementation of CBD objectives, as well as those from other international sustainable development instruments.

The consideration of CBD principles distinguishes the capitalised "BioTrade" from the broader trade in biological resources, which is sometimes referred to as "biotrade." The products sought may be similar in both instances – for example, non-timber forest products; plant-based extracts, oils and other ingredients or compounds; and natural textiles – but the approaches differ significantly. It is important to point this out because the increased trade in or use of biological resources, in itself, is not necessarily positive from a sustainable development perspective. Such trade could lead to unsustainable harvests, negative changes in ecosystems and the rise of social inequities. The CBD, on the other hand, has expressly recognised that BioTrade, as the trade in biodiversity-based and sustainably sourced products, can be a positive incentive for the conservation and sustainable use of biodiversity, as well as a tool to enhance local livelihoods and capabilities.[9]

Ethical BioTrade refers to business practices that follow the Ethical BioTrade Standard. The notion was born out of the need expressed by business – particularly small and medium-sized enterprises (SMEs) – for

additional guidance and ways to differentiate BioTrade products in the market.[10] The Ethical BioTrade Standard builds on CBD objectives and BioTrade principles and criteria to provide a comprehensive framework for business action on biodiversity.[11] It is organised on the basis of seven principles, complemented by information on the measures that companies must take for fulfilling these principles and quantitative and qualitative parameters to assess the appropriateness of these measures. Described later in this paper, the Ethical BioTrade Standard requires, for instance, measures to protect ecosystems where sourcing activities take place and equitably share benefits all along the supply chain.

Ethical BioTrade is thus a specific term. It applies to activities linked to sourcing of biodiversity that are guided by and verified against the social and environmental requirements of the Ethical BioTrade Standard. At the same time, Ethical BioTrade has a broad application. It covers all the sourcing policies and practices of an organisation, rather than specific products or types of use of biological resources. For example, the collection of the fruit of *Argania spinosa* and the production of Argan oil could be Ethical BioTrade. So could the development, elaboration and marketing of products that utilise the oil or other extracts or parts of the Argan tree for their unique genetic or biochemical properties. But these activities would *only* become Ethical BioTrade activities if they were conducted by a company working in the context of the Ethical BioTrade Standard.

2.2 The Union for Ethical BioTrade

The Union for Ethical BioTrade (UEBT) was created in 2007, as a continuation of the work programme of UNCTAD to promote business engagement in ethical sourcing of biodiversity. Its creation responded to calls to create an association of companies committed to the "Sourcing with Respect" of natural ingredients. UEBT manages the Ethical BioTrade Standard and offers the technical support, independent verification and networking opportunities critical for companies to increasingly and successfully engage in ethical sourcing of biodiversity.

Indeed, UEBT has played an active role in growing awareness and action on biodiversity. According to the Aichi Targets, the world's citizens should be aware of biodiversity by 2020.[12] The UEBT Biodiversity Barometer

helps measure progress towards this goal. Between 2009 and 2014, 38,000 consumers in 13 countries have been surveyed on biodiversity awareness, expectations towards ethical sourcing and how this affects purchasing decisions.[13] It has proved a valuable tool for business to identify growing biodiversity awareness among consumers and to promote the consideration of biodiversity in purchasing decisions and reporting requirements. For example, in 2014, the UEBT Biodiversity Barometer, asked consumers whether it is important to them to personally contribute to biodiversity conservation. Among respondents, 84 per cent said it is either essential or important for them to personally contribute to biodiversity.[14]

Moreover, the Ethical BioTrade Standard is regarded as credible, internationally recognised, and achieving measurable impacts. UEBT is a full member of the ISEAL Alliance, the global membership association for sustainability standards, functioning in line with requirements on transparency, relevance and inclusiveness in standard setting and verification and on measuring and improving impacts on people and environment.[15] As a result, UEBT members see their commitment to Ethical BioTrade as an effective contribution to sustainable business strategies. The UEBT system guides companies in improving traceability and securing their supply chains while responding to consumer and stakeholder expectations on ethical sourcing of biodiversity.

2.3 Promoting Ethical Sourcing of Biodiversity

The UEBT vision combines biodiversity conservation with local development and sustainable business growth.[16] To bring about such change in business practices, UEBT combines three dimensions of work, which include a range of different and complementary strategies, activities and outputs. These approaches are described in detail in the UEBT Theory of Change.[17]

The first dimension of the work of UEBT is managing a credible and effective standard system. The Ethical BioTrade Standard orient business practices for companies and other organisations working with natural ingredients – not just native biodiversity.[18] UEBT members commit to gradually ensuring that their biodiversity operations including research and development and their biodiversity sourcing strategies meet the Ethical

BioTrade Standard. The Ethical BioTrade Standard defines practices that ultimately advance sustainable business growth, local development and biodiversity conservation. For example, it requires companies to adopt measures that contribute positively and proactively to biodiversity conservation in sourcing areas, as well as measures that actively reduce negative sourcing impacts. It also requires practices that respect rights linked to land, culture and the use of natural resources.

The Ethical BioTrade Standard not only a set of guidelines – it is effectively mainstreamed in the operations of UEBT members. Ethical BioTrade practices are systematically incorporated in all relevant policies and procedures of member companies. This so-called Biodiversity Management System approach ensures that the standard is gradually implemented for the entire ingredient portfolio. UEBT member companies set public targets and report on their progress annually.[19] They may define the speed in which they implement the UEBT standard in their operations, but claims made about membership should be proportionate to the level of progress. Priority is given to those supply chains with higher strategic value or risks to ethical sourcing – in these supply chains, the Ethical BioTrade Standard is implemented in an accelerated manner.

In addition, UEBT members' commitment to the Ethical BioTrade Standard is externally verified. That is, the Ethical BioTrade Standard also serves as the basis for independent verification of gaps and progress towards compliance with its requirements. These audits are carried out every three years to verify the functioning and level of implementation of the Biodiversity Management System. For instance, an audit may highlight the lack of traceability for certain natural ingredients or insufficient consideration of the effects of sourcing activities on their surrounding environment. These omissions would need to be addressed in the company's work plan. Audits also measure the impact of Ethical BioTrade practices, ensuring broader sustainable development goals are effectively taken into account and fostered.

The second dimension of the work of UEBT is to constitute a vibrant association for members and other organisations committed to the ethical sourcing of biodiversity. UEBT aims to allow its members to interact in a way that promotes the exchange of experiences and generates business

opportunities. Actors from different parts of the supply chain as well as service providers, non-profit associations and international institutions are encouraged to join. For example, affiliate members – organisations that support but are not themselves engaged in Ethical BioTrade – include the International Finance Corporation (IFC) and the Development Bank of Latin American (CAF). IFC, part of the World Bank Group, is the largest global development institution focused exclusively on the private sector. It helps developing countries achieve sustainable growth by financing investment, mobilising capital in international financial markets, and providing advisory services to businesses and governments. CAF is a financial institution consisting of 18 countries in Latin America, the Caribbean and Europe as well as 14 private banks from the Andean region. CAF supports biodiversity-based innovation and sourcing in many Latin American countries by creating adequate institutional infrastructure and supporting research, innovation, training and market promotion.

UEBT, together with affiliate members and partner organisations such as the ABS Initiative and GIZ, supports this network of companies through various tools, technical support and training to facilitate the implementation of their Ethical BioTrade commitment.[20] These tools are specifically designed to provide practical and comprehensive approaches on ethical sourcing for different types of companies sourcing and developing natural ingredients around the world. Through these tools, UEBT members move to ensure that their sourcing practices promote the conservation of biodiversity, the respect for traditional knowledge and the equitable sharing of benefits. For example, an e-training platform provides practical, virtual and interactive lessons on how the Ethical BioTrade Standard is implemented and how to put in practice equitable benefit sharing. Participants can choose the introductory course or deepen their understanding with the complete module. The Ingredient Portfolio Assessment Tool (IPA) allows UEBT members to identify supply chains most relevant for Ethical BioTrade practices, taking into account issues such as social and environmental impacts, and strategic importance of the ingredients for their business.

Several tools focus on the issue of access to genetic resources and the fair and equitable sharing of resulting benefits (ABS). The UEBT manual on benefit sharing offers a practical look at Principle 3 of the Ethical BioTrade Standard. It answers questions such as: How do criteria on fair trade practices

work? What do they require from different types of companies? What is the link between legal and ethical requirements on ABS? How can companies deal with ABS along the supply chains? It also outlines a step-by-step process for assessing the level of compliance with Principle 3 of the Ethical BioTrade Standard within a company or specific supply chain. The UEBT Undertaking is a template offering companies working with biodiversity a simple approach to promoting transparency and understanding along the supply chain; ensuring observance of agreements between provider and recipient; and supporting compliance with ABS requirements. The UEBT Community Kit is a set of illustrated and interactive material to raise awareness on Ethical BioTrade among local producers and their communities and encourage their active participation in putting it in practice.

The third dimension of the work of UEBT is taking on a role as an agent of change towards the conservation and sustainable use of biodiversity and the fair and equitable sharing of its benefits. This includes developing and communicating a clear vision on the 'business case' for ethical sourcing of biodiversity. It also entails building up convening power to gather companies and other stakeholders around a common purpose, as well as the expertise to support the process of change. For example, UEBT organises an annual conference on the "Beauty of Sourcing with Respect."[21] This conference, now in its seventh edition, brings together leading cosmetics and personal care companies, as well as companies sourcing and developing natural ingredients for other sectors. It features presentations from business, government representatives from around the world, internationally recognised experts and a range of other stakeholders. It is widely acknowledged as a unique platform for awareness-raising and business engagement in biodiversity issues. UEBT also organises other training workshops and events in various countries and on specific topics – with a focus not only articulating ethical sourcing of biodiversity but presenting concrete examples and practical solutions.

3. Putting in Practice Ethical BioTrade

Yet the fundamental question remains: how is the ethical sourcing of natural ingredients actually advancing more sustainable and equitable practices? To provide a response, this section provides examples of how UEBT members are putting in practice the central principles of the Ethical BioTrade Standard

– and thus advancing the conservation of biodiversity, the sustainable use of biodiversity, and the fair and equitable sharing of benefits from biodiversity.

3.1 Conservation of Biodiversity

With the loss of biodiversity continuing unabated, conservation remains an utmost priority among international sustainable development objectives. Conservation of biodiversity is also Principle 1 in the Ethical BioTrade Standard, which recognises the need for sourcing practices to support the preservation and restoration of species, habitats and ecosystems. Here, the focus is not on how the natural ingredients are collected or harvested – this is dealt in Principle 2 on sustainable use – but rather on the link between sourcing activities and the integrity of the ecosystem in which they take place. For example, will the collection of a particular type of fruit have a negative impact of the monkey species that depend on it? If so, what can be done to prevent such negative impact? The Ethical BioTrade Standard requires possible threats to be identified and addressed. In addition, sourcing activities should never involve conversion of natural habitats, nor introduce invasive alien species or genetically modified organisms. Moreover, these sourcing activities should align themselves with the traditional practices and local strategies that contribute to preserving biodiversity in the area.

For example, Novel Development Tanzania, a UEBT member, is working in cooperation with organisations such as the International Union for the Conservation of Nature (IUCN), Unilever and UEBT, to develop ethical sourcing of Allanblackia oil in rural communities in Tanzania.[22] Allanblackia trees are evergreen trees which grow in the tropical rain belt of Africa. Creating a market for Allanblackia oil means promoting the value of local biodiversity and forest products which could otherwise be cut and used for firewood. Income benefits from Allanblackia provide sustainable livelihoods and motivate farmers and communities to protect Allanblackia trees.

Native - Products from Nature, another UEBT member, is a Brazilian example of how large-scale food production and biodiversity conservation can go hand-in-hand.[23] It is the world's largest producer of organic sugar and alcohol. Native's products reach consumers' tables in 60 countries. Native has used research and technology to create innovative and sustainable

practices for sugarcane cultivation and processing, while at the same time conserving biodiversity. For instance, through organic crop production and establishing biodiversity islands, the company creates conditions for many species that would not be able to survive in conventional plantations. Native's agroecological farms include organic cane fields and also wetlands, riparian vegetation, native forests, exotic woods and other habitats. This allows the proliferation of species – from arthropods and fungi to birds, mammals and reptiles – which find food, shelter and good breeding conditions in the farms.

3.2 Sustainable Use of Biodiversity

In the sourcing of biodiversity, there is an obvious need to ensure that the way in which biological resources are used does not lead to their long-term decline. Principle 2 of the Ethical BioTrade Standard focuses on the sustainable use of biodiversity, requiring sourcing activities to be based on management documents that consider harvest, productivity and regeneration rates. Collection and cultivation practices, for instance, should not be negatively affecting the population of the sourced species. A monitoring system, moreover, should be in place to allow for continual adjustment of these practices – what is known as adaptive management. Principle 2 also addresses the need for organisations to implement appropriate mechanisms to prevent or mitigate the negative environmental impact. Such mechanisms should deal with issues such as the use of agrochemicals, protection of water resources, preservation of soil and air quality and waste disposal.

For example, Ratanhia is a traditional medicinal plant of the Peruvian Andes, as well as a natural ingredient used in oral and dental care products.[24] As its popularity in local and export markets surged, Ratanhia stocks plummeted. It became imperative to ensure the sustainable harvest of Ratanhia and the protection of its habitat. In this context, and following its commitment to respecting nature and to care for the rights of future generations, Weleda AG, a manufacturer of natural cosmetics and medicines and UEBT member, has been implementing sustainable collection practices for Ratanhia for over 40 years. Through collaboration with local farmers and the Peruvian environmental authorities, Ratanhia is now protected on 5,000 acres of certified organic land. Collectors are trained in good practices: for every plant that is extracted, five Ratanhia seeds are planted

in the same location. Through this project, Weleda has secured the supply of Ratanhia for use in its oral care formulations and ensured a sustainable life for the Ratanhia plant.

Another example is the work of PhytoTrade Africa, the trade association of the natural products industry in Southern Africa and UEBT member, with baobab.[25] Baobab is known in Africa as The Tree of Life because there are many traditional uses for every part of it, from the leaves to the roots. However, for reasons of sustainability, PhytoTrade Africa encourages commercial production of products derived from the fruit and seeds of baobab – not from the leaves or bark. PhytoTrade Africa and its partners are committed to the ethical and sustainable development of the baobab trade. As well as paying communities a fair price for their baobab fruit, producers return part of their sales income to the villages to fund community projects. They also use forestry techniques based on best practice, identifying and monitoring every producing baobab tree and putting in place appropriate measures to ensure long-term sustainable production. PhytoTrade Africa provides its members with ongoing technical training to ensure baobab is harvested, stored and distributed sustainably and to help producers achieve organic and fairtrade status.

3.3 Fair and Equitable Sharing of Benefits Derived from Biodiversity

Equitable sharing of benefits derived from the use of biodiversity is at the core of Ethical BioTrade, which focuses precisely on ensuring there are incentives at the local level for the sustainable use of biodiversity, as well as adequate recognition of the contributions of local actors. Principle 3 of the Ethical BioTrade Standard deals with benefit sharing in relation to biological resources – linked to fair trade practices – and also establishes requirements on access to genetic resources and the sharing of benefits derived from their utilisation – that is, biodiversity-based research and development.

In terms of fair trade practices, perhaps the central requirement, as there can be no equitable result without an equitable process, is that all discussions and negotiations be "transparent and based on dialogue and trust." Principle 3 requires negotiations to involve all relevant stakeholders, which extend beyond the organisations along the supply chain, and include

other communities, groups or individuals with rights over the resources. Information used in these negotiations must be complete and allow those involved to gain an understanding of the issues and potential impacts at stake. There are also requirements on empowering local actors to actively participate in negotiations, as well as on documenting their outcome.

For example, Candela Peru, a UEBT founding member, is working jointly with Asociación Forestal Indigena (AFIMAD), an indigenous forestry association in the Peruvian Amazon, in natural products that promote sustainable development and improve livelihoods for indigenous communities. With the support of UEBT and other partners, Candela Peru and AFIMAD are using tools such as biocultural dialogues to promote mutual understanding.[26] Biocultural dialogues involve an approach to discussions based on the recognition of the inherent links between local communities, their cultures and their natural environments. In 2011, the outcome of a biocultural dialogue between AFIMAD and Candela Peru was the establishment of an "Agreement of Principles and Commitments" between both parties. This document includes the principles on which their working relationship is based, the specific commitments of each party to advancing work under the Ethical BioTrade framework; and the concrete next steps for follow-up in the context of exploring future projects.

In terms of biodiversity-based research and development, Principle 3 of the Ethical BioTrade Standard first requires organisations to have information on any relevant legislation and have taken steps towards meeting any applicable requirements. This is critical because Ethical BioTrade principles aim to support – not replace – compliance with ABS requirements. If the activities of an organisation working with Ethical BioTrade trigger ABS requirements in a specific jurisdiction, then these requirements must be met and Ethical BioTrade policies and practices should complement and build on these imperatives.

Even if there are no laws or regulations with ABS requirements, the Ethical BioTrade Standard requires that biodiversity-based research and development respect the principles of the CBD and the Nagoya Protocol, including prior informed consent and equitable sharing of benefits based on mutually agreed terms. For instance, the Ethical BioTrade Standard requires the fair and equitable sharing of benefits derived from research,

development and commercialisation of biodiversity-based products among all those who have contributed to these processes. These contributions may be supplying biological resources of particular interest or value; providing information about the properties and uses of those biological resources; or allowing product marketing to refer to the link with indigenous or local communities. Benefit sharing is negotiated and defined in each particular case, but the Ethical BioTrade Standard requires a focus on promoting biodiversity conservation and sustainable development, such as through generating employment, promoting sustainable use, transferring technology, and working to build institutional, natural resource management, technical and commercial capacities at the local level.

Ecoflora Cares is a Colombian company recognised as a leader in the development of inputs and services derived from biodiversity. Its vision is providing the best choice in natural bioinputs, while contributing to a more ethical and ecological world. Ecoflora Cares is a UEBT member since 2009. One of its products is a blue dye, extracted from the jagua fruit (Genipa americana) in the Colombian Chocó. Through the sourcing of jagua and the development of this dye, Ecoflora Cares is seeking to provide the market with a natural, high-quality input, as well as to promote sustainable use and economic development in a region rich in biodiversity yet suffering from significant poverty. Ecoflora Cares has secured permits for research linked to the optimum conditions for processing jagua into a stable, concentrated dye.[27] It is also processing the permits required by Colombian legislation on access to genetic resources for commercial development. This work, which seeks to improve local infrastructure for the production of Jagua and build local capacity to contribute to the value chain, and negotiate access agreements and benefit sharing, is being conducted in the context of a project financed by the Nagoya Protocol Implementation Fund.

Natura, one of the world's leading companies in the cosmetics and personal care sector and a UEBT founding member, has pioneered fair and equitable benefit sharing in Brazil. In 2010, Natura adopted a 'Policy for the Sustainable Use of Biodiversity and Traditional Knowledge,' which establishes the manner in which the company conducts biodiversity-based research and development.[28] For example, Natura commits to the principle of prior informed consent and establishes specific directives on benefit sharing. The company shares the benefits from using genetic resources and

associated traditional knowledge with local producers or communities, in line with national legislation implementing the CBD. Benefits to be shared are determined jointly with the local producers and communities, under certain parameters. For instance, for the use of genetic resources, benefit sharing is linked to the development and effective use of raw materials in Natura products. When providers are local producers and local communities, these groups are entitled to a percentage of the net income from the sale of these resulting products. In addition, they receive an advance payment at the moment when a raw material is developed and found to be suitable for Natura products, even prior to the development and commercialisation of such products. Benefit sharing agreements generally cover three years, which is the average time that a product remains active in the company's portfolio.

Finally, Principle 3 of the Ethical BioTrade Standard deals with the link between organisations' policies and practices on patents and equitable sharing of benefits. It establishes that, if organisations do use patents for inventions related to natural ingredients, such patents should be exploited and enforced in a manner that is supportive to the objectives of the CBD and the Ethical BioTrade Standard. In this manner, Principle 3 recognises that the use of patents in relation to biodiversity creates risks as well as opportunities. If UEBT members use patent protection in relation to biodiversity-based products and processes, such use must take into account the UEBT patent and biodiversity principles, which deal with issues such as disclosure requirements, scope of claims and dealing with patent issues along the supply chain. A joint patent on Maruline, which derived from a partnership between PhytoTrade Africa and Aldivia S.A., both UEBT members, is an example of how the role and contribution of local producers can be acknowledged through intellectual property, and how the potential benefits can be increased.[29]

4. Conclusions

"If we destroy the biodiversity that allows natural systems to function, no amount of money will save us," has warned Canadian scientist and environmentalist David Suzuki. That is what makes biodiversity such a fundamental part of the Sustainable Development Goals. It is also what makes efforts to mainstream its conservation and sustainable use – not

only in government policies but also in the approaches and practices of all stakeholders, including business – so critical. Ethical BioTrade, though still a recent initiative, has proved that such efforts can be fruitful. Examples in this note highlight win-win solutions, contributing to local ecosystems and communities, as well as to sustainable business growth.

At the same time, initiatives such as Ethical BioTrade need significant upscaling to achieve sufficient impact. The conservation and sustainable use of biodiversity, as well as the fair and equitable sharing of its benefits, require a market transformation. That is, there must be a widespread and lasting change in business behavior. This is a challenge, but also a real opportunity: Consumer awareness of biodiversity continues to rise – particularly among young people; companies are starting to address biodiversity in their sustainability and business strategies; and new rules on access to genetic resources and the sharing of benefits derived from their utilisation mean changing practices in biodiversity-based research and development. Taking advantage of such an opportunity will require harnessing the momentum created by initiatives such as Ethical BioTrade and continuing to raise awareness, build partnerships, recognise efforts, remove barriers and provide the guidance needed to make ethical sourcing of biodiversity, the new "business as usual."

Endnotes

1 The United Nations has proclaimed 22 May as The International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues. When first created by the Second Committee of the UN General Assembly in late 1993, 29 December (the date of entry into force of the Convention of Biological Diversity), was designated The International Day for Biological Diversity. In December 2000, the UN General Assembly adopted 22 May as IDB, to commemorate the adoption of the text of the Convention on 22 May 1992 by the Nairobi Final Act of the Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity.

2 The 2015 theme reflects the importance of efforts made at all levels to establish a set of Sustainable Development Goals (SDGs) as part of the United Nations Post-2015 Development Agenda for the period of 2015-2030 and the relevance of biodiversity for the achievement of sustainable development.

3 Statement of Mr. Braulio F. de Souza Dias, Executive Secretary of the CBD, on the occasion of the Celebration of the International Day for Biological Diversity, organised by the Ministry of Environmental Protection of China on 22 May 2015 in Beijing, China.

4 For example, in 2008, the G8 Environment Ministers discussed ways to promote the conservation and sustainable use of global biodiversity and adopted the Kobe Call for Action for Biodiversity, promoting international cooperation and engagement of the private sector.

[5] See, e.g., the reports of "The Economics of Ecosystems and Biodiversity" (TEEB), a global initiative focused on "making nature's values visible," which has highlighted the economic contribution and value of biodiversity and ecosystem services.

[6] See, e.g., the findings of the "Bioscience at a Crossroads" briefs and factsheets published by the Secretariat of the Convention on Biological Diversity (CBD).

[7] For information and documents on UEBT and its activities, please see www.uebt.org

[8] UNCTAD BioTrade Principles & Criteria.

[9] CBD decisions VIII/17 and IX/6.

[10] See "History of the Union" at http://ethicalbiotrade.org/about-the-union/history-of-the-union/

[11] The Ethical BioTrade Standard is available at http://ethicalbiotrade.org/verification/ethical-biotrade-standard/

[12] In decision X/2, the tenth meeting of the Conference of the Parties, held from 18 to 29 October 2010, in Nagoya, Aichi Prefecture, Japan, adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the 2011-2020 period.

[13] For additional information on the UEBT Biodiversity Barometer, please see http://ethicalbiotrade.org/biodiversity-barometer/

[14] UEBT Biodiversity Barometer, 2014 edition, available at http://ethicalbiotrade.org/dl/barometer/UEBT_Biodiversity_Barometer_2014.pdf

[15] More information about the ISEAL Alliance and its activities is available at http://www.isealalliance.org/

[16] For more information on the UEBT mission and vision, please see http://ethicalbiotrade.org/about-the-union/

[17] The UEBT Theory of Change is available at http://ethicalbiotrade.org/dl/public-and-outreach/UEBT_Theory-Of-Change.pdf

[18] The Ethical BioTrade Standard applies primarily to natural ingredients used in the cosmetics, food and pharmaceutical sectors, though it could also be adapted for other types of biodiversity-based activities.

[19] UEBT membership conditions and obligations are available at http://ethicalbiotrade.org/dl/membership/GOV25-Membership%20Conditions%20and%20Obligations%20for%20Trading%20Members_2011-12-31.pdf

[20] An overview of UEBT tools is available at http://ethicalbiotrade.org/resources/uebt-tools/

[21] For example, the most recent "Beauty of Sourcing with Respect" conference took place in Paris on 25 June 2015. For more information, please see http://ethicalbiotrade.org/bsr2015/

[22] A case study on Novel Development Tanzania is available at http://ethicalbiotrade.org/our-members/trading-members/novel-development-tanzania-ltd/allanblackia-in-a-nutshell/

[23] A case study on Native is available at http://ethicalbiotrade.org/dl/member-reports/Biodiversity%20and%20Innovation%20in%20Practice%20Native.pdf

[24] For more information on Weleda's ratanhia project, please see http://www.weleda.com/90years/language=en/11181

[25] For more information on PhytoTrade Africa's work with baobab, please see http://baobabsuperfruit.com/

[26] A case study on the use of biocultural dialogues in Ethical BioTrade is available at http://ethicalbiotrade.org/dl/member-reports/UEBT.note2_.BioCultural.Dialogue.BenefitSharing.2O12.pdf

[27] A case study on the work of Ecoflora Cares on jagua is available at http://ethicalbiotrade.org/dl/member-reports/Benefit%20Sharing%20in%20Practice%20Ecoflora.pdf

[28] A case study on the ABS approach of Nature Cosmetics is available at http://ethicalbiotrade.org/dl/member-reports/Benefit_Sharing_in_practice_Natura_Cosmetics.pdf

[29] See, e.g., presentation made by Cyril Lombard and Pierre du Plessis during the 7th Pan-African ABS Workshop, organised by the ABS Capacity Development Initiative, in 2013, in Phalaborwa, South Africa.

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A Footprint Analysis of ASEAN: Ensuring Sustainable Development in an Increasingly Resource Constrained World

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Abstract: The recently proposed Sustainable Development Goals (SDGs) include promoting inclusive and sustainable economic growth as well as well-being for all. Economic activities ultimately depend on ecological assets and their capacity for provisioning primary resources and life-supporting ecological services (Costanza et al. 2014; Georgescu-Roegen 1971); managing the latter is becoming a central issue for decision-makers worldwide (CBD 2010; UN et al. 2014). Thus, living within the limits of the biosphere's ecological assets is a necessary condition for global sustainability, which can be quantitatively measured and must be met to achieve SDGs.

This paper provides a summary of key findings from a joint research project undertaken by Global Footprint Network and the Keidanren Conservation Nature Fund reviewing ecological asset balances for member states of the Association of Southeast Asian Nations (ASEAN), and discusses implications on sustainable development in the Philippines, an ASEAN country that has been experiencing rapid economic growth in recent years. It also provides an in-depth analysis of the trade links and dependencies in ASEAN. This analysis utilises two methodologies: National Footprint Accounting (NFA) and Environmentally Extended Multi-Regional Input Output analysis (MRIO) for the Ecological Footprint to conclude with an overview of the biocapacity and Ecological Footprint of ASEAN nations.

1. Introduction

From over-harvested fisheries to rapid land conversion to alarming rates of fossil fuel emissions – human activity is putting increasing demands on the living planet, so much so that we now demand and emit more than what

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This paper utilises Ecological Footprint and Biocapacity data from the 2012 National Ecological Footprint Accounts published by Global Footprint Network.

the Earth can renewably provide and absorb. Earth's services can no longer keep up with humanity's demands. Changing course is possible, but it will require tools to track and manage our valuable natural assets.

The Ecological Footprint can help us live within our ecological budget by measuring the biologically productive land and marine area required, using prevailing technology and resource management practices, to provide the renewable resources that a population consumes, and to absorb carbon dioxide emitted. This demand in turn can be compared with the productive area available, or the Earth's biocapacity.

The Ecological Footprint measures human demand on six land-use types that are calculated separately. Cropland consists of areas used to produce food and fiber for human consumption, feed for livestock, oil crops and rubber. Forest land is used to produce timber, pulp and fire wood, or to absorb CO_2 emissions from fossil fuel burning (these are two mutually exclusive uses).Grazing land refers to grassland areas that can be used to feed livestock. Fishing grounds are high productivity continental shelf or inland waters used to harvest fish. Carbon Footprint land is the forest area required to absorb carbon emissions caused by human activity.This is the only waste tracked in the Ecological Footprint. Built-up land includes biologically productive areas covered by human infrastructure. Since the area is considered fully occupied by infrastructure, and thus not available for other use, the Ecological Footprint and biocapacity of built-up land are always equal.

These six land types are converted into a common unit, the global hectare (gha), which is calculated by standardising the different land-use types (in hectares) using yield factors and equivalence factors. This makes hectares globally comparable.

Biocapacity tracks ecological assets available in each country and at the global level in a given time period (usually one year). It catalogues the planet's capacity to produce renewable resources and absorb wastes (particularly carbon dioxide). A national biocapacity calculation starts with the total amount of bioproductive land and water available within national borders. "Bioproductive" refers to land and water that supports significant photosynthetic activity and accumulation of biomass.

2. Global Context

From 1961 to 2010, Ecological Footprint accounts indicate that human demand for renewable resources and ecological services increased by nearly 140 per cent (from 7.6 to 18.1 billion global hectares[1]), reaching a point where the planet's bioproductive area (increased from 9.9 to 12 billion global hectares) is no longer sufficient to support the competing demands. In 2010, humanity demanded the equivalent of approximately 1.54 Earth's worth of provisioning and regulatory services (WWF *et al.*2014).

At the global level, the increase in anthropogenic demands was most prominent for the carbon Footprint (+260 per cent due to the growing use of fossil fuels, electricity and energy-intensive commodities) and the cropland Footprint (+125 per cent) components (WWF *et al.* 2014). However, Footprints vary by income groups (Galli *et al.* 2012). Per capita Footprint increased in only high-income countries (indicating life-style improvements) but decreased in low-income countries, which experienced a noticeable population increase. The carbon Footprint grew from 31 per cent (in 1965) to 63 per cent (in 2005), and the cropland Footprint decreased from 37 per cent (in 1965) to 18 per cent (in 2005) in high-income countries. Middle-income countries followed a similar pattern. Conversely, cropland represented the main Footprint component in low-income countries in 2005, although its contribution decreased from 62 per cent to 44 per cent from 1965 to 2005. Galli *et al.* (2012) argue that middle- and low-income countries are following the same development path as high-income countries, characterised by a shift from agrarian (biomass-based) to industrialised (fossil-fuel-based) societies.

Significant biocapacity deficits exist in many countries and a distinction can be made between countries that are driving global displacement of human-induced pressure and countries where such pressure displacement is taking place (Galli *et al.* 2014). Moreover, Canada, Argentina, Brazil, Australia and Indonesia are the top five net exporters[2] of biocapacity, altogether totalling nearly 0.5 billion global hectares worth of renewable resources and ecological services. Japan, Mexico, Italy, the United Kingdom and Egypt are the top five net importers of biocapacity, with a cumulative import of nearly 0.6 billion gha.

Under widely accepted consumption and population projections, global ecological overshoot[3]is expected to increase (Moore *et al.* 2012): continuing

on a business-as-usual path, humanity would demand the equivalent to 2.6 planet's worth of ecological resources and services by 2050 – which may be physically unattainable.

3. Sustainable Development Implications

A country or region (also the world) is considered to be in ecological overshoot when its Ecological Footprint exceeds local biocapacity. This translates to a violation of a basic criterion of sustainability, since it means a population's demand on nature exceeds the available regenerative capacity of natural resources (or biocapacity). This disruption of balance reflects itself in the depletion of life-supporting natural capital, and a buildup of carbon dioxide waste in the atmosphere (expectedly causing climate change). While local overshoot is often overcome by importing resources from abroad, global overshoot is more challenging since there is no net import of resources into the planet.

The amount by which the Ecological Footprint of an area exceeds its biocapacity is defined as a biocapacity deficit. Conversely, a biocapacity reserve is the amount by which the biocapacity exceeds the Ecological Footprint of an area. A national biocapacity deficit can be compensated for by importing biocapacity through trade or liquidating national ecological assets, or by emitting wastes into the global commons. Today, more than 80 per cent of the global population lives in countries that are in a biocapacity deficit, or in "ecological overshoot".

The growing human pressure on Earth's ecosystems measured by Footprint assessments confirms other scientific findings (e.g., Vitousek *et al.* 1997; Krausmann *et al.* 2009).

Biodiversity is declining at an exceptional rate, driven in part by human pressure on ecosystems. Galli *et al.* (2014) have linked human demand on the biosphere, tracked through the Ecological Footprint, to direct threats to biodiversity, concluding that current actions to reduce biodiversity decline may be insufficient because they focus on addressing the symptoms rather than the causes. Thus, traditional conservation measures (protected areas, biodiversity-related aids, etc.) must be coupled with measures targeting the human drivers of pressures on biodiversity[4] (e.g., green economy policies and incentives to favor SCP (Sustainable Consumption and Production) patterns).

Science-based benchmarks and quantitative tracking can help bring focus to the debate on sustainable economics and well-being. Boutaud (2002) and Moran *et al.* (2008) have proposed combining Ecological Footprint and UNDP's Human Development Index (HDI)[5]to monitor whether nations' progress toward advancing human well-being stays within the ecological budget limit – biocapacity – of the biosphere.

According to 2013 UNDP statistics, very few countries are achieving high human development (HDI 0.67 or higher) within a globally replicable level of biocapacity demand (per capita Footprints lower than 1.79 global hectares for 2007). According to Moran *et al.* (2008), as countries improved their citizens' well-being, their resource use grew. Beyond a certain level, small HDI gains are likely only obtainable via large Ecological Footprint increases.[6]

These results highlight the challenge of achieving a globally reproducible high level of human well-being without overtaxing the planet's ecological assets following a business-as-usual development path. According to UNDP (2013), this situation *"does not bode well for the world,"* and *"over time, the situation is becoming more dire."* Technological innovations (e.g., better product quality and durability, resource efficiency, etc.) and a shift in consumption (and production) patterns are thus needed to ease the transition towards high human development within the Earth's safe operating space. According to Kubiszewski *et al*. (2013) *"if we hope to achieve a sustainable and desirable future, we need to rapidly shift our policy focus away from maximizing production and consumption (GDP) and towards improving genuine human well-being."*

4. Historical Trend for Entire ASEAN Region

The ASEAN region went into biocapacity deficit in the early 1990s. This deficit has grown steadily since then. Cropland is the largest component of ASEAN's total Ecological Footprint, followed by carbon and fishing ground. Many ASEAN countries have economies that have long been dependent on agriculture. This is gradually shifting to industry and service sectors. This change, along with the needs of a growing population, means that ASEAN countries are more dependent on biocapacity of other countries than ever before. While this is not uncommon in a global economy, this growing dependence poses risks in a resource-constrained world.

When we analysed the ASEAN region by land type, we found that both the Ecological Footprint of consumption and biocapacity of cropland have been increasing steadily for more than 45 years — meaning increased demand on agricultural products has been compensated by increased production. Grazing land in the ASEAN region has been in ecological deficit since the 1990s, highlighting excessive demand on livestock products. Overall trends for forest land and fishing grounds are moving toward a deficit situation. These trends pose a variety of risks for the region's population — particularly in relation to food security. As resources grow scarcer, ASEAN countries will depend more on other nations' biocapacity and become more exposed to supply disruption and price volatility of essential resources.

When we analysed the ASEAN region by individual country, we found that three countries, namely Indonesia (34 per cent), Thailand (15 per cent) and Vietnam (14 per cent) contributed 63 percent of ASEAN's total Ecological Footprint . On the supply side, three countries, namely Indonesia (43 per cent), Myanmar (14 per cent) and Vietnam (13 per cent)contributed 70 per cent of the region's total biocapacity..

The countries with the largest per capita Footprints are Singapore (6.27gha), Brunei (4.02gha) and Malaysia (2.99gha). But in the Philippines, the Ecological Footprint for the average resident has not increased much since 1961; however, its total Footprint has tripled since then. In other ASEAN countries that follow this trend, population growth has been the primary driver of a growing Ecological Footprint.

Per person, most residents of ASEAN countries have maintained the same level of resource consumption, with the exception of residents in Brunei, Singapore, Malaysia and Thailand. Residents in these countries have shown a significant increase in individual resource consumption. This may be attributed to higher incomes.

Only three ASEAN countries, namely, Indonesia, Myanmar and Laos,arebiocapacity creditors. The Philippines, Singapore and Thailand are operating in abiocapacity deficit situation, while Cambodia and Vietnam are fast moving towards a similar situation.

5. Case Study: Philippines

The Philippines' biocapcity deficit has been increasing steadily over time. By 2012, residents of the Philippines were using more than twice the biological capacity of the country.

As previously mentioned, a country can maintain an ecological deficit by overharvesting domestic resources; through imports, by relying on the biocapacity of other nations (which may not continue to be as available over time); and by using the global commons, such as using the global atmosphere as a sink for carbon dioxide emissions. All three may be happening simultaneously in the Philippines, compounding the challenge of moving towards truly sustainable development.

Already, signs of resource degradation are appearing in the country. Deforestation and declining fish stocks due to overfishing are cited among the top environmental challenges in the Philippines. According to the Philippines' Department of Agriculture, approximately 45 per cent of the arable lands in the Philippines have been "moderately to severely eroded," driving the movement of subsistence farmers to marginal lands in hope of meeting daily food requirements.

Forests in the Philippines continue to be under threat from agriculture and urbanisation, illegal logging and forest fires according to the World Bank, adding to the impact of centuries of deforestation. Other reports, most recently from Asia Development Bank, also depict a 90 percent drop in the quantity of marine organisms found in traditional fishing areas of the country. And according to the Food and Agriculture Organization (FAO), catch rates in major fishing grounds, such as Lingayen Gulf, reached maximum sustainable yield more than 20 years ago. The Philippines' growing population has also led to increased demands on the country's limited biocapacity.

As the Philippines strives towards increasing economic security and improving lives for its residents, incorporating environmental realities in all its planning will help ensure continued success. Without the adequate resources, progress cannot last.

National progress towards meeting development goals can be assessed using the UN's HDI graph, which incorporates Ecological Footprint. UNDP defines an HDI score of 0.7 as the threshold for a high level of development. The Philippines' trajectory over the past 40 years is moving it closer to this goal. Since 1970, its per capita Ecological Footprint has risen only slightly, while at the same time the country has made steady gains in its Human Development Index score. Counter to the trend in most countries,

the Philippines is finding a way to increase the average quality of life for its residents without at the same time increasing their per capita demand on biocapacity.

Still, ensuring progress in the well-being of all residents remains a challenge. While the HDI shows that the average resident has achieved higher levels of development, the Philippines' GINI coefficient - an indicator of income disparity - is among the highest among countries in Southeast Asia. Averagemeasuresofdevelopmentmaynot reflect segments of the population that do not have access to the resources required to meet basic needs such as food, shelter, health and sanitation. If the Philippines is to continue making advances in human development that extend beyond short-term progress, it must find approaches that work with, rather than against, nature's budget. The country's growing population and the world's increasing resource demands are making these challenges ever more difficult.

6. Trade Analysis: ASEAN as a Whole

ASEAN is a net exporting region. Many countries within ASEAN have increased exports to meet the demands of trading partner countries — specifically products related to agriculture, fishing and forest land. This increase has contributed to the region's overall biocapacity deficit, and it is a common challenge for ASEAN: How to increase GDP without liquidating natural assets. Among ASEAN's primary trade partners, the United States, Japan and China make up 41 percent of the region's total export.

The main contributor to the region's imported Ecological Footprint is the carbon Footprint, followed by cropland, which means that the ASEAN region is importing a very large percentage of its crop products. It is not surprising to note that the main contributor to exported Ecological Footprint is carbon Footprint. As expected, most land types are in a net export status, except grazing land Footprint.

When we analysed trade relationships of the 10 ASEAN countries, we found that Indonesia accounted for 27 percent of the region's total import, making it the largest importing ASEAN country. Thailand and Malaysia came second, together accounting for 60 percent of the total ASEAN import. (Due to data availability, Myanmar and Brunei were grouped with the rest of Southeast Asia.)

7. Conclusion

The ASEAN is one of the fastest growing regions in the world, with a population of approximately 600 million people, and a combined GDP that would make it the eighth largest economy in the world. Despite these gains, the region faces myriad challenges: Large numbers of the population remain in poverty, while its member states are among the most vulnerable to climate change, soil exhaustion and fresh water shortages, deforestation, depletion of fisheries and other pressures. These resource constraints pose threats to the region's energy and food supplies.

Climate change is a major challenge for many ASEAN member states, but it is a symptom of a broader challenge: Humanity's systematic overuse of the planet's finite resources. Since the 1990s, the region's population has been demanding more ecological services than what was renewably available within its borders — meaning ASEAN is in biocapacity deficit, and it continues to operate a growing deficit year after year. This poses economic, political and social risks — not just for the region itself, but for trading partners that have grown more dependent on the region's resources.

There is an opportunity to change the trajectory of these trends in the region — and the political will to do so. As ASEAN moves towards further developing and implementing this plan, the Ecological Footprint can help ASEAN member states to better understand the ecological situation of the region, as well as that of the individual countries and their trading partners. This data and analysiswill be crucial in identifying risks and opportunities as ASEAN strives to create more robust trade relations and activities among its member states, and attain sustainable well-being for its growing population.

Endnotes

1 A global hectare, the accounting unit in the biocapacity and Footprint metric, is a biologically productive hectare with world average productivity (Borucke*et al.* 2013).

2 Net exporting countries export more biocapacity than they import and have an Ecological Footprint of consumption lower than their Ecological Footprint of production. The opposite is true for net importing countries.

3 Overshoot refers to the situation where a population's demands exceed itsenvironment's ability to support those demands (its carrying capacity). Global overshoot means that global demands exceed global regeneration (Monfreda*et al.* 2004).

4 According to Galli *et al.* (2014), Ecological Footprint needsto be complemented with other indicators for a comprehensivemonitoring of the whole pressure humans pose on the Earth's ecosystemsand biodiversity.

[5] According to Raudsepp-Hearne *et al.* (2010), HDI constitutes an adequate proxy measure of human well-being as it strongly correlates with health-adjusted life expectancy,adult and youth literacy, gender equality and other measures.

[6] This findingis consistent with the *'threshold hypothesis'* proposed by Max-Neef (1995) and strengthened by Niccolucci*et al.* (2007).

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Business as a Force for Good: Action and Leadership Through and Beyond Post 2015 Agenda

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Abstract: Globally, business leaders are evolving their business models and responding to the challenges of today, thus offering reasons to be optimistic about the future of sustainable development. Business leaders are innovating to provide an entirely fresh perspective of doing business that benefits not only companies but society at large, leading to a positive impact on the triple bottom line - people, planet and profit. Fast-changing markets are turning the traditional business model on its head. This shift is attributed largely to increasing knowledge of the economic costs of environmental degradation and rising oil and food costs, driving businesses around the world to react to consumers and shareholders, who are becoming more informed and more vocal in insisting on corporate sustainability.

The paradigm shift in the global business environment has led to the Indian government promoting inclusive sustainable growth as a policy among corporate sector in India. Responding to the trends, the capital market also shows a sign of the shift towards sustainability with investors' increasing inclination to invest in responsible industries.

The sustainability journey of Indian businesses woven into a backdrop of unique canvass is marked by huge diversity. However, the momentum is now building up through innovation and leadership favourably equalling (if not measuring more) that of its peer group across the world. Companies in India are increasingly assuming a more transformative role, to ensure a 'win-win' situation for all. They open to learning, innovating and collaborating with key stakeholders, including governments, civil society organisations and the community.

United Nations Global Compact, the largest sustainability initiative in the world, further empowers business to continue to grow into a strategic asset with a focus on highest standards of responsible conduct through reporting and disclosure of its actions. Business as a force for good is bound to gain

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wider acceptance with the United Nations launching sustainable development goals in September 2015.

Keywords: Sustainability, innovation, business responsibility, sustainable development goals, responsible investing, Millennium Development Goals (MDGs), leadership and stakeholders, global compact, UNGC, India, social development, inclusion, environment

1. Introduction

More than ever before, there seems a growing consensus that in order to survive and be successful in the long-term, business needs to adopt sustainable practices. Globally, business leaders are evolving their business models and responding to the challenges of today, thus offering reasons to be optimistic about the future of sustainable development. Business leaders are innovating to provide an entirely fresh perspective of doing business that benefits not only companies but society at large, leading to a positive impact on the triple bottom line- people, planet and profit. Given that globalisation has contributed to widening the gap between the rich and the poor, and it makes eminent sense that business should be guided by both commercial and social interests (GCNI 2015). By implementing new creative ideas aligned with sustainability, adapting advanced technologies for product development and managing products throughout their life cycles, businesses can gain competitive advantages, reduce costs and increase their profits. In such scenarios, where the markets are aligned with the requirements of sustainable development, and sustainability is being rewarded and incentivised, a direct impact can be clearly witnessed in the progress of economies.

Fast-changing markets are turning the traditional business model on its head. This shift is attributed largely to increasing knowledge of the economic costs of environmental degradation and rising oil and food costs, driving businesses around the world to react to consumers and shareholders, who are becoming more informed and more vocal in insisting on corporate sustainability. Companies can no longer justify a wasteful business model with a temporarily strong financial bottom line, thus making business operations with environmental, social and fiscal accountability as the yardstick, not the exception, in the market. They recognise the need to rebuild public trust and maintain bridges between business and society and are thinking in terms of longer-term impacts on the environment,

society and the economy. Companies are, therefore, moving beyond their factory gates and market-place and are working towards responsible and ethical practices, which not only provide good returns for shareholders and consumers, and a safe and satisfying workplace for employees but also an equally advantageous proposition to the community at-large, thus strategically acting as a 'Force for Good'.

2. Sustainable Development and India

According to the Brundtland Report published in 1987, sustainable development is defined as:

> "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
>
> - the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
> - *the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs (IISD, n.d.)*."

Sustainable development in India includes a variety of development schemes within social, environmental (clean energy, clean water and sustainable agriculture) and human resources segments, having attracted the attention of both Central and State governments as well as public and private sectors. Social sector focus and investments into green energy and alternative fuels and development schemes for backward and below the poverty line (BPL) families have been tagged as some of the more heavily-invested segments in India over past few years, despite the economic slowdown.

At the release of a report on green accounting in April 2013, the then Indian Prime Minister Manmohan Singh had asserted that in India "a number of national strategies and policies, which inculcate the principle of sustainability, are already in place," while giving examples of the National Clean Energy Fund and the Compensatory Afforestation Fund (PIB 2013).

India's movement towards sustainable development began in 1972, when the incumbent Prime Minister Indira Gandhi emphasised at the UN Conference on Human Environment at Stockholm, that the removal of

poverty is an integral part of the goal of an environmental strategy for the world. In her address, she highlighted on the concept of inter-relatedness and inter-linked responsibilities of environmental protection and human development. It was, however, not until the 1990s that this agenda was seriously considered within the policy corridors of India.

Of late, though, the corporate sector in India has heeded the call of the time, and some leading players have started initiating measures designed towards sustainable development. Realising its importance, Indian companies are increasingly taking into account the environmental impact of their businesses. These companies are shifting away from operations that are driven entirely by profit motives to processes that integrate social and environmental issues, as they strive to achieve long-term sustainability. Business chambers have also joined forces in encouraging members to undertake sustainable development practices and promoting an environment conducive to the growth of industry in India.

3. Evolution of Sustainability Concepts through the 1990s

Until the early 1990s, India was virtually a closed economy with its industrial sector subjected to controls and regulatory mechanisms. With export pessimism underlying the policy approach, India largely directed its policies towards import substitution, quantitative controls and administrative exchange rates right from the beginning of planning era. The 1990s' economic reforms aimed at enhancing industrial competitiveness by opening up the economy to international markets. The phase was marked by the entry of MNCs into India and subsequent opposition by environmental groups who viewed sustainability only through the environmental lens.

The beginning of these economic reforms coincided with a time when countries around the world acknowledged and started addressing the increasing environmental concerns, such as at the Earth Summit in Rio in 1992.

It was during this phase that India embraced the UNDP concept of Human Development, introduced in 1990, which shifted the focus away from national income as the sole indicator of development to include the choices available to people. This shift came with the government's realisation that while it is imperative to eradicate extreme poverty and

hunger, promotion ofagreen economy is of equal importance for sustainable growth and quality of life. India also started receiving funding, especially from International financial institutions such as the World Bank for projects to mitigate environmental damages and address environmental issues based on country assistance strategies. Moving forward, the Government of India (GoI) launched its major environmental document, the National Environmental Action Plan (NEAP) in 1993, which identified pollution of air and water resources as a main priority, as well as land degradation that threaten the health and prosperity of the population. However its implementation was lagging. In 1993, the Ministry of Environment and Forests introduced the first non-fiscal reporting for companies under the Air, Environment, Waste and Water Act that aimed at the prevention and control of pollution of natural resources.

4. UNGC and Its Role in Advancing MDGs

In the year 2000, two major events at the global level brought about a significant change in the development discourse across the world. It was during this year that UN launched the Millennium Development Goals (MDGs) and the United Nations Global Compact. The eight-fold Millennium Development Goals set objectives for achieving progress in the elimination of poverty and hunger, achieving universal primary education, promoting gender equality and empowering women, reducing child mortality rates, improving maternal health, combating HIV/AIDS, malaria, and other diseases, ensuring environmental sustainability and developing a global partnership for development. The United Nations Global Compact (UNGC) was launched to bring together and call upon the corporate sector to innovatively address developmental issues as part of their business strategy.

In the year 2000, with an aim to conjoin private sector activities with civil society initiatives, and for the establishment of inclusive corporate sustainability in the global economy, a leadership platform with a global dimension –the United Nations Global Compact was launched by the then UN Secretary - General Kofi Anan. The UNGC primarily operates on four-fold realms - Human Rights, Labour, Environment and Anti-Corruption, further dispersed into ten universally accepted principles adopted by diverse signatories across geographies, as value-based approaches in achieving sustainable development. The United Nations Global Compact has today

transformed itself into the largest corporate citizenship body in the world that promotes adoption of sustainability practices across the globe. Its representation in the high-level panel of the Secretary-General on post-2015 global development agenda is a direct implication of its increasing role in carving out the sustainability agenda for companies worldwide.

India's progress on the MDGs and across the various indicators has been mixed one over the past 15 years since inception of MDG goals. India has already achieved the target of reducing poverty by half. In education, the country has already achieved gender parity in primary school enrollment and will achieve parity in secondary and tertiary education by 2015. India is also set to achieve the goal of reducing hunger by half and reduce maternal mortality by three quarters. The country has successfully managed to control the spread of deadly diseases such as HIV/AIDS, malaria and tuberculosis. It has also increased the forest cover and halved the proportion of population without access to clean drinking water. However,performance on some indicators has been far from satisfactory. India continues to lag behind on targets for empowering women through wage employment and political participation, reducing child and infant mortality and improving access to adequate sanitation to eliminate open defecation. Reports also suggest that progress on achieving MDGs is mixed across states, with high incomes states such as Tamil Nadu and Gujarat faring better on the MDG performance index (Bakshi 2015).

5. MDGs to SDGs: What Next?

With the Millennium Development Goals (MDGs) due to expire by the end of 2015, the consultation process among the nations states around post-2015 development agenda, is in the final stages. While the MDGs marked a point in history, being a first ever global agreement to address the pressing developmental issues, mobilising governments and business leaders to invest billions of dollars and promoting cross-sectoral collaboration. MDGs have been scrutinised for not being drafted in an inclusive and participatory manner, as only a few key civil servants and development experts were involved in the process of drafting them (Honniball and Spijkers). The process of drafting the Sustainable Development Goals, however, represents a new era of global participation in setting the development agenda, with multiple stakeholders, from civil society as well as the private sector, being

included in the process. The first draft of the SDGs, produced by an Open Working Group (OWG) of the United Nations consists of 17 goals and 169 targets (United Nations 2014). The process of drafting the SDGs also provides a unique opportunity for stakeholders to influence the emerging development agenda. *"The opportunity to rethink and redefine our global development pathway comes once in a generation. This is our opportunity and we must seize it*" (Beyond2015 2014). The post-2015 sustainable development agenda calls for action from the businesses, and there is a need for corporations to take a proactive role in promoting sustainable development in tandem with their influence and sphere of operations.

6. Sustainability Builds Pathways to Value Creation

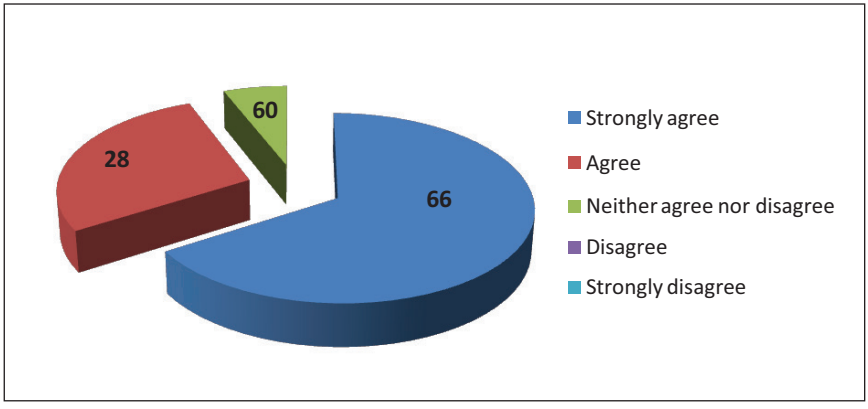
In recent decades, organisations have increasingly found that their profit and loss statements are influenced by parameters that do not feature on the balance sheet. In order to be sustainable, businesses world over have realised the need to recognise and effectively address the complex relationship of good corporate performance, social development, and environmental protection. This paradigm shift in the global business environment has led to the Indian government promoting inclusive sustainable growth as a policy among corporate sector in India. Responding to the trends, the capital market also shows a sign of the shift towards sustainability with investors' increasing inclination to invest in responsible industries.

This shift has been witnessed through policy making mechanisms and amendments to various laws for reinforcing the policy and legal basis of sustainable development. The pillars of sustainable development are embedded in the fundamental rights guaranteed by theIndianConstitution, which lays down the framework for social justice, inclusion and equity. India was one of the first few countries to enact a comprehensive Biological Diversity Act in 2002 to give effect to the provisions of the Convention on Biological Diversity, 1992. The National Environment Policy, adopted in 2006, has attempted to mainstream environmental concerns in all developmental activities. Through its various policies, the Indian Government has been factoring ecological concerns into the development process so that economic developments can be achieved without environment degradation.

Corporate India responded to the call of the times and some leading businesses started initiating measures designed toward sustainable development (Figure 1). The UNGC – Accenture – GCNI report (2014) on sustainability with over 33 CEOs from public and private sector companies and subsidiaries of MNCs in India highlights that Indian companies have evolved from a philanthropic approach, and their priorities now reflect the lens of proximity—focusing on immediate concerns.The Indian companies increasingly are taking into account the triple bottom line impact of their businesses while taking decisions and shifting away from operations aimed entirely on profit motive, and are striving to integrate social and environmental issues into their business decisions, for achieving long-term sustainability (Box 1).

Due to increased scrutiny on the business sector's stewardship of environment, sustainable practices have become a key component of companies' business strategy. Companies are adapting to natural resource constraints by developing innovative products, services, and business models, thus bolstering their growth, profitability, and adding to societal values (International Finance Corporation, n.d.). From pollution control in operations to innovating around green technologies, companies are taking proactive steps to reduce harmful impacts on the environment and society at large.

Figure 1: How Important are Sustainability Issues for the Future Success of Businesses?



Box 1: Business Sustainability Themes in India

UNGC, Accenture and GCNI report (2014) highlights that some of the unique and emerging themes that have enabled Indian companies to integrate sustainability for addressing global challenges and turn businesses as a force for good include:

1. Realism and Context
Understanding and appreciation of the scale of global sustainability challenges-and the opportunities they present.

2. Growth and Differentiation
Sustainability as an opportunity to stand out with consumers and customers; to access new market segments with new products and services; and to grow into new markets.

3. Value and Performance
Measurement, monitoring and management of sustainability metrics; quantification of business value; and tracking of impact on sustainability outcomes.

4. Technology and Innovation
Investing in technology and business model transformation led solutions to sustainability challenges; generating competitive advantage through new technologies and innovation.

5. Partnerships and Collaboration
Partnerships within and across industries and sectors to find new solutions for sustainability.

6. Engagement and Dialogue
Listening to and understanding the needs and wants of all stakeholders; establishing constructive two-way dialogues to negotiate the role of business in sustainability.

7. Advocacy and Leadership
Leadership in developing new systems and shaping the business contribution to global challenges; willingness to advocate for policy and market incentives that change the game.

Changing consumer preferences towards green products, which save on water usage, lessen GHG emissions, etc., have also pushed companies to develop green products using environment-friendly technologies in order to gain a competitive advantage. This translates into an increasing need for responsibility at every stage in the lifespan of a product to reduce its environmental, health and safety impacts. Companies have thus begun to integrate sustainability into their entire product cycle, to meet the increasing demand for sustainable products.

Moving beyond the factory gates and supply chain, sustainability for Indian companies resonates with their commitment towards community development and inclusion. According to a recent report by UNGC (2014), CEOs of top companies in India indicate that communities will have the

greatest impact on the way in which companies manage their societal expectations. About 63 percent of the respondents believe that in the next few years, communities will have the greatest impact on the way businesses manage societal expectations, as against the 28 percent of CEOs globally.

Strategic integration of sustainability has thus become important, enabling companies to achieve better growth and cost savings, improve their brand and reputation, strengthen stakeholder relations, and boost their bottom line. It is through this integration that companies are aiming at sustainable value creation, which is essentially a business strategy that recognizes the opportunity of addressing societal issues and creating a competitive advantage that result in profits as well as a positive outcome for the community. According to a report by Accenture and CECP (2011) on value creation, "*Sustainable Value Creation is, in many ways, an extension of the same capabilities at which leading businesses already excel: understanding consumer needs, investing in innovation, mobilising around change, creating markets, and managing a complex ecosystem of stakeholders*". Globally, the business landscape is constantly changing and companies are adapting their business models accordingly so as to ensure that the company's operations complement the triple-bottom line; People, planet and profit that creates long-term value for all stakeholders. Being referred to as 'Value Based Businesses' (Garrett-Cox 2013), such businesses have placed profit alongside people and planet.

Businesses are increasingly assuming a more transformative role, to ensure a 'win-win' situation for all. They open to learning, innovating and collaborating with key stakeholders, including governments, civil society organisations and the community. They feel that governments can 'soft peddle' situations where sustainability practices and initiatives need to be scaled up several notches from the current levels. Business leaders are unanimous that governments at the regional and national levels can play a more decisive role in allowing them to grow faster and innovate on a bigger scale, by providing enabling policy support and a stable tax regime and by incentivising good business practices with tax breaks and soft loans. This would also allow businesses to scale their initiatives and play a more vital role in growth and development of economies where they operate, yielding positive outcomes in the creation of capital, job opportunities and development of infrastructure for more inclusive, sustainable and justice-

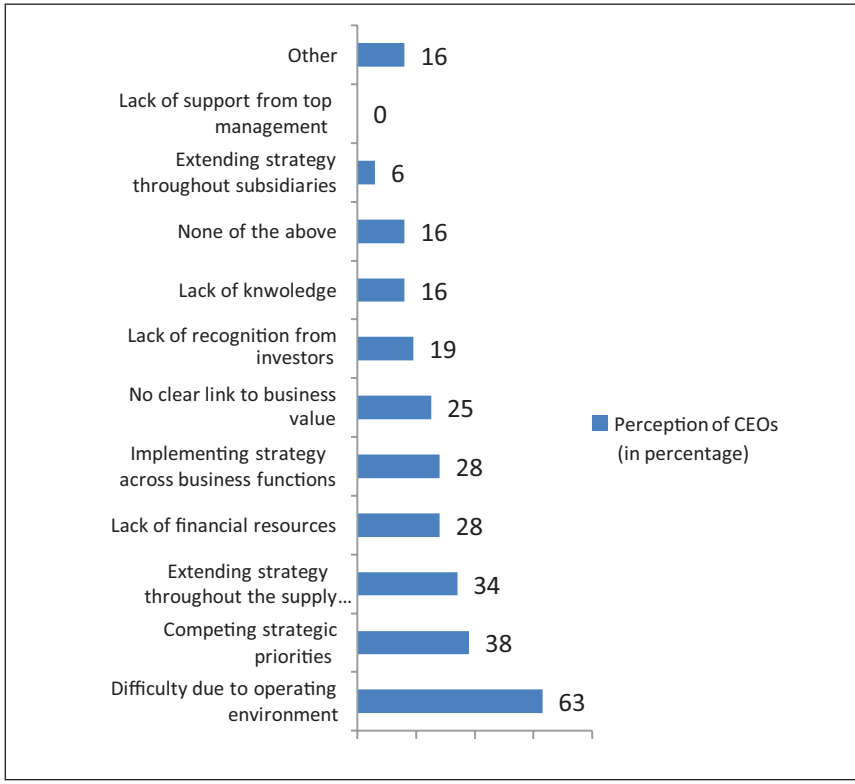
driven societies. This also helps businesses build a sound ground on which they can operate, with economies of scale and move the existing 'business as usual model' into a more 'transformative business blueprint'.

7. Sustainability is not Without Challenges

The practice of sustainability is India is not without challenges. According to the UNGC-Accenture-GCNI report (2014), each sector has its own sustainability challenge, with sector-specific solutions. However, some of the most recurrent challenges include:

- Complexity of the existing regulatory policies, which do not incentivise sustainability;
- Lack of skilled workforce to meet growing demands;

Figure 2: Perception of CEOs on Challenges in Integrating Sustainability (in percentage)



Source: UNGC-Accenture-GCNI report (2014).

- Lack of an integrated reporting framework with unified and standard definitions;
- Inability to create the business case for sustainability; and
- Challenges in institutionalising sustainability within the DNA of the organisations.
- These challenges faced by the companies in India create hurdles for them in accelerating sustainability within the workplace, marketplace and community. Figure 2 depicts the perception of CEOs on the barriers in implementing an integrated strategy aimed at sustainability.

8. Measuring Performance to Create Value

The increasing awareness among various stakeholders about sustainable development is combined with the growing understanding for the need of holistic disclosures and transparency. There is a growing recognition that regular and transparent sustainability reporting is in the interest of businesses, as it is a powerful tool for decision-making and development of corporate policy and strategy. If a business implements its sustainability report accurately, completely, and in a timely manner, it may be able to increase its productivity and efficiency, which, in turn, may result in higher economic returns, greater value creation and more transparency.

Sustainability reporting started in 2001in India, initially marking a very slow pace of growth. In December 2007, recognising the contribution of financial institutions including banks towards sustainable development and considering the crucial role they can play in financing economic and development activities, the Reserve Bank of India drew the attention of banks to their roles in corporate social responsibility, sustainable development and non-financial issues. By the year 2009, out of over 7,000 listed companies in India, only a handful 25 companies voluntarily reported on sustainability strategy, vision, and performance or governance. These reports were mainly from oil & gas, mining, cement, steel, minerals, automotive, pharmaceuticals and other such 'industrial' sectors (Mitra 2012). To address this issue, the Ministry of Corporate Affairs launched the 2009 Voluntary Guidelines on Corporate Social Responsibility, which was later replaced by National Voluntary Guidelines (NVGs) on Social, Environmental and

Economic responsibilities of business (NVGs) in 2011. In the year 2012, the Securities and Exchange Board of India (SEBI) mandated the top 100 BSE/NSE listed companies by market capitalisation to include a Business Responsibility (BR) Report in their Annual Reports on the basis of the NVGs. In April 2010, to bring the central public sector enterprises under the gambit of reporting, the Department of Public Enterprises, Ministry of Heavy Industries and Public Enterprises also launched the comprehensive "Guidelines on Corporate Social Responsibility for Central Public Sector Enterprises", which was later replaced by the 'Guidelines on Corporate Social Responsibility and Sustainability for Central Public Sector Enterprises' released in April 2013. These efforts were made to serve the dual purpose of setting internal controls of sustainability in order within an organisation and meeting the demands of the stakeholders through a balanced disclosure on performance. These steps mark a definite shift from voluntary to mandatory sustainability reporting. The Companies Act 2013 further mandated the companies with net worth of Rs. 5 billion or more, turnover of Rs. 10 billion or more or net profit of Rs. 50 million or more to spend 2 per cent of their annual profit on CSR activities and report theirprogress on these activities in their Annual Report.

Apart from these national regulations and instruments, companies are also expected to report through international instruments such the Communication of Progress (CoP) of UNGC, GRI Reporting and Carbon Disclosure Project (CDP) Reporting. Indian companies have been using these instruments for sustainability reporting since 2001. These instruments promote the use of reporting as a way for organisations to become more sustainable and transparent and to contribute to sustainable development. The CoP calls upon corporate signatories of UNGC to provide a public disclosure to stakeholders (e.g., investors, consumers, civil society, governments, etc.) on progress made in implementing the ten principles of the UN Global Compactin support of broader UN development goals. Reporting mechanisms are indicators of business' performance in a holistic manner and demonstrates corporate citizenship through disclosure on responsible businesses.

There is enough evidence to suggest that the Indian companies are now paying increased attention to sustainability issues and the large companies have established a clear link between sustainability and risk management.

In recent times, it has also been observed that companies are including sustainability elements as part of internal audit so that the issues are discussed at the board level (Sharma n.d).

9. Key Sustainability Trends: Post-2015 and Beyond

Beyond 2015, the sustainability movement in India will blend the rapid growth of the global sustainability agenda with societal and economic imperatives in the Indian context. Companies need to tailor the global best practices to fit the unique diversity of India and carve out a unique path toward achieving inclusive growth through sustainable development. In a departure from the past, businesses now need to increasingly collaborate and partner for scaling up and innovation, deploy policy advocacy for influencing the policy climate around sustainability and its reporting, develop strategic communication techniques that promote sustainability practices and create a winning proposition for all key stakeholders, while ensuring that their operations are able to build long-term value and also address global challenges (Box 2).

Box 2: Key Emerging Trends in Sustainability Beyond 2015

A recent GCNI study on sustainability titled '*Sustainability Practices: Perspectives and Insights from Leading Indian and Global Businesses*' (2015) presents the following sustainability trends that will define the new approach to businesses:

- Sustainability is not just change in the process but change in mindset
- Sustainability is a good model for social value creation
- Community participation is a key to drive sustainability agenda
- Voluntary sustainability policies and codes of conduct ensure greater transparency
- Product responsibility makes a good business case
- Leveraging technology and programme innovation for scale and efficiency
- Extending sustainability to supply chain is equal to shared value approach
- Global Compact's Ten Universal Principles are driving sustainability agenda globally
- State incentives can help businesses escalate their sustainability initiatives
- Adoption of bottom-up approaches will fast track social license to help facilitate operational advantage
- Robust internal mechanisms are key to increase operational business efficiency
- Sustainability initiatives deepen business brand value and its reputation

10. Conclusions

Business has a far greater role to play in the post-2015 sustainable development goals, both to demonstrate its involvement and leadership towards greater public good andtotake tangible steps to ensure that its actions equally, if not more, positively impacts societal concerns within which it operates. Global Compact's role is growing in influencing businesses, in its promotion of the uptake of its development agenda. Sustainable development goals provide an intra-governmental agreement for businesses and government to work toward more just, equal and inclusive society that will be pivotal for global peace, safety and security over the next 15 years until 2030.

This approach presents the business sector's need to play a more meaningful role in post-2015, which assumes critical relevance at a time when governments continue to get more local and businesses march forward to grow global and transnational.

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Reconciling Food and Industrial Needs for an Asian Bioeconomy: The Enabling Power of Genomics and Biotechnology

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Abstract: While bioeconomy as a concept has been used by many countries in the world in policy and strategy development not many countries in Asia have used this concept. This paper discusses how Asian countries can use biotechnology and various omics technologies to address their pressing problems and develop strong bioeconomies. The paper explores the potential and limitations for using different technologies in Asia and points out that as these technologies can be applied in different sectors ranging from aquaculture to forestry. They will enable Asia to meet the problems in effective utilisation of biomass and address critical problems like food security. These applications will result in economic gains and better returns on investments. While the potential to reconcile industrial production with food needs is yet to be fully realised as these technologies can enable better utilisation of waste and related biomaterials by turning them into feed stocks, they provide many opportunities to Asian countries in meeting diverse needs and reconciling multiple demands from similar resources. Application of biotechnology, omics technologies, synthetic biology and green chemistry can be the enabling technologies for the biorevolution that may usher in better bioeconomies in Asia.

Keywords : omics technologies, bioeconomy, Asia, food security, biomass

1. Introduction: Why A Bioeconomy in Asia?

In a previous paper for this journal (Philp and Pavanan 2013) some of the basics of bio-based production in relation to sustainable development in Asia were explored. In this paper, we take up the theme again, but in

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Much of the material for this paper was inspired by a joint OECD-HUGO Workshop "Genomics for Sustainable Development in Emerging Economies: Food, Environment, and Industry", held during the Human Genome Organisation (HUGO) conference held in Kuala Lumpur on 14 March 2015. In particular, we thank Dr. Abdelbagi M. Ismail, International Rice Research Institute, Philippines; Dr. Hugo Volkaert, Kasetsart University, Thailand; Dr. Norwati Muhammad, Forest Research Institute, Malaysia, and Dr. Mohd Nazlee Kamal, Malaysian Biotech Corporation, Malaysia for their expert contributions.

The opinions expressed and arguments employed herein are those of the authors and do not necessarily reflect the official views of the Organisation for Economic Cooperation and Development (OECD), or of the governments of its member countries.

a wider bioeconomy context – the need to reconcile food and industrial production from biomass(Jiménez-Sánchez and Philp 2015). This is perhaps the critical issue in a bioeconomy, and it is in sharp focus in Asia. South East Asia, for example, is quite different in bioeconomy terms from many developed economies with regard to biomass. A large amount of global biodiversity resides in some countries of South East Asia, much more so than in many OECD nations. Nevertheless, they have a similar deeply complex problem to wrestle with – how to economically exploit this biodiversity and biomass in a sustainable manner that does not cause unintended social and environmental problems.

Since the OECD (2009) publication, *The Bioeconomy to 2030: Designing a Policy Agenda*, several countries and regions have responded with bioeconomy strategies, among them Belgium, Canada, Denmark, Finland, Germany, Ireland, the Netherlands, Sweden, the United States, the European Union and South Africa, many foreseeing a gradual replacement of fossil-derived materials with bio-based.Now, key objectives for a bioeconomy are embedded in the strategic activities of more than 30 countries. Very few Asian countries have followed suit. A notable exception is Malaysia (Bioeconomy Malaysia 2014), which has produced a plan for a very ambitious bioeconomy (see Box 1). Japan does not formally have a bioeconomy strategy (Bioökonomierat 2015), but has many policies consistent with a desire to build a bioeconomy.

In everything from research and development to full-scale implementation and biomass production, Asian countries are likely in the long-term to be leaders in bio-based production. With growing commitments to climate change mitigation, Asia can reap the benefits of economic growth, jobs and environmental improvements that bioeconomy promises. But careful international co-ordination and co-operation will be necessary.In addition, many of these Asian economies have a very different agricultural model from most OECD countries. The value added per agricultural worker tends to be much lower than in the OECD, and farmer ageing and poverty are central issues in food security. Perhaps the trend can be mitigated or reversed by participation in a global bioeconomy.

Long ignored as a potential engine of economic growth, modern biotechnology has many benefits to offer, both in food and industrial

production. The case is made that, even without genetic modification, genomics and other -omics technologies can solve scientific, environmental and economic problems in relation to the bioeconomy, and it can also be argued that there are follow-on social benefits that are pertinent to Asia beyond the obvious job and wealth creation benefits.

Box 1: The Malaysian Bioeconomy Strategy

Malaysia launched its Biotechnology Transformation Programme (BTP) in 2012 as part of the nation's economic transformation strategies. To do so, Malaysia is providing an incentivised platform for the bio-based industries to contribute to its sustainable development agenda, to improve industry competitiveness, to encourage public-private partnerships and bring socio-economic benefits. The initiative is supported by public sector stakeholders such as universities and research centres, economic corridors, financial institutions and inter-ministerial coordination.

Some Early Targets for the Malaysian Bioeconomy

The early targets to 2020 and those beyond are ambitious. Malaysia expects by 2020 a contribution of: US$ 15 billion to GNI; the creation of 170,000 jobs, and investments of US$ 16 billion. For comparative purposes, by 2020 the bioeconomy is expected to contribute 8-10 per cent towards Malaysia's total gross domestic product (GDP), from the current 2-3 per cent.Malaysia expects to achieve this ambitious target by a transition towards higher value downstream activities.

The Strategic Position of Biomass in Malaysia

Malaysia is one of the world's 17 megadiverse countries. It, therefore, has a rich source of biodiversity to tap into to support of its bioeconomy. A large amount of biomass is generated every year across a variety of crops such as palm oil, rubber and rice. Within this sector, by far the largest contributor to GNI is palm oil, contributing about 8 per cent to the national income. While the opportunity is immense, palm oil biomass is also utilised for a variety of additional higher value uses including wood products, energy pellets, bioenergy, biofuel and bio-based chemicals. By year 2020, Malaysia's palm oil industry is expected to generate about 100 million dry tonnes of biomass. This includes empty fruit bunches (EFB), mesocarpfibres (MF) and palm kernel shells (PKS) as well as oil palm fronds and trunks. Moreover, oil palm is only part of the Malaysian bioresource. Other examples are timber waste, paddy waste, coconut trunk fibre, sugarcane waste, kenaffibre.

Box 1 continued...

Box 1 continued...

Secured Major Investments in Malaysia Demonstrate a Shift Towards Higher Value Markets

Initiative	Partners
Application of biotechnology for lobster aquaculture	Darden
High value chemicals from non-food based, renewable feedstock	Verdezyne
First commercial bio-isobutanol plant in Asia	Gevo
Bio-isoprene production from crude glycerine	GlycosBio
World's first bio-methionine plant and Asia's first thiochemical platform	CJ, Arkema
Integrated biorefinery project	Genting, Elevance
Regional hub for manufacture of biopharmaceuticals and injectables	Stelis Biopharma
Biopharmaceutical manufacturing and development facility	Biocon

Source: Kamal (2015).

2. The Perfect Storm: The Convergence of Key Grand Challenges

"*Grand Challenges priority should be to address global inequalities; secondly how to rapidly decarbonise the global economy. The world needs to save the biosphere as well as the banks!*"

— Anthony Costello[1]

At this point in time, several societal grand challenges are interacting with each other to create one of the most difficult periods in human development. Because these grand challenges are truly global, one of the main problems has been achieving consensus of action across countries with different starting points and levels of economic development.

The key to the enormity of the challenge is in the word 'interacting'. Food and water security obviously interact with each other, and measures to improve the security of one may negatively affect the security of the other. Therefore, the challenges are of a planet-wide nature that interacts very much like a global ecosystem (see Box 2).

Box 2: The Grand Challenges Ecosystem

"*In an era of increasingly pervasive human influence on physical and biological components of the Earth system, what are the most effective strategies for maintaining the integrity of natural systems and the services they provide?*"(NAS 2010).

Whenever humans intervene in a system, from the level of genetics to whole community, all the way to globally, there are interactions with other components of the system, and new consequences. The 'behaviour' of these grand challenges is assuming characteristics of an ecosystem: an intervention in one location results in changes there but also elsewhere. Single human interventions are unlikely to work. There are some such interactions that are quite clear. There will be many more that are subtle and unforeseen.

Growing more crops on more land, or increasing the productivity of crops on the existing land addresses food security, but maybe only temporarily. This strategy is likely to negatively affect soil health, and will require more water, which is already stressed in many locations. It may decrease biodiversity. And people still want wild places to visit (e.g. national parks). Higher yields will require more artificial fertilisers, which mean more emissions and agriculture becoming even more dependent on the fossil industry. More agro-chemicals can lead to further pollution while production increase reaches a maximum that cannot be further increased. Bioenergy, biofuels and bio-based materials produced from biomass instead of fossil resources addresses GHG emissions reductions, central to the mitigation of climate change. But this requires more biomass, which can impinge on food security, and can interfere in many of the ways highlighted above. The interferences can partly be ameliorated by, say, using algae as a source of biomass, or using waste industrial gases as the feedstock for fermentations. Deliberately increasing the production of algae, or removing existing stocks unsustainably, inevitably affects other parts of the marine ecosystem, and may interfere with local, traditional industries and practices. It could be that the best locations for growing, harvesting and processing algae are not served by infrastructure, such as road and rail transport. The costs of developing marine biotechnology to an extent that will significantly address global challenges are very high, so a lot of attention has to be paid to consequences.

Faced with constrained finances, the policy challenges are long-term and there are no quick fixes. Ultimately the goal is interacting solutions to interacting grand challenges. This calls for multi-disciplinary research and systems innovation. There is no simplistic technological fix, and genomics

Box 2 continued...

Box 2 continued...

is merely one part of the jigsaw. But it is a very important part because genomics can offer interactions. Many of the on-going R&D activities in crop science make some of these interactions foreseeable. For example, the combination of drought/heat tolerant traits with the ability of a plant to make its own fertilisers addresses several grand challenges: water security, food security, resource depletion, climate change. Unfortunately, creating such a crop is a gargantuan task. Therefore, although genetic modification and gene editing offers the possibilities to address many of the ambitions ahead, negative interactions have to also be considered, not least of them the possible public reaction to such a strategy.

2.1 Human Population Dynamics: Asymmetry and Uncertainty

Ultimately, there is huge uncertainty about what the eventual equilibrium number of people alive will be, and when it will occur. It is expected that there will be over 9 billion people living on the planet by 2050. The implications for Asia are different than for Western countries due to demographics. For many European nations the ratio of European working people-to-elderly is changing quickly (Carone and Costello 2006): in Denmark, for example, the ratio will change from currently 4:1 to 2:1 by 2050 with serious economic consequences (IMF 2008). The ageing of populations will have large repercussions for OECD labour markets, economic growth, and public finances. The population of the more developed regions is expected to change minimally, passing from 1.24 billion in 2011 to 1.34 billion in 2100, but with the population inexorably ageing.

Meanwhile, 95 per cent of the burden of population growth will be in developing countries (UNDESA 2011). Across Asia population growth is also asymmetric. By 2021, the population of India is likely to surpass that of China and the two will account then for about 36 per cent of the world population. However, China and India have experienced a rapid fall in the average number of children per woman. These Asian giants are also ageing, and as life standards improve, this phenomenon is expected to become even stronger. By 2100, India is projected to have 130 million persons of age 80 or over, and China 107 million. Together the Indian and Chinese over sixties accounted for 34 per cent of the world population in 2011 and they are expected to constitute 38 per cent by 2050 (Chatterji *et al.* 2008; Kowal *et al.* 2012).

In East Asia several countries, like in Europe now have very low levels of fertility, well below their 'replacement rate', meaning that their populations are ageing even more rapidly and these countries face great challenges in how to care for and support these ageing populations. Projections by the Japanese government indicate that if the current trend continues, the population of Japan will decline from about 127 million in 2014 to about 97 million in 2050 (National Institute of Population and Social Security Research 2012), a phenomenon which has been termed Japan's "demographic disaster".[2]

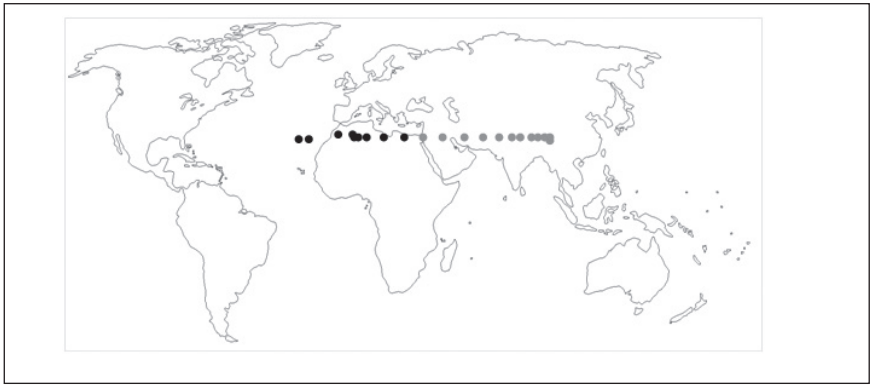
Growth of the Asian Middle Class

Of particular relevance to this paper is the predicted growth of the Asian middle class. As of 2010, Asia accounted for less than one-quarter of today's middle class.[3] By 2020, thisshare could double due to a large mass of Asian households having incomes that currently position them just below the global middle class threshold. More than half the world's middle class could be in Asia and Asian consumers could account for over 40 per cent of global middle class consumption (OECD 2010). Globally, the middle class could increase to 4.9 billion by 2030, with 85 per cent of the growth coming from Asia.

2.2 Shift in the Global Economic Centre of Gravity

The economic centre of gravity (the average location of economic activity across geographies on Earth) is moving towards Asia (Figure 1). By 2010 Asia accounted for 34 per centof global activity, but by 2034 it could account for 57 per cent of global output (OECD 2010). Not only China, India, Korea and Japan will lead this shift, but other large countries like Indonesia, Thailand, Malaysia and Vietnam will have significant economic mass. With a growing middle class and wealth comes growth and consumption, and with growth comes several environmental costs, e.g. increased greenhouse gas (GHG) emissions. A primary objective of an Asian bioeconomy should be to decouple growth from GHG emissions.

Figure 1: Shift in the Global Economic Centre of Gravity



Source: Redrawn from CNN (2011).http://globalpublicsquare.blogs.cnn.com/2011/04/07/worlds-center-of-economic-gravity-shifts-east/

Note:The global centre of economic gravity has shifted east over the past 30 years (black dots), and could well shift even farther east over the next 30 years (grey dots).

2.3 Food and Water Security versus Land Limitations

With so many more people alive by 2050, food and water security becomeincreasingly important. With over nine billion alive by 2050, food production will need to rise by 50-70 per cent (UN FAO, 2009).[4,5] More arable land, or more efficient use of existing arable land, will be needed to meet the food demands, while less may be available because of changing climate conditions. Using more land for production also impacts biodiversity.With much of the growth in population and economic output in Asia, these challenges are all the more acute. Moreover, developing countries have changed dietary patterns. In about the last 30 years meat consumption in developing countries has doubled, and egg consumption has quadrupled. The demand for more meat has significant environmental implications. Beef production is notoriously costly in resources such as water and land, and is also responsible for high GHG emissions compared to some other forms of animal protein. For every kilogram of beef produced, 4-5 kilograms of high energy feed are required, and well over 10,000 litres of water is consumed.

As many as two billion people rely directly on aquifers for drinking water, and 40 per cent of the food in the world is produced by irrigated agriculture that relies largely on groundwater. Globally, 70 per cent of all freshwater use is for agriculture (Sophocleous 2004). Vast territories

of Asia rely on groundwater for 50-100 per cent of the total drinking water (UNEP 2003)and groundwater depletion is accelerating worldwide. Some of the highest rates of depletion are in some of the world's major agricultural centres, including North West India, NorthEast China, and NorthEast Pakistan (Wada *et al.* 2010). Also climate change is projected to decrease freshwater availability in Central, South, East and South East Asia, particularly in large river basins. With population growth and increasing demand from higher standards of living, this decrease could adversely affect more than a billion people by the 2050s. Asia has 28 per cent of the world's freshwater resources (UN FAO 2003) but is using 50 per cent of the world's water (Gore 2013).

2.4 Energy Security and Resource Depletion

Most countries are plagued by energy insecurity as a result of the geography and geopolitics of fossil fuel production. Many of the larger economies within the OECD import most of their oil and gas, much of it from countries and regions that are regarded as unstable. A greater proportion of crude oil in future will be from unconventional sources such as tar sands and the deep subsea. These sources are much more expensive and dangerous to exploit. The current price fluctuations do not change the fundamentals and higher prices are most likely to return in the future. Low prices inhibit investment in alternative energies, but also in conventional exploration. There is also a looming danger that prices rebound way beyond what is desired after a slump, causing large detrimental effects on the global economy.

Some Asian countries typify the energy security dilemma. Thailand is highly dependent on crude oil imports, accounting for more than 10 per cent of GDP (Siriwardhana *et al.* 2009). Energy security and rural and economic development led to Malaysian R&D on biodiesel derived from palm oil as early as 1982. Korea has similar needs, as the country imports 97 per cent of its energy, which still comes from fossil fuel reserves. Korea aims to replace 30 per centof fossil fuel with biofuel to become more energy independent. To achieve this Korea has an important programme to develop biofuel from algae. Likewise, China also has a huge demand for crude oil that cannot be met through domestic production, but faces limitations in sacrificing food security for energy. Recently, India has turned to bio-based energy to reduce dependence on imported oils. India has to import approaching 80 per

cent of its crude oil requirements (Ministry of Petroleum and Natural Gas, Government of India 2009). India leads the way in planting and cultivating the non-food Jatropha plant on an industrial scale for biodiesel production (Wonglimpiyarat 2010).

No country illustrates the situation better than Japan, the world's third largest economy which is just 16 per cent energy self-sufficient.[6] Japan is the world's largest importer of liquefied natural gas (LNG), the second largest importer of coal and the third largest net importer of oil. Japan relied on oil imports to meet about 42 per cent of its energy needs in 2010 and to feed its vast oil refining capacity (some 4.7 million barrels per day at 30 facilities as of 2011), and relies on LNG imports for virtually all of its natural gas demand. Japan consumed an estimated 4.5 million barrels per day of oil in 2011, whilst it produced only about only 5,000 barrels per day (OECD 2014). Since the oil crises of the 1970s, the Japanese government has embarked on national projects in developing alternative energy resources, including raising productivity of bioethanol production.

Beyond fuels and bioenergy, however, bio-based materials offer unique economic and environmental opportunities. Bio-based chemicals usually have higher value-added and create more jobs than either biofuels or bioenergy. As climate change legislation becomes more stringent, the pressure to find new forms of manufacturing, without sacrificing lifestyle, will increase. Bioplastics illustrate the situation very well. Plastics are the most successful materials of all time, but they have come to create environmental problems, such as a landfill dilemma and large quantities of GHG emissions associated with their manufacturing. Plastics are, and bioplastics promise to be, extremely important in Asian economies (see Box 3). Bioplastics, using biomass instead of crude oil as the feedstock, represents a huge economic as well as climate change mitigation opportunity. By using biomass, there could be significant gains in energy security also: around 7-8 per cent of the oil barrel is used in current production of plastics (as feedstock and energy source). By 2050 plastics consumption could quadruple, putting enormous strain on crude oil utilisation and the need to discover more new oilfields.

Box 3: Bioplastics and Asia

Thailand is an interesting test case for bio-based production. Thailand has more than 4,000 companies in the petro-plastics industry, and is also very rich in biomass (Ministry of Science and Technology of Thailand 2008). Since 2006, the Thai Government has declared the bioplastics industry to be one of the strategic industries that the government is promoting in its drive towards sustainable growth and development. This resulted in 2008 in a *National Roadmap for the Development of Bioplastics Industry*, developed by the National Innovation Agency (Ministry of Science and Technology of Thailand, 2008). This action plan for 2008-2012 was focused on four main strategic areas:

- Sufficient supply of biomass feedstock;
- Accelerating technology development and technology co-operation;
- Building industry and innovative businesses; and
- The establishment of supportive infrastructure.

Several Asian countries (e.g. Malaysia, Japan, Korea, Singapore and China), offer attractive tax reductions to companies that want to research and invest in the bioplastics sector (OECD 2013c). Both Japan and Korea have well-developed policy frameworks for the development of bioplastics industries.

The mitigation of resource depletion objective of developing a bioplastics industry is exemplified by Japanese policy. Following the ratification by the Japanese Government of the Kyoto Protocol in June 2002, the Government announced (December 2002) two measures: the *Biotechnology Strategic Scheme* and the *Biomass Nippon Strategy*. The main objective of the two measures was to promote the utilisation of biomass and to reduce the consumption of fossil resources and to mitigate global warming through the use of biotechnology. The policy objective stated in the *Biotechnology Strategic Scheme* is to replace approximately 20 per cent (2.5 to 3 million tonnes per year) of conventional plastics with plastics from renewable resources by 2020. This stimulated some major Japanese corporations into sourcing bioplastics for their products, e.g. Toyota.

Similarly, in 2012 the Korean government announced a *Strategy for Promotion of Industrial Biotechnology*, with the goal of establishing a mid- to long-term strategy to develop related technology and devise detailed measures for implementation, contributing to lowering the existing dependence of the economy on crude oil. By 2020, this effort is expected to result in replacing 4.8 per cent of crude oil imports with biochemical product manufacturing, reducing CO_2 emissions by approximately 10.8 per cent, and generating at least 43,000 new jobs.

2.5 Climate Change and Global Warming

UNEP (2010) calculated that a doubling of wealth leads to an 80 per cent increase in emissions. An objective of building a bioeconomy is to break this vicious cycle so that economic growth can be achieved without increasing the threats of climate change induced by greenhouse gas emissions.

To date 167 countries have signed up to the Copenhagen Accord[7], in trying to limit the temperature rise, compared to pre-industrial levels, to 2ºC by limiting greenhouse gas emissions from fossil resources. And yet, taking into account the impact of measures already announced by governments to improve energy efficiency, support renewables, reduce fossil fuel subsidies and, in some cases, to put a price on carbon, the world seems on a trajectory consistent with a long-term average temperature increase of 3.6°C (IEA 2013).

Theimplication of limiting the greenhouse gas effect is that most of the known and projected fossil fuel reserves may be unburnable(Meinshausen*et al.* 2009; Carbon Tracker 2013). This has recently been quantified: a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2°C (McGlade and Ekins 2015). Moreover, achieving a 2°C scenario means only a small amount of fossil fuels can be burned unabated after 2050. In the view of Friedlingstein *et al.* (2014), two thirds of the CO_2 emission quota consistent with a 2°C temperature limit has already been used, and the total quota will likely be exhausted in a further 30 years at the 2014 emissions rates. By century end, the IPCC (2014) has warned that GHG emissions need to be close to zero to achieve the 2°C obligation.

Many of the worst effects of climate change are expected to affect developing nations. This includes a large number of Asian countries. Bangladesh, for example, is a 'frontline state' of climate change[8], predicted to be one of the first and the hardest hit countries to face the adverse impacts of warmer global temperatures, e.g. glacier melt, increased flooding from the sea, very often accompanied by outbreaks of infectious diseases.

A cruel irony of climate change is that many of the countries that desperately need to develop their economies will in future have to do so without fossil fuels. A second irony is that climate change has been

caused by the nations that have developed through exploitation of fossil fuels. Therefore, there is a clear need for international cooperation in the development of a global bioeconomy – many of the developed nations lack biomass, and many developing nations can provide biomass. But these latter nations will benefit much more from developing a bioeconomy in which they combine biomass exports with a home-grown, knowledge-based and biotechnology-driven bioeconomy.

Drought, Temperature and Crop Yields

Agricultural productivity is ultimately defined by crop yield. Elevated temperatures have long been known to affect plant growth. Schlenker and Roberts (2009) demonstrated for three major US crops that an increase in temperature above the optimum for each resulted in a very rapid decline in yield. Their modelling suggested that average yields could be predicted to decrease by 30–46 per cent before the end of the century under the slowest warming scenario and decrease by 63–82 per cent under the most rapid warming scenario. The US Environmental Protection Agency (EPA) has predicted that by mid-21st century, crop yields could increase up to 20 per cent in East and South East Asia. In the same period, yields could decrease up to 30 per cent in Central and South Asia.[9]

The US has just experienced its most widespread drought in more than half a century (Reardon and Hodson, 2013), and the drought in 2014 in California was perhaps the worst ever recorded (*National Post*, 2014). In 2015, for the first time in decades, officials in California have forced thousands of farmers to reduce water use.[10]In Brazil, the three most populous states are currently experiencing their worst droughts since 1930.[11] As agriculture accounts for around 70 per cent of all fresh water use, measures that conserve water are of the utmost social and economic importance.

High temperatures in many cases can be expected to be accompanied by drought conditions. Evidence suggests that heat and drought stress can cause disproportionate damage to important crops compared with either stress individually (Atkinson and Urwin 2012). Therefore, improvement of dual stress tolerance to heat and drought in crop plants has become a top priority for the development of agricultural biotechnology for both food and bioenergy markets.

2.6 Soil Destruction

Often overlooked in policy making, soil is the ultimate genetic resource; soils are the critical life-support surface on which all terrestrial biodiversity depends. More than 95 per cent of all food is derived from cropland (Gore 2013). But soil is being destroyed at unprecedented rates due to soil erosion (e.g. through deforestation), pollution, desertification and salination. About 2.5 per cent of arable land in China is too contaminated for agricultural use (Chen and Ye 2014). In terms of the number of people affected by desertification and drought, Asia is the most severely affected continent[12], with the largest area under eroded drylands condition (Ma and Ju 2007).

It takes around 500 years to form 25 mm of soil under agricultural conditions, and about 1,000 years to form the same amount in forest habitats.[13] Therefore, soil should be treated as a non-renewable resource. In the bioeconomy and sustainability context, soil accounts for some 20 per cent of the capture of human CO_2 emissions (European Commission 2007). The message is clear – our society is utterly dependent on maintaining the global stock of healthy soil. Any plans for a future bioeconomy dare not ignore this. An increasing rate of soil degradation must be reversed. In the face of soil destruction, more crops will have to be grown more efficiently, while methods should also be explored to halt or limit soil destruction.

3. What Can Biotechnology and Genomics Offer?

The potential of the modern genomics technologies, when allied to more traditional genetic engineering, is so great that most of the applications are as yet not thought of. For a continent as vast as Asia, it is beyond the scope of this paper to cover the potential in detail.

3.1 Selection or Genetic Modification?

Although very powerful, it should be stressed that genomics does not necessarily involve genetic modification (GM) or synthetic biology, and the negative societal issues that have haunted GM in many applications can be avoided. Rather, -omics technologies can be applied to animal and plant breeding to greatly improve the efficiency of selection of traits. In the case of trees, this is especially important given the long timescales needed for tree growth and trait expression.

To use the full potential of genomics there is a need to link genomics information to phenotypic characteristics. The availability of well-defined linkage maps and the extent of genetic studies conducted on them vary among different crops, and this influences the feasibility of any Marker Assisted Selection (MAS)[14]-related activity. MAS allows to reduce the breeding cycle time significantly (e.g. for cassava from five to two years) and is much more accurate (Ly *et al.* 2013).

The yield increase of the so-called green revolution in modern agricultureafter the Second World War is flattening out. In addition, current agricultural practices with higher inputs, such as pesticides and fertilisers to ensure high yields, are not considered environmentally sustainable. For further yield improvement of commonly used crops or for so-called orphan crops, the use of advanced breeding methods, using MAS and increasing germplasm will be essential. Today many orphan crops have not yet been pushed to their limits and will still benefit from traditional and advance breeding.

3.2 Crop Genomics

There are many applications of genomics and genetic engineering/synthetic biology to increase crop production that will be utilised in the future bioeconomy, e.g. pest resistance, more "efficient" plants that use less water, resistance to environmental stresses, the development of crops that can fix nitrogen to replace synthetic fertilisers or change C3 plants into C4 plants.[15] Heat and drought stress are used as examples of the potential of the application of genomics to agriculture. On the other hand, too much water can also lead to crop destruction.

Dual Heat and Drought Tolerance

Genomics can be used in conjunction with either modern techniques of plant breeding or genetic engineering to improve the accuracy and efficiency of selection. For example, the most obvious dilemma for agriculture posed by climate change is the dual stress of heat and drought. A subset of target genes that constitute a novel transcriptional regulatory cascade that controls plant responses to the combined stress has been identified (Huang 2013). In laboratory conditions, *Arabidopsis* and canola plants with mis-sense expression of these regulatory genes were able to tolerate independent higher

temperature or drought treatment. More importantly, these plants produced higher seed yield comparing to their controls when both stresses were applied simultaneously. The dual stress tolerance and yield enhancement properties of the transgenic plants were further confirmed by large-scale, multiple season and location field trials. These results represent a significant breakthrough in crop improvement and technologies derived from this research could enable farmers around the world to maintain higher yield and productivity over variable and adverse environmental conditions.

Genetic Engineering and Synthetic Biology, Food Security and New Crops

More controversial than genomics in selection, genetic engineering and synthetic biology could transform future agriculture under conditions of grand challenges. There are many publications regarding risk associated with genetic modification, most of them indicating low risk (e.g. European Commission 2010). As the challenge in a future with many more mouths to feed, while climate effects may negatively interact with crop growth and yield, genetic modification may be the most sustainable approach. Here lies the potential to adapt crops to warmer and drier climates and to increase the net yield of harvests on less land, with less input of water and agrochemicals, so that the impact on biodiversity should be as low as possible.

Again it is not within the scope of this paper to be comprehensive. Given the need for more crops and higher yields with improved nutritional qualities, there are other serious problems that may be posed by grand challenges, e.g. new and migrating plant pathogens (such as the fungal banana diseases), multiple stresses (such as drought and heat already discussed), flooding, increased salination of soil. Further, new stresses are likely to arise more frequently, driving a need for faster approaches to crop development and adaptation. This is how a future synthetic biology could be very beneficial, if its 'design and engineering' expectations come to fruition. This would remove much of the trial-and-error from crop design, allowing targeted modifications in more rapid time frames.

Crops that make their own fertiliser

Several efforts are on-going in this tantalising research area. A collaborative project with UK and US scientists aims to design and build a synthetic

biological module that could work inside a cell to perform the function of fixing nitrogen.[16] The cyanobacteria are able to fix nitrogen using solar energy via specialised cellular machinery. This project aims to re-engineer this machinery so that it can be transferred into a new host bacterial chassis as a first step towards transferring the machinery, and thus the ability to fix nitrogen, into plants themselves.

If successful, the significance of crops of the future that make use of atmospheric nitrogen rather than using synthetic fertilisers needs to be appreciated. The reliance of artificial nitrogen fertilisers for food crop production and their damaging environmental effects are often underestimated. For example, the Haber-Bosch process for the production of ammonia, which is used to produce agricultural fertilisers consumes 3 to 5 per cent of the world's natural gas production and releases large quantities of CO_2inthe atmosphere (Licht *et al.* 2014). Therefore, it may be possible to decouple agriculture from the fossil fuels industry.[17] Other effects of intensive fertiliser use, such as the concerns about nitrates in water and vegetables, and eutrophication of water bodies, have been recognised for decades (e.g. UN FAO 1972). Nevertheless, such a strategy is likely to meet with resistance from the public if the necessary safety research has not been conducted, and communicated, to minimise other environmental effects.

3.3 Sustainable Forestry

Major global economic models tentatively suggest that ambitious climate change mitigation need not drive up global food prices much if the extra land required for bioenergy production is accessible or if the feedstock, such as wood, does not directly compete for agricultural land (Lotze-Campen *et al.* 2014). What is not clear, however, is what will be the long-term effect on wood prices. Increasing demand for wood pellets is likely to drive up the price of biomass significantly in a market constrained by supply, not demand (Deloitte 2012). There is a danger in this that the demand for pellets overcomes the sustainable production of wood, and this could affect Asian countries directly through deforestation and its attendant problems, e.g. soil erosion.

A new approach to forest development and exploitation, particularly regarding the sustainability of new forestry, is also critical to second

generation biofuels development (OECD 2013a). As well as the woody energy crops, some fast-growing tree species have also shown promise for biofuels production. Important attributes include the relatively high yield potential, wide geographical distribution, and relatively low levels of input needed when compared with annual crops (Smeets *et al.* 2007).

However, the lignin, a major component of plant secondary cell walls in woody plants, makes the sugar molecules that build the cellulose microfibrils less accessible to enzymatic depolymerisation and fermentation and thus limits the conversion of biomass to bioethanol. Down-regulation of one of the central genes in the lignin biosynthetic pathway in poplar trees produces wood that contains about 20 per cent less lignin and more cellulose per gram of wood. Lab and greenhouse experiment indicated that at least 50 per cent more bioethanol can be produced by this low-lignin wood. Results from field trials largely confirm these experiments although when the lignin level is too low there is a significant reduction of yield of wood (Van Acker *et al.* 2014).

The forest products sector is looking for new opportunities to produce value-added products while securing access to emerging carbon capture markets (Sheppard *et al.* 2011) and the example of lowering lignin content in wood may open new opportunities, especially as the approach although classified under GM is not using transgenic expression of poplar foreign genes.

Extending the limits of conventional breeding, which is a very slow and inefficient process in tree development, to give faster and more accurate trait improvement for application in plantation forests (including faster growth, improved pest and disease control) has the potential to allow easier and cheaper development of bioenergy and second generation biofuels.

3.4 Metabolic Engineering and Industrial Production

In a resource-constrained future world, bioenergy, biofuels and bio-based chemicals and plastics will use biomass as the feedstock, thus competing directly for land with food and feed. A clear interaction of energy security, food security and climate change is visible here.

Metabolic engineering of (primarily) microbial strains is increasingly being used to make both natural and synthetic organic chemicals. In

mass production of the scale of bulk chemicals and transportation fuel, biotechnology processes have been notoriously inefficient, and unable to compete with the petrochemicals industry. The biocatalyst usually lacks the industrial robustness that is required to synthesise products at high yield under industrial conditions (Olson *et al.* 2012). Part of the vision for synthetic biology in the bio-based industries is to improve on these inefficiencies. Another part of that vision is to improve on greenhouse gas (GHG) emissions savings in bio-based production, which are already viewed as significant in comparison to the equivalent petrochemically manufactured products (e.g. Weiss *et al.* 2012).

The bio-based industries are placed in a position of competition for biomass and land in the production of food. Another frontier for synthetic biology in the future bioeconomy, then, will be applications that alleviate the strain on sustainable biomass production in the face of an increasing global population, when the primary focus must be on food (Pavanan *et al.* 2013). For example, fermentation of waste industrial gases takes pressure from land as the source of carbon for bio-based chemicals production (e.g. Bomgardner 2012).

Replacing the Oil Barrel

The arguments discussed regarding climate change and the need to leave large amounts of oil, gas and coal unburned has been a significant spur for R&D on liquid biofuels and bio-based chemicals and plastics. To be consistent with renewability, sustainable development and a future low-carbon society, a reality check relates to how much change in lifestyle society will tolerate. The Milken Institute (2013) estimated that 96 per cent of all manufactured goods in the US contain at least one chemical, and businesses dependent on the chemical industry account for nearly US$3.6 trillion in US GDP. The only feasible source of carbon to continue making chemicals is renewable, bio-based carbon.

To make the plethora of chemicals synthesised in the petrochemicals industry directly from metabolically engineered microbes is unrealistic. What is more realistic is to make bio-based intermediates, and use these as the basis for further production through (green) chemistry. It is estimated that over 30 different intermediate chemicals could be manufactured sustainably

and economically from inexpensive sugar in the future (Burk 2010). Now it has been shown that entirely unnatural chemicals can be synthesised in metabolically engineered microbes (Yim *et al.* 2011). In the past few years much progress has been made in bio-based production of chemicals, and the idea of (eventually) replacing the oil barrel seems much less fanciful now than previously (Jiménez-Sánchez and Philp 2015).

4. Rice, the Iconic Crop of Asia

Rice is the major staple food for almost half of the world's population. Perhaps more than any other, rice is a defining crop of Asia. It has naturally been the model cereal for genetic, breeding and agronomic research. This is a fortuitous choice: rice has a small genome, it is easily transformed and there are similarities of its gene order and gene sequence with other cereals (Upadhyaya and Dennis 2010).

Conventional breeding over the last three decades has resulted in a doubling of rice production. However, breeders are in need of new tools and resources with which they can address the major production constraints such as pests, pathogens, submergence, salinity and drought in order to provide the required increase in the rate of production. Rice genomics has the potential to provide such tools and resources in the form of molecular markers for genes and gene control sequences determining the desired traits or as genes and gene control sequences *per se* for use in transformation breeding.

Regarding climate change and other abiotic threats to crop production, a major challenge is identifying genes involved in complex traits of agronomic significance. It is likely that there will be many genes with some effect in abiotic stress, and pinpointing critical genes will require inputs from all aspects of genetics and genomics. These characteristics will be of critical importance in altered environments caused by changing climate.

4.1 Rice and Submergence Tolerance

Rice is a crop well adapted to wet, monsoon climates and allows farmers to produce food in flooded landscapes. Of the lowland rain-fed rice farms worldwide, over 22 million hectares are vulnerable to flash flooding, representing 18 per cent of the global supply of rice. In total, some 30-40

million hectares get submerged, and this happens roughly every three years. Most rice varieties can tolerate only a few days of submergence and die after about a week.

Success in fine mapping of SUBMERGENCE 1 (SUB1), a robust quantitative trait locus (QTL) on chromosome 9 from the submergence tolerant FR13A landrace, has enabled marker-assisted breeding of high-yielding rice capable of enduring transient complete submergence (Bailey-Serres *et al.* 2010). It provides protection from complete submergence for 3-18 days. SUB1 belongs to the Ethylene Responsive Family (ERF) transcription factors (Xu *et al.* 2006). It functions by slowing down growth, preserving chlorophyll and conserving energy reserves.

With traditional lowland rice, when flooded the plant reacts by spurring growth to get above the water, continues to grow when the flooding continues, and finally runs out of nutrients and dies. Variety SUB1A does not grow while flooded and starts growing again after the flooding has subsided. In this case a single mutation is involved in tolerance.

SUB1 has been introduced into several mega-varieties of rice through marker assisted selection (MAS) and backcrossing[18] (MABC). Under submergence for 7-14 days these tolerant cultivars have an average yield advantage of 1.5 tonnes per hectare over intolerant cultivars, with no reduction in yield under non-submerged conditions. SUB1 is gradually being introduced to all varieties developed for lowland ecosystems by the International Rice Research Institute (IRRI)[19], and several national programmes are also introducing the gene into locally-adapted varieties. To date, over 4 million farmers have been reached with seeds of SUB1 varieties with the cooperation of the private sector.

Social Impacts

About 90 per cent of the world's rice is produced and consumed in Asia. Over 70 per cent of the world's poor are in Asia. In Asian countries with subsistence rice farming, when submergence occurs and the rice crop fails, the first most obvious effect is that the farmers' income decreases. Almost the first knock-on effect is that the farmers attempt to save money by taking their children out of school. They may be forced to sell land. Continuing poverty leads to people migrating off the land to find jobs in cities. So the cycle of poverty in the countryside continues.

One of the difficult issues encountered is to convince farmers to switch from their traditional varieties to the submergence resistant rice varieties. The strategy taken by IRRI was to convince single farmers to use the resistant varieties on one field, and when flooding happened the result of this is so convincing that most farmers around were convinced to switch. There is evidence that the introduction of submergence tolerant rice strains is now decreasing these negative social effects, and efforts are underway in the IRRI to try to quantify these effects.

4.2 Golden Rice

The story of Golden Rice is interesting beyond the science. It speaks to the geographical divisions on attitudes to GM technologies, and on their regulation. The story is concisely summarised by Potrykus (2013). Vitamin A deficiency is a serious health problem in rice-dependent populations, which are often poor. Genetic engineering provided a solution to produce beta-carotene in the endosperm of rice. Beta-carotene is then converted to vitamin A in the intestine. Only 40 grams of GM Golden Rice a day (modified for the production of vitamin A) are sufficient to prevent the severe health consequences of vitamin A deficiency. However, the deployment of this technology was delayed for 12 years by regulation. More recently, however, it seems that Golden Rice is gaining better acceptance.[20]

5. Banana: a Critical Food Security Crop with many Threats

> "*The* Musa *genome sequence is therefore an important advance towards securing food supplies from new generations of* Musa *crops*…" D'Hont *et al.* (2012).

5.1 Banana and Food Security

Banana as a crop for food security is often overlooked and yet it is the fourth most important food crop in the world. It is a staple in many diets. A large number of people in East Africa consume 1 kg or more per person per day. India and Uganda are the largest producers, but none are exported: the whole crop is required for food security. More than 70 million people in West and Central Africa are estimated to derive more than one-quarter of their food energy requirements from plantains. Banana is the most popular fruit in industrialised nations (Lescot 2011). But this is all from one variety

– Cavendish – and in global terms it is relatively minor. In 2012, the volume of global gross banana exports reached a record high of 16.5 million tonnes, but this represents only 15–20 per cent of total banana production.

Banana is perhaps the most important orphan crop of all. Because of the fact that banana reproduces mostly vegetatively, breeding and increasing the gene pool within a species is complicated.Crop species like this may benefit more readily from genetic modification arising from direct introduction of genes isolated from other species or organisms. The Musa Germplasm Information System (MGIS)[21,22] contains key information on *Musa*germplasm diversity, including: passport data; botanical classification;morpho-taxonomic descriptors; molecular studies; plant photographs, and; GIS information on 2281 accessions managed in 6 collections around the world. This is the most extensive source of information on banana genetic resources globally. However, information on the wild ancestors of the current banana varieties in Asia is still unknown. Having access to the full germplasm is important to address the pathogen attacks that many banana cultures are facing. This complete germplasm is likely to lead to new pathogen resistance genes.

5.2 Banana is Threatened by Many Pathogens

Various pathogens and pests threaten banana crops and its attendant food security (De Lapeyre de Bellaire *et al.* 2010; Dita *et al.* 2010). The race against pathogen evolution is particularly critical in clonally propagated crops such as banana. For example, *Fusarium* wilt, known as Panama disease, is a lethal infection caused by the fungus *Fusariumoxysporium*. Once infected,the plant is effectively doomed. *Fusarium* destroyed the Gros-Michel banana plantations in Central America in 1950s.

A new strain, Tropical Race 4 (TR 4), identified first in Malaysia, has spread to other South East Asian countries. It is now also in the Middle East and southern Africa. In Queensland, Australia, it threatens to make the AUD 600 million banana industry extinct.Tropical Race 4 attacks not only the Cavendish cultivar, but also many other cultivars grown widely in subsistence farming systems in Africa. What is worse, *Fusarium* spores can persist in soil for many years, so eradication of TR4 will require an approach similar to Ebola outbreaks – tracing all possible infection paths and quarantine.

Pest control is also expensive. Up to 50 pesticide treatments a year are required in large plantations against black leaf streak disease (also known as Black Sigatoka), a recent pandemic caused by *Mycosphaerellafijiensis*. The situation is not helped by monoculture: every Cavendish is genetically identical, and all have the same susceptibility to disease. Other major threats for banana include banana bunchy top virus (BBTV), burrowing nematode and banana weevil. More recently, banana *Xanthomonas* wilt (BXW) has emerged as an important bacterial disease that apparently originated in Ethiopia and caused a major disease epidemic in much of East Africa in the last decade. Breeding for resistance to these diseases and pests is one of the major goals in Africa and Asia.

The potential of natural resistance is very well illustrated in the banana variety Yangambi km5 (Hölscher *et al.* 2013). This variety is resistant to the nematode *Radopholus similis*, a roundworm that infects the root tissue of banana plants. This roundworm infects banana crops worldwide. The nematodes are invisible to the naked eye, but they can penetrate the roots of banana plants by the thousands. Once infected, these plants absorb less water and nutrients, resulting in yield losses of up to 75 per cent. Lesions in the roots also make the plant more susceptible to other diseases. Eventually, the roots begin to rot. In the final stage of the disease, the plant topples over, its fruit bunch inexorably lost. Analysis of Yangambi km5 indicated this variety produced nine metabolites that are toxic for nematodes. The popular Grande Naine is very susceptible to the nematode infection although it also produces these metabolites, be it much more slowly and in lesser quantities. These findings open new perspectives to use in plant protection.

5.3 The Banana Genome and Breeding

Very few new varieties have been obtained by crossing (e.g. FHIA-01 Goldfinger, FHIA-03 Sweetheart). A few new varieties have been obtained by mutational breeding (e.g. GCTCV-218 Formosana). But acceptance of the new varieties has been low because of different taste, ripening, cooking qualities. Among the difficulties are:

- Banana is seedless and most clones are also pollen sterile;
- It is very difficult to obtain seed from cultivars;
- It is very difficult to germinate viable seedlings;

- They are relatively large plants with long cycles;
- Inadequate germplasm collection, and vitally; and
- The understanding of the genetic mechanism of parthenocarpy[23] and unreduced gametogenesis is completely lacking.

The reference *Musa* genome sequence is considered a major advance in the quest to unravel its complex genetics. Having access to the entire *Musa* gene repertoire is a key to identifying genes responsible for important agronomic characters, such as fruit quality and pest resistance (D'Hont *et al.* 2012). In South East Asia, at its origin, wild *Musa* still remains, although the global gene pool information is still missing. Access to wild varieties could lead to identification of resistance markers that can be used against pest attacks through breeding or breed more nutritious hybrids.

6. Oil Palm: An Asian Crop at the Nexus of Bioeconomy Issues

Oil palm illustrates a classic bioeconomy dilemma. It is the most productive oil-bearing crop, accounting for one-third of all vegetable oil and 45 per cent of edible oil worldwide. Although it is planted on only 5 per cent of the total world vegetable oil acreage, increased cultivation competes with dwindling rainforest reserves. Global production of palm oil more than doubled between 2000 and 2012 (FAO 2013). Thus, the competing imperatives of a bioeconomy are clear to see: creating economic growth while reining in detrimental environmental effects to create a future economy that is sustainable.

Palm oil production is central to the economy of Malaysia, employing close to half a million people. Historical statistics indicate that Malaysian palm oil yields have typically appreciated over time, until 2009, when an unexpected break in the long-term national growth pattern occurred which has persisted to the present day. Explanations for the abrupt change are varied, which include a combination of adverse weather, ageing trees and plant disease (USDA Foreign Agriculture Service, 2012).

Data indicates that the vast majority of trees have already reached or passed through their peak yielding years. A small but growing problem is a lethal fungal disease. *Ganoderma* has the capacity to cause significant yield losses well before it has actually killed an oil palm, while its spores can

spread to ever increasing areas of a plantation once it has been introduced. Therefore, very obvious targets for genomics applications would be increasing oil yield and disease resistance. With growing needs for edible and biofuel uses, increasing yield would reduce the rainforest footprint of oil palm.

6.1 The Oil Palm Genome and Oil Yield

The oil palm genome sequence was published by Singh *et al.* (2013a). The sequence enables the discovery of genes for important traits as well as alterations that restrict the use of clones in commercial plantings. The oil palm is largely undomesticated and is an ideal candidate for genomic-based tools to harness the potential of this remarkably productive crop. The authors claim that the dense representation of sequenced scaffolds on the genetic map will facilitate identification of genes responsible for important yield and quality traits.

The modern oil palm tree *Elaeis guineensis* has three fruit forms: *dura* (thick-shelled); *pisifera* (shell-less); and *tenera* (thin-shelled). The *tenera* palm yields far more oil than *dura*, and is the basis for commercial palm oil production in all of South East Asia. In 2013 a remarkable discovery was made. The *Shell* gene has proven extremely challenging to identify in oil palm, given the large genome, long generation times and difficulty of phenotyping in experimental populations. Singh *et al.* (2013b) identified the gene and determined its central role in controlling oil yield. Regulation of the *Shell* gene will enable breeders to boost palm oil yields by nearly one-third, excellent news for the industry, the rainforest and its champions worldwide, and bioeconomy policymakers.

Seed producers can now use the genetic marker for the *Shell* gene to distinguish the three fruit forms in the nursery long before they are field-planted. Currently, it can take six years to identify whether an oil palm plantlet is a high-yielding palm. Even with selective breeding, 10 to 15 per cent of plants are the low-yielding *dura* form due to uncontrollable wind and insect pollination, particularly in plantations without stringent quality control measures (Cold Spring Harbor Laboratory News 2013).

Accurate genotyping such as this has a critical implication for a bioeconomy. Enhanced oil yields will optimise and ultimately reduce

the acreage devoted to oil palm plantations, providing an opportunity for conservation and restoration of dwindling rainforest reserves (Danielsen*et al.* 2009).

7. Forestry and Genomics

Despite many publications regarding the use of waste materials in a bioeconomy, wood is currently the most widely used resource as a feedstock, and this is likely to continue. It is used in energy, biofuels and bio-based materials applications. Long experience of the exploitation of timber has shown the dangers of over-exploitation. That is why sustainable forestry is critical to future bioeconomy plans.

Malaysia, like other South East Asian nations, has an economy highly dependent on wood. Figures vary, but one estimate is that 62.3 per centof Malaysia is forested. Of this 18.7 per cent is classified as primary forest, the most biodiverse and carbon-dense form of forest. However, between 1990 and 2010, Malaysia lost about 8.6 per cent of its forest cover. Forests are very diverse in Malaysia, covering the ecosystem spectrum from mountain forests to mangroves. About 4.2 million cubic metres of timber are harvested annually from the forest in Peninsular Malaysia. The timbers consist of about 900 different species. As with all tropical rainforest systems, the main threats are global warming, loss of biodiversity and deforestation.

As in most countries, Malaysian forest genomics research and development is at an immature stage. Much other genetic knowledge is required to unleash the potential of genomics. However, future work is likely to fall into one of two (inter-related) categories: conservation of forest genetic resources, and; sustainable utilisation of forest genetic resources.

The Forestry Research Institute Malaysia (FRIM)[24]is a leading institution in tropical forestry research. Regarding genomics, the early development of this area is divided into five topics:

1. Microsatellite marker;
2. Genetic diversity of timber species;
3. Optimum population size for conservation;
4. Effects of logging on plant species; and
5. Full genome sequence of *Shorealeprosula*, a very important timber species.

Many of the Malaysian timber types are of high value, and the business is susceptible to both fraud and over-exploitation of rare species. Timber tracking is, therefore, very important on the international stage, and DNA barcoding is rising in importance. DNA barcodes are also important in the authentication of the many Malaysian medicinal plants.

Another large country with a relatively large dependence on forestry in its economy is Canada. In Canada the area of forest affected by natural disturbances such as insect infestations, e.g. the mountain pine beetle, and wildfire is much larger than the total area of logging. These sources of biomass represent the largest potential for further development of the bioenergy industry in Canada by far. A strategic market is the EU, where biomass imports are predicted to triple between 2010 and 2020 (Lamers *et al.* 2014), with biomass demand to further increase up to 2030, mostly for bioenergy utilisation.

Recognised as a sector of economic importance in British Columbia, the forest sector has benefitted from significant investment from Genome Canada and Genome BC. Large sums have been invested in capacity-building discovery research along with a number of more applied research projects such as the:

- Development of genomic tools to identify forest fungi and understand forest ecosystems;
- Genomic resources for beetle-fungal-tree host interactions;
- Exploration of genome organisation and structure of spruce and pine trees;
- Understanding the genomic diversity of forests;
- Identification of genes activated during fungal infection;
- Developing tools to forecast mountain pine beetle outbreaks; and
- Testing of genomic markers for utility in management of climate change.

It is clear that these two countries, with very different forest resources, share similarities in their expectations from genomics research and the impact on forestry and the concomitant economic development.

8. Industrial Uses of Biomass with Reference to an Asian Bioeconomy

There is a large existing body of literature on the increasing number of crops and waste materials that can be used in bio-based production of fuels, electricity, plastics, chemicals and textiles. Indeed many of the crops being considered in OECD nations as non-food 'energy crops' have Asian or tropical origins. For example, the plant *Jatropha* is widely grown in tropical and sub-tropical regions for the oil.

Jatropha incentives in India are a part of the national goal to achieve energy independence (Biswas *et al.* 2014) and it is also grown in Africa as a promising alternative for biodiesel production.[25] For a long time, however, optimisation of production has long been neglected, while yields can be significantly improved in agronomy studies.[26] In addition, the right variety for the right environment needs to be selected. Breeding to develop cultivars that have high yield and result in a stacking of desirable traits are essential. Results from field trials in India demonstrated that yield can be significantly increased.

Arundo donax, the giant cane, is native to Eastern and Southern Asia, and is another promising crop for energy production (Lemons e Silva *et al.* 2015) in the Mediterranean climate of Europe and Africa that could benefit from selection breeding.

However, a detailed discussion is beyond the scope of this paper. Here, the discussion is limited to rice and banana and their potential for non-food uses. What is quite clear is that both of these crops are absolutely essential in food security for many people, especially in Asia and Africa. And in bioeconomy strategies food security is the top priority. However, in keeping with the ethos of the circular economy[27], it is paramount for society to start using waste materials as resources.In this regard, both rice and banana can also produce materials other than the edible components that can be used in a bioeconomy for industrial production.

Whereas all of the banana plant is in current use, and therefore, using it as biomass for industrial production may be seen as a competing use, a component of rice, the straw, currently represents a difficult waste disposal problem. More widely, it is important to realise that more than half of all absolutely dry matter in the global harvest is in cereal and legume straws;

in tops, stalks, leaves, and shoots of tuber, oil, sugar, and vegetable crops; and in pruning and litter of fruit and nut trees (Smil 1999). On the global scale, the non-edible part of crop production is a vast, untapped resource for utilisation in a bioeconomy.

8.1 Rice Straw: ADifficult Waste Product

Rice farming results in two types of residues – straw and husk – that are attractive in industrial use. Rice husk, the main by-product from rice milling, accounts for roughly 22 per cent of paddy weight, while rice straw to paddy ratio ranges from 1.0 to 4.3. Although the technology for rice husk utilisation is well-established worldwide, rice straw is sparingly used. One of the main reasons for the preferred use of husk is its easy procurement. In the case of rice straw, however, its collection is difficult and its availability is limited to harvest time.

Rice straw is unique relative to other cereal straws in being low in lignin and high in silica (Van Soest 2006). Silica (up to 12 per cent by weight, Nayar *et al.* 1977) and lignin in that order are the primary limiting factors in rice straw quality as an animal feed. As a result, widespread burning of rice straw at the field is practiced. The practice has been cited as an air pollution problem, with a possible link to increased instances of asthma (McCurdy *et al.* 1996; Torigoe *et al.* 2000).

The energy content of rice straw is around 14 MJ per kg at 10 per cent moisture content. The by-products are fly ash and bottom ash, which have an economic value and could be used in, e.g. cement and/or brick manufacturing. Straw fuels have proved to be extremely difficult to burn in most combustion furnaces due to engineering difficulties, especially those designed for power generation. Due to recent advances in lignocellulosic conversion, however, the possibility is opened up for the use of rice straw for bio-based chemicals production. There are at least 12 Asia-Pacific countries with biofuels mandates or targets (OECD 2014). Here is a unique opportunity. Rice is a huge volume crop, its straw, produced in very large volumes, is not only virtually of no use, its disposal by burning represents a health problem. Its use in bio-based production would, therefore, represent a new market opportunity for farmers that does not interfere with their other markets.

Two bio-based production strategies are worth noting. Kim *et al.* (2010) demonstrated that *Lactobacillus brevis* is able to simultaneously metabolise all fermentable carbohydrates in acid pre-processed rice straw hydrolysate for the production of high-value lactic acid. More controversially, Oraby *et al.* (2007) expressed the catalytic domain of the *Acidothermus cellulolyticus* endoglucanase gene in rice (to convert cellulose into fermentable sugars for subsequent fermentation to ethanol as biofuel). This is an alternative to using extracellular enzymes, which remain relatively expensive. They concluded that the approach may be commercially viable.

Expectations are rising in developing Asian countries like Indonesia for poverty alleviation and energy diversification through second generation biofuel production from rice straw.A recent (Samuel 2013) environmental and socio-economic assessment of rice straw conversion to ethanol for Bali, Indonesia was conducted. The study found that, assuming all the technically available rice straw in Bali is used (~244-415 kilotonne/year), ethanol production may yield: gasoline replacement, lifecycle GHG savings, GDP contribution, foreign exchange savings, and employment beneficiaries of: 55-93 million litres/year, US$ 140-240 million/year, 19-32 kilotonne of CO_2-equivalent/year, 100-180 million US$/year, and 2,200-3,700 persons, respectively.

8.2 Banana Waste Utilisation

Much of the banana plant, beyond the edible fruit, can be used for a variety of purposes. However, once the banana fruit is harvested in South China, Li *et al.* (2010) reported that the pseudostems become organic waste and cause environmental pollution.Cellulosic fibre obtained from the pseudostem of the banana plant is extensively used for paper board, tissue paper, clothing, weaving baskets and natural sorbents (Mohapatra *et al.* 2010). However, banana sap from the pseudostem is under-utilised. Paul *et al.* (2013) investigated the productionof a bio-based resin from the pseudostem banana sap. They discussed the possible use of such a resin in the automotive industry.

8.3 Justification for the Dual Use or Cascading Use of Vital Food Crops

By focusing on two critical Asian crops, it is hoped that it can be demonstrated that even food crops that are considered top priority can

find a role in bio-based production of industrial materials such as fuels and chemicals without interfering with their primary role in food security. Governments can invest in the R&D required to explore the possibilities for such utilisation at relatively low cost. Many such investigations will prove fruitful in research but will not prove to be commercially viable. But when a commercially viable proposition is discovered, the advantages could include:

- Above all, extra markets are offered to farmers for their produce that may help them escape poverty, or at least improve income security;
- Achieving sustainability in a bioeconomy, and helping to meet national emissions reduction targets; and
- In the case of rice straw, a serious air pollutant that causes environmental and human health damage could be removed.

When it is realised that in terms of total biomass produced, these by-products of agriculture account for more biomass than the food portion of the crop, this is the vast unexplored resource for use in a bioeconomy. Then a future role of government could be to incentivise collection and make sure that a robust infrastructure is established with the cooperation of the private sector.

9. Other Genomics-Related Topics Relating to Food Security in an Asian Bioeconomy

Along with increasing incomes in developing economies, there has been a large increase in meat and milk consumption. From the beginning of the 1970s to the mid-1990s, consumption of meat in developing countries almost tripled the increase in developed countries (Delgado 2003).

Taiwan offers a good example of this shift in dietary pattern as development proceeds. In the 30 years from 1959-1989, *per capita* consumption of rice halved, while meat consumption (chicken, beef and pork) quadrupled, fruit consumption quintupled, and fish consumption doubled (Huang and Bouis 1996). Similar patterns were seen in Japan and Korea as household incomes increased.

Growing animal protein foods requires large amounts of high-energy feed, water and land. Naturally, this creates strain on a bioeconomy as less biomass can be devoted to industrial uses. Therefore, there is clearly a need to find new ways for increasing food production efficiency. The roles of

genomics can be subtle, but small incremental advances in selective breeding over many years can lead to significant effects. The major role of genomics could be to increase the speed and efficiency of traditional breeding. By selecting genes already in the food chain and their introduction to new varieties via breeding, this may overcome political GM issues.

9.1 Chicken as a Food Source in a Bioeconomy

Chicken is a major source of protein in the world, with around 20 billion birds alive today, producing around 1.2 trillion eggs.[28] Asia already consumes 40 per cent of global chicken production and consumption is growing.[29] It is the first livestock species to be sequenced and so leads the way for others (Burt 2005). It is an excellent food source in bioeconomy terms as its production is relatively low in GHG emissions (Table 1), and is cheaper to produce and less energy intensive than rearing lamb, beef or pork.

In parallel with the chicken genome sequencing project (Hillier *et al.* 2004), a consortium set about identifying single nucleotide polymorphisms (SNPs[30]). When a large number of these are verified, the availability of a standard set of 10,000 or more SNPs holds much promise towards the identification of genes controlling quantitative trait loci (QTL), including those of economic interest.

One of the key traits improved every year through selective breeding is feed efficiency – the number of kilos of animal feed needed to produce a kilo of poultry meat (Technology Strategy Board 2010). Genomic technologies are expected to enhance this trend. Since animal breeding is cumulative, even small enhancements to the rate of improvement can multiply into huge differences for commercial customers over time and have very large impacts. The result of this is that more people can be fed from the same land resources or land resource can be freed up – for example for biomass production for industrial use.

The Aviagen[31] genomics project, for example, is concerned with identifying naturally occurring markers within the genome of elite birds and using those markers to help breed stronger and more productive birds through the current selective breeding programme, a completely natural process. Aviagen became the first company to include genomic information as a critical additional source of information in a R&D breeding programme.

Table 1: The GHG Emissions Associated with Various Meat Production Systems

Product	CO_2 (eq kg^{-1})	Comments
Beef	44.8	Mainly a result of methane and N_2O, not CO_2
Belgian beef	14.5	
Idaho and Nebraska beef (average)	33.50	Farm-gate, quoted as 15.23 kg per pound of beef
Idaho lamb	44.96	Farm-gate, average of low and high productivity
Swedish pork	3.3-4.4	
Michigan pork	10.16	Farm-gate
Farmed trout	4.5	Raised in ponds. Frozen, leaving retailer
Cod	3.2	Frozen fillet, leaving retailer
Chicken	2.0	(Round weight, US)
Poultry (US)	1.4	
Chicken	4.6	(Round weight, UK)
Farmed salmon (sea-based, UK)	3.6	Including processing and transportation
Farmed salmon (sea-based, Canada)	4.2	Adjusted to fillet based on figures for live fish
Farmed salmon (sea-based, Norway)	3.0	Transportation to Paris
Farmed salmon (global average)	2.15	Farm-gate estimates
Capture fish (global average)	1.7	

Source: OECD (2013b).

9.2 Beef Production

The Australian beef industry today sees "*unprecedented demand from the entire Asia Pacific as well as the Middle East*" (Kondo 2014), whereas before the demand was mostly from Japan, and then later China. But beef production requires lots of land, feed, water and creates large GHG emissions, therefore, measures that improve beef production efficiency are being sought. Genomics offers some solutions.

The possibility of predicting breeding values using genomic information has revolutionised the dairy cattle industry and is now being implemented in

beef cattle. A challenge in the development of genomic tools for beef cattle selection, however, is in the diversity of breeds represented in the industry.

There is large scope for the development of novel applications in the livestock sector, such as selection tools for new traits (meat quality, diseases resistance, feed efficiency, heat tolerance), animal traceability and parentage verification (e.g. McClure *et al.* 2013). Efforts in sequencing important animals in the global beef industry are underway to identify variants and to associate those variants with the genetic variation observed across beef populations.

It is also feasible to postulate that in the near future the artificial reproductive technologies (ART), such as artificial insemination, embryo transfer and in-vitro fertilisation, combined with genomic evaluation (GE) approaches will be the driving forces to lead cattle breeding to a finer process than it is nowadays.

9.3 Genomics and the Fishing Industry

Between 1998 and 2008, global exports of fish products doubled to a value of over US$100 billion. It is estimated that over 20,000 species of fish are used for food. Of a total global fishers (i.e. excluding aquaculture) of over 34 million in 2008, over 8.25 million were in China alone, and over 2.25 million in Indonesia (compare this to just under 13,000 in Norway). From the bioeconomy perspective, fish protein relieves pressure on land as the source of biomass for both agricultural and industrial uses. Given the health benefits and the lower GHG emissions associated with fish (Table 1), increased fish consumption would appear to be desirable for a future bioeconomy.

However, about 90 per cent of global wild fish stocks are already at capacity or are in precipitous decline.[32] Wild fisheries should, therefore, be regarded as ‘not necessarily renewable’. Well-reported universal difficulties associated with wild fisheries are related to fish species identifications, e.g. species with limited diagnostic morphological features, cryptic species, juvenile identification, or unavailability of adequate drawings and descriptions. Such problems are probably global, with almost 34 per centof the world’s fisheries catch from 1950–2002 lacking species level identification.

Molecular markers, such as DNA barcodes, can address many such difficulties. In addition to the use of DNA barcodes for species delimitation, the availability of a standardised and globally accessible database (Barcode of Life Data System, BOLD)[33],facilitates numerous related applications, including issues relating to traceability, illegal fishing and fish fraud (Costa *et al.* 2012). A common fraudulent practice is species substitution, which can be unintentional or intentional for tax evasion, for laundering illegally caught fish or for selling one fish species for a higher-priced species. Traceability is become an increasing urgent need.

For example, about 70 per cent of the global tuna fish catch is taken from the Pacific. Most of the 23 tuna stocks are either over-exploited or depleted. Bluefin tuna are unrivalled in popularity, especially in sushi, and the economic value per fish is unmatched by any other species. However, its over-exploitation seriously threatens its future, and some advocate that consumers should avoid eating bluefin altogether. Moreover, prices of yellowfin tuna and Pacific bluefin tuna are drastically different. But if they are used in cooking, it is difficult even for experts to distinguish between them. DNA barcoding,therefore,holds out promise for various policy goals: to reduce fraud, to play a role in cultivating conscientious consumerism (by helping threatened species conservation) and to effectively regulate by eliminating market ambiguity (Lowenstein *et al.* 2009).

To date, no one technique is perfect in its ability to identify species at the molecular level. However, DNA barcoding analysis is a significant advancement upon previous DNA techniques because it is based on a universal methodology (Hanner *et al.* 2011). It has been argued that linking DNA barcoding to a universally accessible, expert-authenticated database of species identification data would address many of the problems that plague the current system of species authentication (Clark 2015).

9.4 Aquaculture and Genomics

Aquaculture production has continued to grow annually at around 6-8 per cent. Today, farmed seafood production exceeds that of wild fisheries and has significant potential for future growth. World aquaculture is heavily dominated by the Asia–Pacific region, which accounts for roughly 90 per cent of production, mainly due to China. In 2008, 85.5 per cent of fishers

and fish farmers were in Asia, compared to 1.4 per cent in Europe and 0.7 per cent in North America (FAO/WHO 2010). However, much remains to be done in productivity in Asia: fish farmers' average annual production in Norway is 172 tonnes per person, while in China it is 6 tonnes and in India only 2 tonnes.

High priority traits for farmed fish are the development of single sex populations and improving disease resistance. Production of mono-sex female stocks is desirable in most commercial production since females grow faster and mature later than males. Understanding the sex determination mechanism and developing sex-associated markers will shorten the time for the development of mono-sex female production, thus decreasing the costs of farming.

Nile *Tilapia* is one of the most important farmed species with a production exceeding 2.8 million metric tonnes in 2010. *Tilapia* farming is increasingly important in Asia, with (at least) Bangladesh, China, Indonesia, Malaysia, Myanmar, the Philippines, Thailand and Vietnam all producing significant tonnages. Most Asian countries do not export significant amounts of *Tilapia*, demonstrating its role in food security.

Tilapia is unusual in that intensive commercial production generally requires all-male stocks, not only because males grow faster but also to avoid uncontrolled reproduction before harvest. A restriction associated DNA (RAD) sequencing study by Palaiokostas *et al.* (2013) identified a reduced candidate region for the sex-determining gene(s) and a set of tightly sex-linked SNP markers. Although they could not identify the causative gene(s), no female was mis-assigned using their sex-associated SNPs. This means that those SNPs could be of high practical value towards the production of all male stocks for the *Tilapia* aquaculture industry.

10. Concluding Remarks

The presence of an abundance of biomass in many Asian nations and a massive burden of crude oil importation makes Asia a continent where a bioeconomy should be exceptionally attractive. Moreover, climate change mitigation policy could prove very expensive for Asia, but the bioeconomy offers many new economic as well as environmental and social opportunities. It is impossible to predict all of these. This paper serves to highlight some

of the major challenges and opportunities for Asia, utilising its traditional strengths in biomass production when allied to modern biotechnology and genomics.

However, bio-based production processes are notoriously inefficient. And although great strides have been made in agricultural efficiencies through traditional breeding techniques, -omics technologies open up the possibilities of making breeding much more quantitative and rapid. A few Asian countries are at the cutting edge of biotechnology and genomics. In other Asian countries, which have traditionally relied more heavily on exporting their natural resources, investments in growing biotechnology research infrastructure and encouraging both domestic and foreign private investments could be transformative. Their arrival within the status of 'developed' nations would also herald a knowledge-based economy that is entirely consistent with a new type of economy in which environmental protection is accorded a much higher importance because it make more economic sense – this is the essence of a future bioeconomy.

The paper is deliberately skewed towards food genomics for a very good reason. We previously outlined some of the challenges in bio-based production in an Asian bioeconomy (Philp and Pavanan 2013). Here we emphasise that these industrial production opportunities must be reconciled with food needs. What we hope we have shown is that biotechnology and genomics technologies can improve food and industrial production, with or without genetic modification, often in ways that are not obvious, and that the potential is only just beginning to be realised.

Fewer people than ever before are hungry, but switching to bio-based materials production obviously puts enormous strain on biomass availability. While the use of food crops for industrial production should by no means be discounted, we must also get much better at using waste materials of agriculture, forestry, food and industrial production as the feedstocks of the future. The -omics technologies and synthetic biology, converging with green chemistry, are the enabling technologies for that revolution.

Endnotes

1 Professor of International Child Health and Director of the UCL Institute for Global Health. See, https://www.ucl.ac.uk/intercultural-interaction/For_2website_Grand_Challenge_review_event_report.pdf

2 http://thediplomat.com/2013/02/japans-demographic-disaster/

3 Defined as all those living in households with daily per capita incomes of between USD10 and USD100 in PPP terms (OECD 2010).

4 http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

5 http://esa.un.org/wpp/Documentation/pdf/WPP2012_Volume-II-Demographic-Profiles.pdf

6 www.eia.gov/countries/cab.cfm?fips=JA

7 http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php

8 http://www.oxfordresearchgroup.org.uk/publications briefing_papers_and_reports/climate_change_drivers_insecurity_and_global_south

9 http://www.epa.gov/climatechange/impacts-adaptation/international.html

10 http://www.bbc.com/news/business-33119960

11 http://www.bbc.com/news/world-latin-america-30962813. January 24, 2015

12 http://www.unccd.int/en/regional-access/Asia/Pages/alltext.aspx

13 Food and Agriculture Organisation (FAO), www.fao.org/sd/epdirect/epre0045.htm

14 Marker assisted selection or marker aided selection (MAS) is a process whereby a marker (morphological, biochemical or one based on DNA/RNA variation) is used for indirect selection of a genetic determinant or determinants of a trait of interest (e.g. productivity, disease resistance, abiotic stress tolerance, and quality).

15 C3 refers to the Calvin cycle that plants use for photosynthesis. The C4 pathway is an alternative of the Calvin cycle. The latter pathway has an advantage because it fixes more carbon dioxide and can operate under low carbon dioxide concentrations, without inhibitory effects of oxygen or sunlight as is the case for C3 photosynthesis.

16 http://www.bbsrc.ac.uk/news/food-security/2013/130822-pr-uk-usa-collaborate-to-design-crops.aspx

17 When the price of Brent crude oil rose from around US$ 50 per barrel to about US$ 110 by January 2013, the prices for ammonia in western Europe and the mid-western corn belt in the United States roughly tripled.

18 Backcrossing is a crossing of a hybrid with one of its parents or an individual genetically similar to its parent, in order to achieve offspring with a genetic identity which is closer to that of the parent.

19 www.irri.org

20 http://www.goldenrice.org/

21 http://www.crop-diversity.org/mgis/

22 https://www.bioversityinternational.org/research-portfolio/conservation-use-of-bananas-tree-crops/international-musa-germplasm-transit-centre/

23 In botany and horticulture, parthenocarpy (literally meaning virgin fruit) is the natural or artificially induced production of fruit without fertilisation of ovules. The fruit is, therefore, seedless.

24 www.frim.gov.my

25 https://www.cde.unibe.ch/News%20Files/BIA_policy_brief_jatropha_grows.pdf

26 http://www.jatropha.pro/PDF%20bestanden/Quinvita%20presentation%20June%202011.pdf

27 http://ec.europa.eu/environment/circular-economy/

28 http://www.bbsrc.ac.uk/news/food-security/2013/130404-f-what-lives-inside-a-chicken.aspx

29 http://www.thepoultrysite.com/articles/2929/global-poultry-trends-2013-asia-consumes-40-per-cent-of-worlds-chicken/

30 A SNP represents a difference in a single DNA building block, called a nucleotide. http://ghr.nlm.nih.gov/handbook/genomicresearch/snp

31 http://en.aviagen.com/research-development/

32 http://www.bbc.com/news/business-33068446

33 www.barcodinglife.org

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