Extractives, climate and health equity

Trends in extraction of biodiversity and genetic resources in east and southern Africa

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Background

This brief is produced as part of the scoping work in the Regional Network for Equity in Health in east and southern Africa (EQUINET). Co-ordinated by TARSC, SATUCC and SEATINI, the EQUINET work aims to use scenario planning to explore the distributional consequences for current and future wellbeing of projected trends in extraction of water, minerals, biodiversity and genetic materials and of climate change, to promote understanding and dialogue on how different choices made today can influence these different long-term outcomes. This paper focuses on trends in biodiversity and genetic resources and presents

- The current situation and projected trends related to biodiversity and genetic resources in east and southern Africa (ESA).
- The implications for the wellbeing of current and future generations of these trends.
- The policy choices and alternatives to respond to these trends and the factors that influence policy design and uptake of choices.

Key messages

1. The biodiversity, genetic diversity of plants, animals and forests in ESA countries are declining at alarming rates, risking the health and wellbeing of populations in the region.
2. Based on current trends and policies these losses are projected to continue to 2050, with accelerated biodiversity losses in southern Africa and deforestation in east Africa.
3. Biodiversity and genetic material in ESA countries are extracted by the loss of land to mono-cropping and industrial agriculture, the erosion of farmer managed seed diversity, livestock intensification, the introduction of invasive exotic species and trafficking of local species, and through mining, pollution and expansion of urban settlements.
4. Losses of biodiversity and genetic resources have led to poorer diets, poorer living conditions, encroachment on areas with animal populations and an erosion of wild foods and medicinal plants that raise the risk of chronic and zoonotic diseases and pandemics.
5. Current policies have not reversed these trends, nor met the targets of the Convention on Biodiversity (CBD). International treaties and negotiations have not protected farmer managed seed systems and farmers' rights, nor addressed access and benefit sharing of genetic resources and traditional knowledge in digital systems.
6. This calls for an urgent paradigm shift from industrial agriculture to diversified agro-ecological systems, to allow the full and free use and exchange of agricultural varieties and breeds amongst local farmers, their communities or public breeders; to encourage a one health approach, that recognise the complex, intergenerational interconnections between human and animal health, plants and our shared environment. It implies reintroducing biodiversity buffers through widely diverse species and varieties in livestock, poultry, and seeds, reproducing on-site, harnessing diversity, and increasing disease resistance.
7. We need more genetic diversity, not less, and we need to vigorously defend genetic diversity as a common good, not something that can be extracted and privately profited from.

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The current state of biodiversity and genetic resources in ESA

This report focuses on the current status of biodiversity and genetic resources in Eastern and Southern Africa (ESA) and how these are impacted by various extractive industries. It provides an overview of the current state of biodiversity and genetic material in ESA and suggests projected trends on this to 2030 and 2050. It explores the impacts of these trends on health and well-being, current policy responses and policy spaces and options that might be explored.

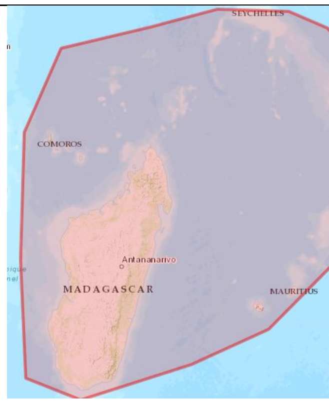
Biodiversity is defined as “the variety of life at genetic, species and ecosystem levels” (FAO, 2019:16). It covers plants, animals and microorganisms and their genetic differences, the pests and disease agents that affect human, animal and plant health, and the species used to control disease, such as traditional and modern medicinal plants (Perrings et al., 2019). Biodiversity is declining faster than it has at any other time in human history (IPBES, 2019). The current rate of species extinction is tens to hundreds of times higher than the average over the past 10 million years—and it is accelerating (WEC, 2020). In 2019, the International Union for the Conservation of Nature (IUCN) Red List assessed 105 732 species, of which 28,338 are threatened with extinction (IUCN, 2019).

The current situation

Africa continent is home to 8 of the 36 biodiversity hotspots identified worldwide. A hotspot is an area that has a high percentage of plant life found nowhere else on the planet and thus irreplaceable and 30% or less of its original natural vegetation, indicating that biodiversity is threatened (CI, undated). Of these, 2 hotspots are from the ESA region as shown in *Table 1.*

The Horn of Africa hotspot lies outside the ESA region but is one of the most degraded hotspots in the world, with only about 5% of its original habitat in relatively pristine condition due to uncontrolled hunting, overgrazing, charcoal production, political instability and infrastructure development (CI, undated). As shown in *Table 1* the Southern African hotspot is a result of expansion and intensification of agriculture, deforestation, timber extraction, hunting and bush meat exploitation, climate change, commercial trade in wild plants and animals and invasive species (CI, 2012), while the degradation in the Indian ocean islands is identified to have resulted from poverty, invasive species, climate change, deforestation and hunting for local consumption (CI, 2012).

Table 1. Species listed on the IUCN Red List as a result of bioecological resource use, ESA countries

Area species threated in	Hunting and trapping of terrestrial animals	Gathering terrestrial plants	Logging and wood harvesting	Fishing and harvesting aquatic resources	
Comoros, Mada-gascar, Mauritius and Seychelles	299 of which 267 for intentional use. Of these, 8 species are used or treated for medicinal use	113, of these, 66 are threatened as a result of intentional use. Of which 3 plants extracted for medicinal use (Dypsis andrianatonga, craterispernum mircrodon and ixora ripicola)	1216, of which 172 species are impacted (animals and plants) as a result of subsistence harvests and 32 species are impacted as a result of large scale harvests (pluchea grevei and helichrysum flagellare)	1090 of which 829 species are impacted as a result of subsistence harvests and 244 species are impacted as a result of large scale harvests (incl. 20 species threatened as a result of medical commercial use, such as pristis pristis (largetooth sawfish) or carcharhinus albimarginatus (the silvertip shark)	

Area species threated in	Hunting and trapping of terrestrial animals	Gathering terrestrial plants	Logging and wood harvesting	Fishing and harvesting aquatic resources	
Southern Africa - Malawi, Zambia and Zimbabwe	198 – of which 153 species are threatened as a result of intentional use, including 22 species threatened as a result of medicinal use (otters, fruit bats, vultures, pangolins, rhinoceros, lions, genets)	11, of these, 3 are threatened as a result of intentional use, all of which are extracted for medicinal use (aloe canis, aloe duckeri,corrigiola litralis)	269, of which 13 species are impacted (both animals and plants) as a result of subsistence harvests and 7 species are impacted as a result of large-scale harvests.	565 of which 416 species are impacted as a result of subsistence harvests and 104 species are impacted as a result of large-scale harvests (of these, 5 species are threatened as a result of the medical use, such as eels (Anguilla marmorata; Anguilla bengalensis) or otters (hydrictis maculicollis)	

Source: IUCN, 2019 from data collected in April 2020. Note: Impacts for animal hunting and plants gathering are differentiated between intended use, unintentional effects and when animals are persecuted or plants removed for control. The table underlines the number of species resulting from intentional use. For both logging /wood harvesting and aquatic resources, impacts are differentiated between small-scale intentional subsistence use, and large-scale intentional, with unintentional effects for both. A species can be found in more than one category e.g. bull sharks are threatened by both small- and large-scale fishing

Levers of deforestation in ESA countries are shown in *Table 2*. Madagascar has severe deforestation. Remote sensing analyses found forest losses between 2000 to 2012 to be concentrated in Mozambique, Tanzania and Zambia, with the latter having amongst the highest rate of deforestation globally (WWF, 2015; Henry *et al.,* 2011).

Table 2. Annual loss of primary forest cover and tree cover, ESA countries 2010-2018

Country	**Percent deforestation loss over 2010 – 2018 in order of severity**
Madagascar	16.3 - 21.0% (*)
Zimbabwe	10.1 – 14.0% (*)
Malawi	4.4 – 11.0% (*)
Zambia	6.6%
Mauritius	3.1- 4.6%
Seychelles	0.1%

Source: Rainforests Mongobay (2020) and Global Forest Watch (2020) (*) Range depends on source

Drivers of the loss of biodiversity

As noted in the discussion of *Table 1* above, there are numerous drivers of these biodiversity losses, with climate change being a key driver, an aggravating of factor and biodiversity loss further exacerbating climate change (Sintayehu, 2018). In this paper we focus on extraction of plants and animals as a driver of biodiversity and genetic material erosion.

The primary level of extraction of biodiversity arises in the conversion of natural habitats into agricultural land and urban areas. How we grow food, produce energy, dispose of waste and consume resources impacts on the delicate balance of clean air, water and life that all species depend on for survival. Infrastructure developments, the overexploitation of biological resources, the introduction of invasive exotic species, pollution of air, water and soil, poaching and wildlife trafficking create critical pressures on biodiversity, as do pests and diseases (IPBES, 2019). These drivers lead to habitat loss, degradation and fragmentation (FAO, 2019).

Industrial farming practices incentivised by agri-business, seed and pharmaceutical transnationals, supported by governments, philanthropies and external funders. Local tree and seed species are displaced by 'improved' corporate/industrial seed varieties, a loss in genetic diversity that is compounded by a shift to market-oriented and monoculture crop production. Associated with this is the patenting of plant genetic material for medicines and other uses, as a privatisation of intellectual property that is leading to the loss of control over these genetic resources by those living in their natural environments (FAO, 2019).

Indigenous ecosystems are lost through invasion of imported alien species

The spread of invasive alien livestock, fish and plant species is eroding genetic diversity on the continent, with report of nearly half of Africa's crops lost because of this. In 2012, a total of 26 such species were reported in Zimbabwe for example (Critical Ecosystem Partnership Fund, 2012). These invasive species take various forms: A parasitic plant, *Striga hermonthica*, was identified to cause US$7 billion worth of maize losses annually, adversely affecting 300 million Africans (Burgiel and Muir, 2010). Exotic tree species such as eucalyptus have replaced local species, particularly in the East African highlands (Omoro and Luukkannen, 2011). This has led to acidified soils and contamination of water bodies making them unsuitable habitats for wildlife, affecting communities reliant on foraging of wild foods for livelihoods and nutrition (World Rainforest Movement, 2020).

Islands have been particularly affected by the introduction of rats, cats and mongooses (CI, 2014; Burgiel & Muir, 2010). In Mauritius, native bats were reported to be threatened by 13 species of exotic mammals, in Seychelles, invasive species have threatened birds, reptiles, and invertebrates, while in Madagascar exotic rats constitute a major threat to the survival of small forest mammals, especially local rodents, and exotic fish such as Tilapia have reduced local fish distribution and diversity by changing their habitat, by direct predation or by competition (Benstead et al., 2003). Wetlands are particularly affected by invasive alien species, such as the widespread water hyacinth, affecting the diversity of and yield from local fish populations, or the water lettuce, with the latter covering much of the Seychelles wetlands, with cascading consequences for animals and plants (FAO, 2019).

The introduction of invasive species may come in various ways, such as documented in Ethiopia in the case of Parthenium in *Box 1* below.

Box 1 **Parthenium hystrophorus threating yields and grazing in Ethiopia**

In Ethiopia in the 1980s, drought-induced famine triggered a massive multinational relief effort. Parthenium hystrophorus is reported to have been accidentally introduced to the country in relief wheat grain contaminated with its seeds as it was first spotted growing near food-aid distribution centres (CI, 2012) The weed soon dominated pastures and crop fields as it releases chemicals that suppress the growth and germination of neighbouring plants, with sorghum grain yield losses of 40-97% , and undermining grazing shortages as it is unpalatable to livestock (Tamado et al., 2002). Removing of the weed and hand-weeding crops in Parthenium infested fields was reported to lead to skin disease and fever, while ingestion of the week by animals was said to taint the meat and make diary milk unpalatable (Wubneh, 2019).

Commercial logging and expanding demand for energy, land and settlements driving deforestation

The main drivers of deforestation are the expansion of traditional smallholder agriculture for crop and livestock production, exacerbated by growing population density around forests, uncontrolled fires and charcoal use, unsustainable commercial logging, infrastructure development, large-scale mining and related infrastructure development along 'development corridors' located through forests, as has happened in the Mtwara corridor covering Malawi, Mozambique, Tanzania and Zambia; the Nacala corridor in Malawi, Mozambique and Zambia; and the Beira and Limpopo corridor s in Mozambique and Zimbabwe and the Limpopo corridor. A further driver is the in-migration for harvesting timber and fuelwood. Much of this logging is illegal, whether for precious timber destined for Asian markets or to make charcoal for local use, as is the trafficking of plants. Overharvesting by licensed operators is also a problem due to poor enforcement of regulations. A, growth in plantation and biofuel crops is also leading to deforestation (WWF, 2015). The specific drivers vary by country. In Zambia, deforestation is strongly linked to urbanization (UN REDD, 2012). In Madagascar, slash and burn agriculture (*tavvy*) and illegal trafficking of wood species are major drivers of deforestation.

Hunting and trafficking of animal and plants species

The marketing and trafficking of plant and animal species for international trade is also on the rise. Madagascar's 23 rosewood and palissander tree species are highly exploited for their precious wood, with over 90% of them now threatened. Rosewood species are used across the world in the timber trade and have become the most trafficked group of endangered species in 2005-2014 (Zhu, 2020). Other trafficked species include elephants, reptiles, agarwood and pangolins, with the latter taken from the African wild for local consumption in West Africa and to feed demand in China where they are consumed and used for traditional medicine. As populations of the Asian pangolin have declined, demand has shifted to Africa, with Ethiopia and Nigeria identified as key trafficking hubs on the continent (*The East African,* 2018; Uwagbale, 2020). In East Africa, a flourishing illegal trade in animal parts has affected rhino, musk deer, monkeys and pangolin populations (Alves and Rosa, 2007). Bushmeat consumption has also risen in local trade and for local consumption in Madagascar and East Africa (CI, 2014; Katani et al., 2019).

Mining as a driver of biodiversity losses

Mining has been an important driver of biodiversity loss, in countries with established mining sectors (such as Zambia, South Africa and Zimbabwe) and in new mining explorations, such as in Mozambique, Uganda and Madagascar. For example ,in Southern Africa, the impact on biodiversity has been reported from diamond mining in Zimbabwe's Chimanimani National Reserve or bauxite mining on Mount Mulanje in Malawi (CI, 2012). In its latest biodiversity report, Zambia reports one negative impact of the discharge of effluents from Copperbelt mines into river systems to be a reduction in the diversity of butterflies, dragonflies and other invertebrates due to elevated levels of redox, electrical conductivity and turbidity (FAO, 2019). Box 2 shows an example of this.

Box 2: Mining impacts on biodiversity in Madagascar

Several large projects in the southeast of Madagascar have been involved in mining of chromium and nickel-cobalt mining since 2012, producing refined nickel, cobalt, and ammonium sulphate fertiliser. A 2500 ha forest was directly affected by the project and numerous households were displaced, with controversial compensation agreements dividing the community. Health incidents such as a sulphur-dioxide leak have affected human health, while extensive spraying of insecticides are reported to have led to the collapse of local bee colonies (Soustras, 2017; Sumitomocorp, undated).

Industrial farming and biotechnology displacing local plant and genetic materials

FAO (2010) raised an alarm on the dwindling diversity of traditional seed varieties in production and conservation due to replacement by modern or so called 'improved' varieties. The ESA region has various crop gene pools, such as for pearl millet in the mountainous regions of Ethiopia or finger millet and cowpea in Madagascar (FAO, 2010). Genetic uniformity due to monocropping is fuelling crop vulnerability and genetic erosion, with the expansion of a skewing of crop production towards a handful of commercial crops that can be grown to scale as a result of market and trade forces and the dominance of grain conglomerates (ACB, 2017). In Africa, this has been exacerbated by research and agricultural subsidies favouring crops such as maize to the detriment of crops that have a potentially greater role in food security in mitigating vulnerability to climate change. As recently introduced species, maize and cassava are now grown on a large proportion of the continent's agricultural land and have displaced local crops such as sorghum and millet, with, for example, 61% of maize farmers in Malawi using 'improved' varieties (McCann, 2005; Westengen et al., 2019; FAO, 2010). This homogenisation of crops leads the plants to be highly vulnerable to pests and pathogens, with similarity of genomes that deprives them of the immunity that diversity brings and that enables them to resist or slow down transmission of pathogens (FAO, 2015). This is not only the case for maize. For example, the expansion of farming of high yielding, early maturing improved varieties of rice in Madagascar has both impacted on loss of habitat and on diversity in the growth of wild yams, cassava, coffee and other beans in the country (FAO, 2010).

The corporate take-over of Africa's seeds systems

Worldwide, small-scale farmers are the custodians of biodiverse seeds, ensure the diversity of crop species in farming on (Mulvany, 2019). Their loss of control over seeds and the side-lining of local knowledge systems and the genetic wealth that accompanies it are part of the extraction of biodiversity and genetic resources. The adoption by African governments of the Green Revolution agenda has provided an impetus for the privatisation and corporate capture of African agriculture. Farm input subsidy programmes play a central role in financing seed - including genetically modified seed- and inorganic fertilisers, eroding the genetic richness of indigenous seeds (ACB, 2017).

The introduction of genetically modified (GM) crops has been promoted by a handful of corporations who also control global seed and agrochemical industries, with three corporations- Bayer-Monsanto, China National Chemical Corporation's (ChemChina's) merger with Syngenta and DuPont-Dow - controlling about 60% of the global patented seed market and 64% of the agrochemical market. South Africa, Sudan, Nigeria and Ethiopia now grow GM crops commercially and in the ESA region the governments of eSwatini and Malawi have recently approved the commercial cultivation of GM cotton. The Gates Foundation and USAID are funding capacity building and technology transfer through an intricate network of institutions and programmes that also feed into biosafety policy development, technical guidelines and GM public relations. Agribusiness corporations have entered into public-private partnerships to promote the adoption of GM crops, such as in the Monsanto 'Water Efficient Maize for Africa project'. (ACB, 2017d)

Enormous pressure is being exerted on countries to adopt GM crops with the argument that it helps to address challenges posed by climate change, nutrition deficiencies, urbanisation and population growth. Biotech companies are also gradually taking control of the food chain, obtaining patents on genetic traits used in conventional and GM crops, giving them power in the market to maintain repeated sales year on year, threatening farm-saved seeds, local varieties of crop plants and agricultural biodiversity. Conventional and organic farmers, bee keepers, seed developers and others in the food production chain are threatened by contamination from GM crops. Technical advances for generating novel plant traits have now moved beyond the scope of current regulations for GMOs, raising concern that GMO producers may be able to push products onto the market without regulatory testing on their food, feed or environmental effects or ensuring consumer protection through labelling, even where labelling laws are in place.

Projected trends in biodiversity in ESA: where will we be by 2050?

Global push for more plantations

A momentum in the expansion of plantations suggests that the trends towards deforestation, loss of biodiversity and genetic resources will advance, potentially more rapidly. Plantations of exotic, often invasive, species can be construed as an extractive activity as it displaces indigenous eco-systems, mining their water resources and soils. The World Rainforest Movement (2020) recently warned of a corporate push for a new round of industrial tree plantation expansion, succeeding the first wave of monocultural plantations that swept across Africa in the 1960s and 1970s that saw eucalyptus, pine, acacia, teak and rubber take over and indigenous ecosystems and destroy the topsoil of forests, grasslands and savannas, whilst drying up or contaminating local water source with agro-toxins.

Box 3 The African Forest Landscape Restoration Initiative (AFR100)

Launched in 2015 by the World Bank, the German Ministry of Economic Cooperation and Development (BMZ), FAO and other agencies, the AFR100 claims it will "restore" 100 million hectares of deforested and degraded land in Africa by 2030 (AFR, 2020). Mozambique is already in the pipeline of approved plans. However the development will have severe negative impact on local communities displaced to make way for the plantations and on local livelihoods, especially for girls and women who derive a large portion of household food from wild forest harvesting (World Rainforest Movement, 2020)

There is a false argument, including by oil and energy companies, that these invasive plants and trees have a broader tolerance for a range of weather conditions and habitats and are thus more resilient to trends in climate change and that promoting exotic plantations offsets carbon emissions (Walther et al., 2009). This was promoted by the Paris agreement adoption of the FAO definition of 'forest' as including any trees species, even though natural forests act as much better carbon sinks than plantations, without the negative impacts, that themselves weaken resilience to climate change, described earlier.

Increasing level of deforestation and forest degradation

WWF's *Living Forests Report: Saving Forests at Risk* reports that East African countries are among the eleven places in the world that will account for over 80% of forest loss globally by 2030, with projected losses between 2010 and 2030 estimated to be 12 million ha (WWF, 2015). Areas of intensified deforestation are shown in *Figure 1a and 1b* below, showing the threats for parts of Malawi, Zambia and Zimbabwe. The Zambia government protect that at current rates the country could lose its entire forest cover by 2199 (Xinhua 2019).

Figure 1a: Africa's deforestation front

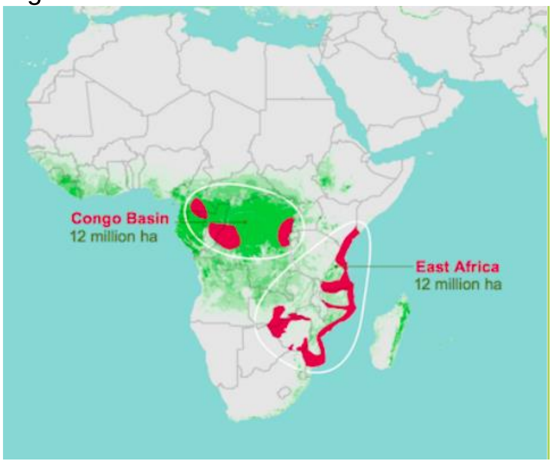
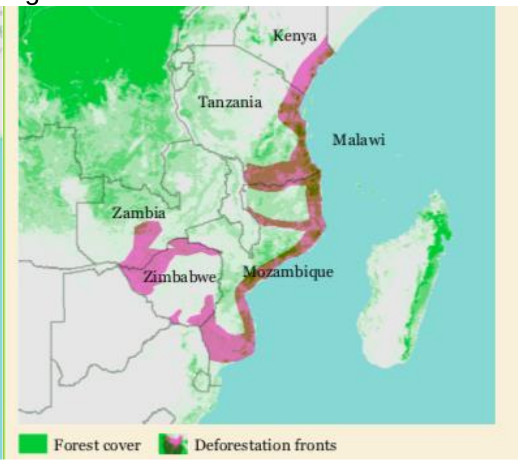


Figure 1b: Zoom on deforestation fronts in ESA



Source: WWF 2015:32

Note: In Figure 1a current forests are in green and the deforestation fronts and projected deforestation over 2010-2030 in red, with projected deforestation in purple in Figure 1b.

In the region, between 2000 and 2010, 890 400 ha of forest was lost. This is projected to reach 1.358 million ha in 2020 and 1.238 million ha in 2030. In a scenario where deforestation can occur outside and inside protected areas, Morell et. al., (2020) projects a dramatic decline of Madagascar's eastern rainforest over the next several decades, with the consequent loss of habitats for other species described earlier, with only 57% remaining by 2050, only 16% by 2070 and total loss by 2080.

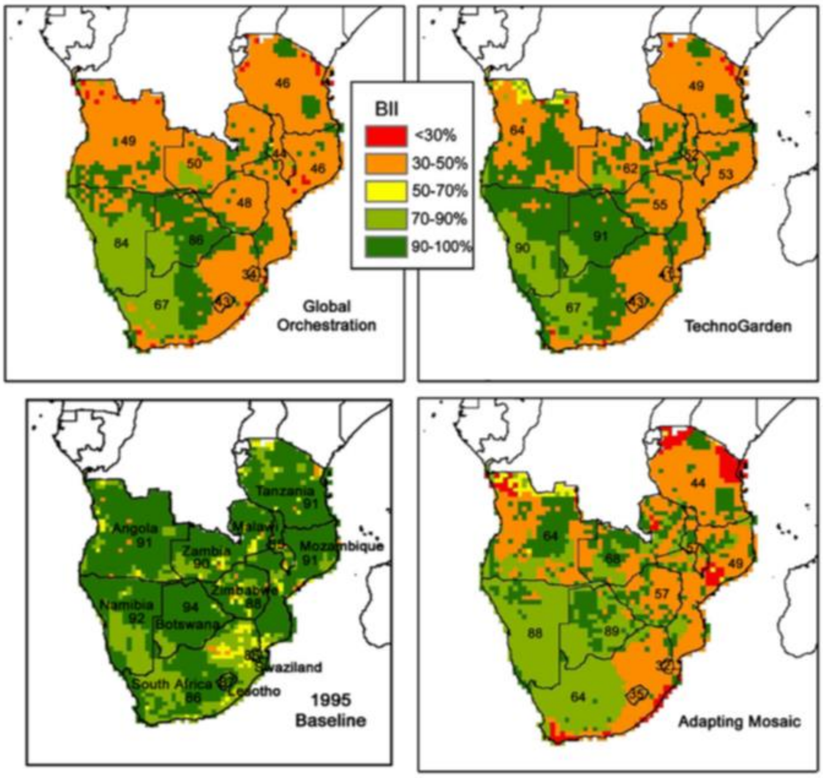
Projected effects of global environmental changes on biodiversity

Biggs et al (2008) modelled future land use and climate change in southern Africa under scenarios developed by the Millennium Ecosystem Assessment (2015a), assessing the impacts of these various scenarios on biodiversity using the Biodiversity Intactness Index (Scholes & Biggs, 2005). They project "substantial and ongoing loss of biodiversity' comparing 2060 to a 1995 baseline under all three scenarios, even for those that emphasize environmental sustainability. (See *Figure 2*). Forests and grasslands are projected to experience the most dramatic biodiversity loss, with some countries, such as Zambia, showing important variability between the three scenarios.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2019) comes to similar conclusions of largely negative impacts of global environmental changes for biodiversity in Africa, especially for marine (sea) systems. While a carbon richer world may benefit land-based growth of organisms', this may growth be offset by greater degradation and high species extinction.

The expansion of agro-chemical farming is protected to further exacerbate biodiversity losses. In a comprehensive study of global insect populations, it was found that 40% of all insect species are in decline and could die out in the coming decades, with intensive pesticide use a major driver of the decline (Sánchez-Bayo and Wyckhuys, 2019). While not specifically on ESA countries, the study forewarns of similar potential trends in ESA (FAO, 2019). Locusts swarms in East Africa are affected by climate change, and are more active in hotter and wetter conditions, both of which are projected to increase in future decades (FAO, 2020).The response to locust swarms decimating crops in East Africa by spraying of organophosphate chemicals will further affect biodiversity (UNEP, 2020).

Figure 2 Projected impacts of biodiversity loss in ESA



Source: Millennium Ecosystem Assessment (2015b)

Biosynthesis of alternatives to natural products at a cost of livelihoods and biodiversity

Synthetic biology is being used to synthetically produce in a laboratory products that were natural resources in Africa, as exemplified in *Box 4.* Such genetic engineering with microbes that feed on sugar or other biomass will raise demand for wider industrial monocropping for production of sugar or other biomass, replacing natural plants and with widening impacts on biodiversity (ETC,TWN & ACB, 2018).

Box 4: Biosynthetic production impacting Africa

Stevia is a natural sweetener and medicine grown in East Africa. Biosynthetic production of stevia led to launch of a product called EverSweetTM by Cargill in 2018. *Artemisia annua* (sweet wormwood) is an annual shrub. East Africa now grows an estimated 10% of the growing global supply, and it is used in anti-malarial medicine. An attempt by Sanifi to produce synthetic artemisinin failed in 2015, due to a glut of the natural counterpart and subsequent low prices. But natural production is likely be under increased pressure if synthetic production costs and yields can be improved. Madagascar is the leading global producer of vanilla, the cultivation of which is key for maintenance and sustainability of agroforestry. The rise of chemically synthetic vanillin caused a collapse in the market during 2004–14, with farmers curbing of production. Prices recovered since but this first wave of synthetic production warns of the risk of future such synthetic alternatives. (ETC,TWN and ACB, 2018).

Intensified extraction of genetic resources

Synthetic biology is increasingly referred to as part of the 'fourth industrial revolution,' encompassing the digitisation of biology and involving genetic synthesis, sequencing, genome editing and gene drives to manufacture synthetic fragrances and ingredients, as well as to modify living organisms with novel traits for agricultural or ecosystem changes. It includes a second generation of GMOs, dubbed GMOs 2.0, and their products, many of which are intended for export to African nations, given the plateauing of adoption of GMOs globally and still weak penetration of GMOs in African markets (ACB, forthcoming).

Gene editing, communicated as a more precise form of genetic engineering, comes with a number of biosafety concerns that are also associated with current GMOs (ETC,TWN & AC 2018). They also provide a means for extraction of resources as a form of biopiracy through digital sequencing Information (DSI) discussed below, using a gene editing method to produce new strains of maize, cassava, sorghum, cowpea, banana and moringa and the African yam bean in laboratories outside Africa (ACB forthcoming).As these second-generation technologies gain momentum in Africa, we can expect an expanded production of GM staple crops. This not only applies to crops. The 'Target Malaria' research consortium led by Imperial college London with funding from the Gates Foundation is piloting the trial release of 7000 mosquitoes that are genetically engineered to be infertile in two villages in Burkina Faso, with the intention of this expanding to other countries. There is concern that these modified mosquitoes can spread and persist in the environment, with no ability to recall them or prevent spread across borders, a concern expressed by countries neighbouring Burkina Faso (ACB, 2019).

The 2020 locust infestations of the East African region could just as well be the entry point for the next wave of genetic engineering, and GE proponents have suggested use of a GM fungus as a solution, with Chinese media reports of Chinese factories are already producing thousands of tonnes of it for export (Alliance for Science, 2020).

Digital sequence information: the new frontier in the extraction of genetic materials

Digital sequence information (DSI)[2] refers to genomic and protein sequences, epigenetic information and other data about seed, which can be shared globally via e-mails, uploads to internet databases. Access to ad use of digital genetic information originating from plant genetic resources for food and agriculture (PGRFA), although mentioned since 2013 as "dematerialization", falls outside the bounds of current international treaties and their objective of benefit sharing. Seed companies can now extract genetic information without needing to rely on the physical seeds pooled by the Treaty. DSI constitutes a modern genetic (digital) form of extraction. Industry claims to only be using the "information" of their genetic sequences and thus refuse to pay for access to DSI data in a digital form. For ESA countries, as for others in the global south, this means that high income countries are seeking to advance the interests of their biotech industries, without benefit sharing, "while at the same time benefitting from free access to DSI" (ACB & TWN, 2019b:7).

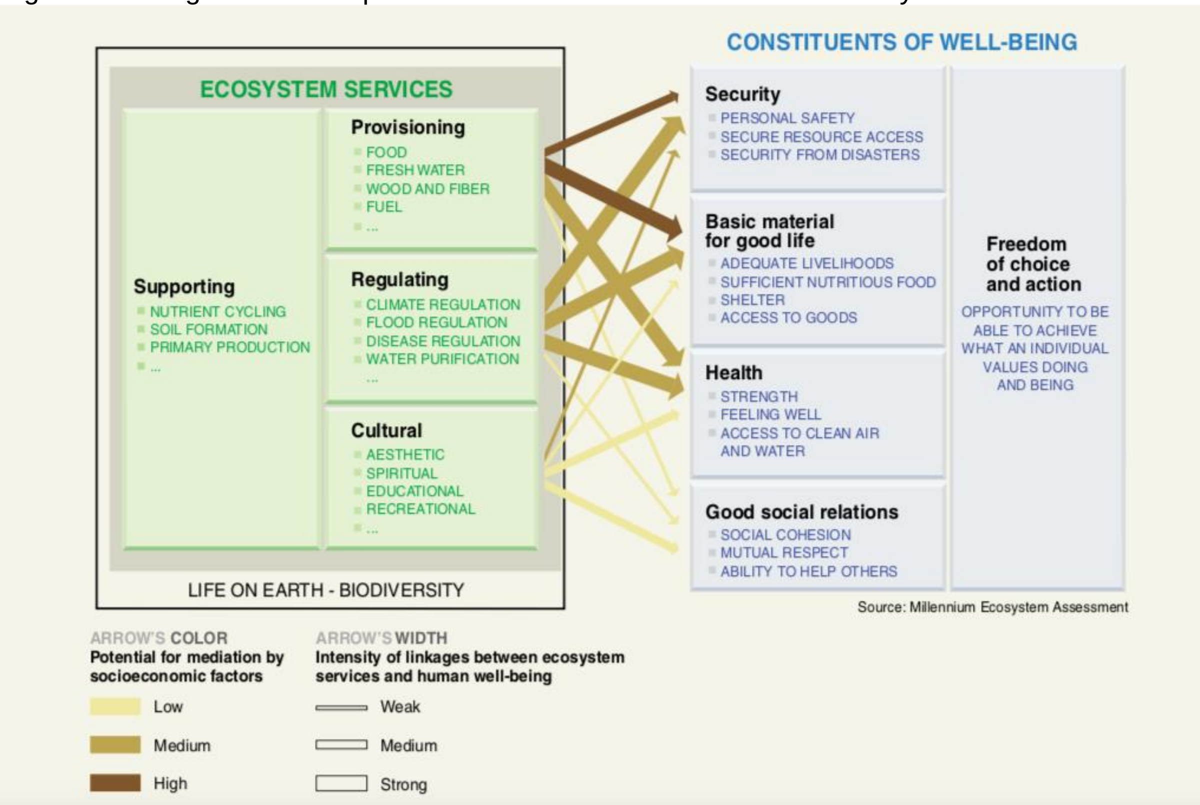
The recent applications for the release of GM potato derived from DSI in Rwanda illustrate this issue. The Rwandan government has been fast-tracking the development of a biosafety policy and legal framework that would enable the release of the first GM crop to be grown in Rwanda – a GM potato variety named 'Victoria', genetically modified to be resistant to late blight (ACB and PELUM Rwanda 2020). The genes used, originally from South America, were synthesised from sequences that researchers downloaded from GenBank. For indigenous people this use of their genetic material and traditional knowledge appears as a form of 'digital biopiracy', contrary to their interests and harmful for potato farmers in Africa and the South American Andes. These practices point to a DSI as a potential "free for all" by companies, that call for negotiation of international treaties in the post 2020 Global Biodiversity Framework discussions on what users can (and cannot) do with DSI to protect public interest (ACB & TWN, 2019b).

[2] The terminology is not consensual and DSI is seen as a placeholder term. The Africa group would prefer the term "natural information" or "genetic information" (African Group of Negotiators on Biodiversity-Ad Hoc Group on Digital Sequence Information 2019)

Health and wellbeing impacts of current and projected trends

The degradation of ecosystems and the loss of biodiversity directly affect the well-being and livelihoods of humans, and of societies on the whole (CBD, 2010). Indeed, the COVID-19 and other zoonotic outbreaks such as Ebola are illustrative of the complex interactions between deforestation, reduced biological diversity, ecosystem destruction, and human health and safety, in large part driven by the globalised industrial agriculture and food system. The deep-cutting into forests for agricultural development and commodification of wildlife are the sources of todays' zoonotic pandemics: "Rampant deforestation, uncontrolled expansion of agriculture, intensive farming, mining and infrastructure development, as well as the exploitation of wild species have created a 'perfect storm' for the spill over of diseases from wildlife to people." (Settele et al., 2020; online). The factors driving declines in biodiversity in ESA, including monocropping and plantation expansion and intensified livestock production suggest that the region faces a risk of such outbreaks (Bills, 2008).

Figure 3. Linkages and co-dependencies at the intersection of biodiversity and human health



Source: WHO & CBD, 2015:27

For people to be healthy, they need healthy environments. In 2015, the World Health Organisation (WHO) and the Convention on Biological Diversity (CBD) released a joint paper on how biodiversity and health interconnect. They identified "ecosystems services" that perform multiple 'ecological health' functions: provisioning (food, freshwater, biomass), cultural (aesthetic, spiritual, recreational), regulating (of the climate, floods, diseases, water purification) and supporting (nutrient cycling, soil formation, primary production). These are social determinants of health that affect the conditions of daily life and health, as depicted in *Figure 3* (WHO and CBD, 2015). Biodiverse rich ecosystems provide clean air, water and food, as well as plant species for medicines, with about and 50% of modern medicines developed from natural products (WHO and CBD, 2015; IUCN, 2019). Even within our bodies, the microbial communities "in our gut, skin, respiratory and urino-genital tracts, contribute to our nutrition, regulate our immune system, and prevent infections". (WHO and CBD, 2015:1). The adverse health effects caused by loss of biodiversity exceeds the dangers posed by climate change to human health, even while there is a two-way interaction between biodiversity loss and climate change (WHO and CBD, 2015).

Biodiversity contribution to food security and nutrition

Plant genetic resources for food and agriculture underpin food production and nutritional well-being. Avoiding nutrient deficiencies and boosting immune systems is best achieved through eating a varied diet (FAO 2010). While the latest national biodiversity study conducted in Zambia estimated that one-third of rural households harvest wild food resources in the form of fruits, mushrooms and roots/tubers, it also raises how overexploitation and overharvesting are depleting wild-food resources such as edible caterpillars, affecting dietary quality, while reports from Zimbabwe point to the loss of biodiversity affecting medicinal plants (FAO, 2019). The erosion of biodiversity due to changing agricultural patterns and the invasion of species discussed earlier further undermines dietary quality and food security. An example of this is in the Asian toads, which invaded Madagascar in the early 2010s. These toads have been proven in South East Asia to have toxins that are lethal for humans. Predators that feed on them and on rats could be poisoned, which in turn is reported to increase the population of black rats, and thus increased losses of stored food. The impacts on human health are potentially two-pronged: the Malagasy commonly eat frogs and could suffer poisoning and increase in rat numbers could undermine food stocks and lead to an increase in rat borne diseases, with plague already present in the incursion area (McClelland et al. 2015).

Biodiversity contribution to medicines

Natural products from plants and animals are extremely important sources of pharmaceutical products. In some African and Asian countries, up to 80% of the population depends on traditional, mainly herbal, medicine, while natural products have also been used in western medicines, such as for cancer (FAO 2010). A loss in biodiversity thus diminishes these raw materials and affects the management of illness (Alves and Rosa, 2007). It is estimated that over two thirds of the 50,000 medicinal plants in use today are still harvested from the wild, from which 4,000–10,000 may now be endangered (Hamilton, 2003). Many of the natural products that led to allopathic medicines emerged from the ESA region, such as Taxol (*Taxus brevifolia*), Vinblastine (*Catharanthus roseus*) used in cancer therapies, antimalarial drugs such as quinine (*Cinchona* spp.) and artemisinin (*Artemisia annua*) used to treat malaria. Natural products provide source materials for innovative medicines, although with caution on the use of DSI systems that may lead to extraction of these genetic resources without benefit for the region

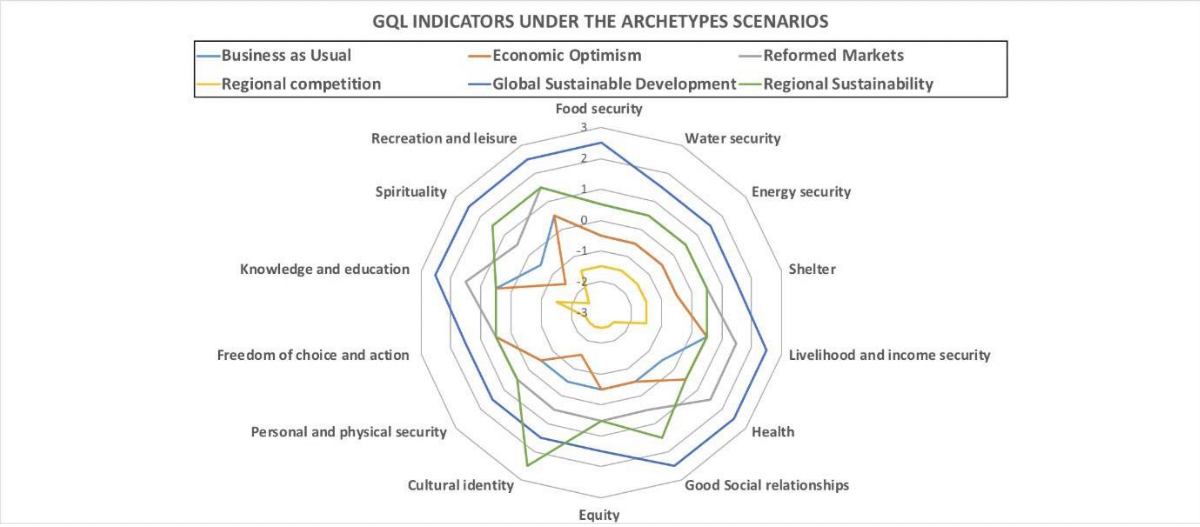
Nutritional and non-communicable disease risks related to loss of biodiversity

ESA countries are confronted by the triple burden of communicable, re-emerging and non-communicable diseases, with the latter a rising cause of illness and fatalities. The loss of species and mono-cropping described earlier undermines the diversity of diets, adding to the risk factors for non-communicable diseases (NCDs) in the region. Diets are shifting towards more fats and processed foods, leading to an increase in diabetes, hypertension and heart disease non-communicable diseases and obesity (WHO, AFRO, undated). An erosion of cultural values and traditional knowledge is adding to this, as public perceptions shift towards a preference for processed foods, reducing the appreciation of and abandoning ESA country biodiversity for food and agriculture. In Kenya for instance, despite the highly documented benefits of african leafy vegetables (International Plant Genetic Resources Institute, 1999), consumer perceptions of them as associated with poverty and low status and demand for them has fallen, while their diverse and often wild or weedy nature makes them easily exploitable as horticultural crops (Biodiversity International, 2020).

A projection of declining future well-being from biodiversity loss

Different future scenarios governed by market forces suggest that multiple dimensions of good quality of life (GQL), both material and non-material, can be expected to decline in the future, although scenarios where markets are reformed in the interest of sustainability result in improved GQL outcomes, as shown in *Figure 4* (IPBES, 2019). Projections of the impacts of land use and climate change on biodiversity and the impact on people's food security and wellbeing in ESA between 2015 and 2050 indicate that the region would be highly affected under adverse scenarios, more-so than for other regions globally (IPES 2019). This reflects the reliance in the region on small-scale farming, fishing, harvested forest products and other features of local environments for incomes and food production. In Zambia, for example, forests have been estimated to supply over 20% of the income of rural households (Puustjärvy et al., 2005).

Figure 4. Dimensions of good quality of life under different scenarios



Source: IPBES 2019:120 The numerical scale (-2.5 to 2.5) refers to the progress from "very negative" status = -2.5 to "very positive" status = 2.5 in the corresponding GQL indicator.

The threat of current and future pandemics: drawing lessons from COVID-19 and Ebola

The current COVID-19 pandemic and the previous experiences of Ebola, Zika, MERS, and SARS show the direct relationship between biodiversity and health and the risk to health, immunity and human security of loss of habitats and biological diversity and human health and safety. The trends described in earlier sections are reshaping of eco-landscapes and animal and wildlife trading in ways that have disrupted the traditional protective functions that natural ecosystems play in keeping viral loads at bay, with a consequence in greater human-wildlife interaction and intensive livestock production. Factory farm expansion has pushed smallholder farmers more and more into the verge of wild life habitats, enabling the transmission of pathogens from wildlife to humans, directly or via intermediaries (IPBES, 2020; Wallace 2020a, 2020b).A region rich in diversity of vertebrates species can protect against this leap of vector-borne zoonotic diseases to humans, diluting the risk of humans contracting zoonotic diseases, as a form of biodiversity buffer (Pati et al, 2o18).. The decline in species diversity, urbanisation, global wildlife trade, marketing and consumption of bushmeat and other features described earlier in contrast damages this buffer (Wallace, 2020b; WHO and CBD, 2015; Katani et al., 2019).

The emergence of the biggest Ebola outbreak ever recorded in West Africa in 2014-2016, which infected over 28,000 people with over 11,000 fatalities provides a further demonstration of this risk (WHO, 2016). Rice and coffee plantation production in Guinea, one of the epicentres of the outbreak, opened up vast tracts of land, including in Guinea’s forests, dispossessing smallholdings and traditional foraging grounds, adding intensive agriculture to mining and logging to create conditions for the emergence of the epidemic: “Commoditizing the forest may have lowered the region’s eco-systemic threshold to such a point that no emergency intervention can drive the Ebola outbreak low enough to burn out. Novel spillovers suddenly express larger forces of infection. On the other end of the epicurve, a mature outbreak continues to circulate, with the potential to intermittently rebound”(Wallace, 2020b; online).

The integration of wet markets with industrial production through land use changes, combined with the destruction of wild ecosystems is thus argued to create perfect conditions for the spill-over of disease (Settele et al., 2020), disrupting the biodiversity buffer and increasing the risk of new pathogens spreading from animals to humans.

The impact is not only the immediate illness and fatalities from the epidemics, but as is taking place with COVID-19, the responses to contain risk have also disrupted supply chains, closing open food markets, often the main source of food in some ESA countries, which combined with concurrent shocks (locusts invasions discussed above) threaten food insecurity, contribute to spikes in food prices and undermine urban household food access (Famine Early Warning Systems Network 2020a; IPES Food, 2020). A disruption of fresh food supplies can lead to a shift towards consumption of processed foods, including to secure foods with longer- shelf lives due to supply chain disruptions, further undermining the quality of diets and raising the risk of diet-related non communicable diseases.

According to the recently published Global Risks report (World Economic Forum, 2020), the steady rise of deforestation over the past two decades can be linked to 31% of outbreaks such as Ebola, Zika and Nipah virus. The upsetting of natural equilibrium through deforestation is also linked to other human infectious such as malaria and leishmaniasis (Wlash et al. 1993). Populations living within or near fragmented forests have a much higher risk of infection due to increased contact with vectors at forest edges and the reduced biodiversity of the area. Research has for instance shown that human-vector contact in newly created forest edges led to increased risk of malaria in communities in South America (Chen, 2015).

These risks and pandemics resulting from the human encroachment on nature are projected to grow, given the projections based on current trends of further biodiversity loss, discussed earlier, and a warming and unstable climate (Wu et al., 2016). A resurgence of Zika, malaria, dengue fever and their expansion to new regions, moving to previously cooler, higher altitudes in East Africa, could potentially combine with outbreaks of new pathogens, from within the region or imported from other regions. Not all parts of the region will be equally affected, with viral haemorrhagic fever pandemic potential greater in areas where viral haemorrhagic fever outbreaks have previously occurred, such as West Africa or DRC, but also in areas currently considered non-endemic, with an “index case” having the potential to escalate into a widespread epidemic in the absence of intervention (Pigott et al., 2017). While the prevention of such risk is not solely related to biodiversity, the role it plays and the negative impact of persisting with current trends suggests a need for a review of responses and policy choices.

Responses, choices, and policies

Current responses and policy frameworks

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), created by the United Nations, observes that current decision-making processes in Africa tend to disregard or not give due recognition to biodiversity or the value of nature’s contributions to human well-being (IPBES, 2019). Many African countries have no policies in place that explicitly address the management of biodiversity for food and agriculture (World Bank, 2019).

Two international environmental agreements shape the conservation and use of plant genetic resources for food and agriculture, namely: the Convention on Biological Diversity (CBD) that rules any terrestrial genetic resources and the United Nations’ International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (‘the Treaty’), which applies only to a subset of species relevant to agriculture and food security. The Treaty is a legally binding instrument whose objectives are the conservation, sustainable use of and equitable benefit sharing from plant genetic resources for food and agriculture, in harmony with the CBD.

The Seed Treaty failure to reign in the industrial seed sector

The ‘Treaty’ is the only international instrument that attempts to create a global commons around plant genetic resources. It provides for farmers’ rights to save, use, exchange, and sell their biodiverse seeds (Aubry 2019 Mulvany, 2019). But, given pressure from the global seed industry and their influence on Western country positions, the Treaty has failed to adequality protect and empower farmer seed systems in the face of the concentration of seed value chains controlled by a few corporate giants. Low- and middle-income countries have thus lamented the failed multilateral system of access and benefit-sharing established by the Treaty (ACB and TWN, 2019a). Neither the Treaty nor the CBD provide safeguards that prevent the privatisation and commodification of seeds through patents and plant variety protection. These instruments have also failed to pushback against draconian seed laws and regulations, which limit the development and enhancement of local seeds on-farm. No regulations have come into force to rein in the increasing corporate seizure of seed systems through GMOs including second generation genetic modification and DSI (Kastler et al., 2019). Seed companies have historically tapped into the multilateral system without making any significant mandatory monetary payments to its Benefit Sharing Fund (BSF). A working group was actually established in 2014 to improve the Treaty and to set a revenue target for the system, but this faced North American opposition to fixing any specific funding goal (ACB and TWN, 2019a).

There were aspirations of defenders of seed and food sovereignty to address this in 2019 in the discussion of a reform of Standard Material Transfer Agreement (SMTA), a mandatory model/template for parties wishing to provide and receive material under the multilateral system. It takes the form of a "subscription system" that requires companies/ breeders to make an annual payment to the BSF, linked to seed sales, in return for access to more than a million seeds in the multilateral system. In the negotiations, south countries made it clear that any expansions of the coverage of the 64 crops – which contribute to an estimated 90% of calories, fat, protein, and weight consumed worldwide, but a fraction of the entire spectrum of plant genetic resources for food and agriculture, should be underpinned by adequate payments to the BSF and enforcement of a solid financial mechanisms (ACB and TWN, 2019a). However, the proposed subscription system failed to get traction during the 2019 negotiations due to the resistance from high income countries (Mulvany, 2019). The 2019 session also discussed the implementation of farmers' rights. A Farmers' Rights Ad Hoc Technical Expert Group was not able to complete its tasks, however, due to the "opposition of a block made by industrialized countries" and the restriction of these rights by the primacy of breeders' Intellectual Property Rights (Muzurakis, 2019: online). Since 2020, these discussions have been frozen and no agreements have been found to continue the working group to address unresolved issues.

Debates over DSI also unresolved

DSI as an issue emerged initially during discussions on synthetic biology under the CBD in 2013, and became a crosscutting issue in discussions under the CBD and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (the Nagoya Protocol in short). A coordinated process was thus established in 2017/18 at the 14th Conference of Parties (COP 14) to address the access to and use of DSI in scientific research, non-commercial and commercial activities, and as an international community to resolve diverging views of DSI (CBD, 2019). However, during the 15th meeting of the Treaty in 2019, disagreement over benefit sharing for DSI caused the collapse of a six-year negotiation aimed at overhauling the Treaty's benefit sharing system.

Discussion around DSI is multi-faceted and not limited to plant genetics. It also affects health, such as in the use of the Ebola genome sequences to develop medicines (WHO, 2018) and in efforts to enhance genetic information sharing in public-health emergencies to allow for timely exchange of pathogen specimens, while ensuring that benefit-sharing takes place (CBD 2019). DSI related to seeds is deeply socio-political, hinging on farmer's critical right to food sovereignty. The African group, the Group of Latin America and the Caribbean (GRULAC) and the Middle East Group share the desire to link DSI with benefit-sharing. Many developing countries have indicated that they will not support the adoption of a Post-2020 Framework that does not include this. However, discussions are caught in issues of terminology, with DSI itself a placeholder term, and the concept and scope very much in discussion. High income countries prefer the term "Genetic Sequence Data", as they are then not directly linked to plant genetic resources for food or agriculture and thus not subject to benefit sharing or the prohibition of patenting. However, farmer rights organisation have rejected this, explaining the clear link between these data sets and the physical plant and genetic resources they were extracted from, as discussed earlier. The outcome in the debates on the Treaty depends on the outcome in the debates on the CBD as the agreements need to be mutually supportive. DSI looms large on the

CBD's agenda during its intersessional work currently underway, and for negotiations in late 2020 and 2021 onwards.

Global instruments still allowing the extraction of genetic resources

The Agreement on Trade-Related Aspects of Intellectual Property ("TRIPS") of the World Trade Organisation (WTO) allow member states to broadly exclude plants from patentability (whether wild or obtained through conventional breeding methods of crossing and selection, hybridization, mutagenesis, genetic modification) (Oxfam, 2018). However, the TRIPS Agreement is silent with regard to naturally occurring material and does not list genetic material as an exception to patentability (Fowler 2010). This changed when the United States Supreme Court in *Diamond v. Chakrabarty* ruled that genetically-modified or engineered products are patentable so long as the patentee produces a product that "is not nature's handiwork, but his own." This opened the floodgates of gene patenting in the USA, Asia and Europe from the 1990s onwards.

Patenting has thus gradually been extended to cover plants and their parts and components, despite the existence of plant variety protection (PVP), a special regime for new plant varieties. Currently, patents are granted in many jurisdictions on the basis of claims relating to plant and/ or genetic characteristics. The patent gives the owner exclusive rights to breed, grow and sell the product. This restricts farmers from sowing, planting, harvesting or breeding that variety without permission. The presence of a single patented component in a plant may also create a barrier for research and breeding (Oxfam, 2018). Hence despite the TRIPS provisions excluding plants from patentability, a number of Free Trade Agreement's (FTAs) between low- and middle-income countries and the USA have included an obligation to provide for the grant of patents on plants. The number of patents on plant genetic materials by companies is sharply rising. It has increased a hundredfold from just under 120 in 1990 to 12,000 today (Schauenberg, 2019). Provisions in national laws may affect this, but by 2020 no ESA countries had granted any permits or their equivalents through the ABS-Clearing-House since the entry into force of the Nagoya Protocol and many ESA countries have not fully utilized the TRIPS flexibilities, their laws currently excluding only plant varieties and essential biological processes to obtain them (Oxfam, 2018).

The corporate control of genetic diversity is best exemplified by the patenting of marine gene sequences. A single German chemical company, Baden Aniline and Soda Factory owned by the BASF group, the largest global chemical production company, owns 47% of 12 998 patented marine gene sequences in 2017 (Blasiak et al., 2018). Moreover, more than half of all university patents were registered by the Yeda Research and Development Co. Ltd., the commercial arm of the Weizmann Institute of Science (Israel), exceeding the combined claims of the 77 other universities. The corporate ownership of marine global resources is more consolidated than that of the seed industry, which came under global scrutiny when a wave of agricultural mega mergers swept the globe (ACB, 2017). Yet the potential for commercialization of the genetic diversity of the oceans currently is resting in the hands of a few corporations and universities has not yet drawn similar levels of public attention, despite its potential long-term impact.

Critically reviewing global measures for nature-based solutions and net zero loss

ESA countries need to be vigilant in discussions on genetic loss and food security. The concepts of "nature based solutions" and "net zero loss" are one such example. The former are defined by the European Commission (2016:3) as: "actions […] and solutions to societal challenges […] which are inspired by, supported by, or copied from nature". However, this definition is rejected as enabling the neo-liberalisation and commodification of nature for elite economic players at the expense of widespread socio-ecological benefits (Kotsila et al. 2020). Nature-based solutions are often cited to include planting trees for reforestation, although the modalities of how this is done needs scrutiny (UN 2019). Yet, as noted earlier, natural ecosystems such as forests, soils, grasslands, estuaries and mangroves cannot be conflated with monoculture tree plantations, or their role in ecosystems.

The notion of "net zero" emissions, as a response to stabilizing global warming to below 2°C has been sent in law in some European countries, but with a possibility of international carbon offsetting to reach the goal. If displaced to ESA countries, this carbon offset can disproportionately shifts the burden to biodiverse-rich ESA countries, while high income countries continue high-emission trajectories. The UN Framework Convention on Climate Change provides for a REDD+ offset scheme, which encourages ESA and other low- and middle-income countries to protect and expand natural forests, with one REDD+ project currently in operation in Zambia. ESA countries need to ensure that such programmes to expand forests avoid violating indigenous land rights, disrupting local peoples' livelihoods and strategies, institutions and socio-cultural systems, with unequal benefit sharing, food insecurity, introduction of new powerful stakeholders, illegal land acquisition and unfair free prior and informed consent (Russell 2019). Such critiques of the REDD+ initiative raise a caution for ESA countries to assess such measures for their implications for their biodiversity interests.

A shift towards biodiversity and genetic resources as a common good

The evidence reported in this brief call for an urgent paradigm shift from industrial agriculture to diversified agro-ecological systems and a one health approach, that recognise the complex interconnections between human and animal health, plants and our shared environment. This means moving away from silos and taking the long-term and intergenerational costs and consequences for people and nature of development actions into account. For ESA countries it implies reintroducing biodiversity buffers through of widely diverse species and varieties in livestock, poultry, and seeds, with livestock and crops reproducing on-site, harnessing diversity, passing immune capacities to the next generation, and increasing disease resistance (Wallace, 2020a; IPES Food, 2020). It will be crucial to base local food security and nutrition on diverse and nutritious local varieties and crop wild relatives that harbour genetic adaptations to drought, pest and diseases resistance, grown with fewer resources and in harsh environments, drawing on the experience of small scale farmers in the region (Ceccarelli, 2009; Maxted et al., 2013; IPBES, 2020). The resulting genetic diversity will help ESA countries to contend the projected risks and increasingly uncertain and variable climatic patterns and pandemics (Wallace, 2016).

These policy choices become even more essential with climate change. They build on the momentum being generated by social movements across the world, linking small producers to local communities, and to continue providing food even under difficult circumstances, offering a glimpse of what new and more resilient food systems might look like. We need more genetic diversity, not less, and we need to vigorously defend genetic diversity as a common good, not something that can be extracted and privately profited from.

Photographs:
Above: Tsavo West National Park Kenya, DMCA, undated; Below: Menabe Madagascar USAID, 2019
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