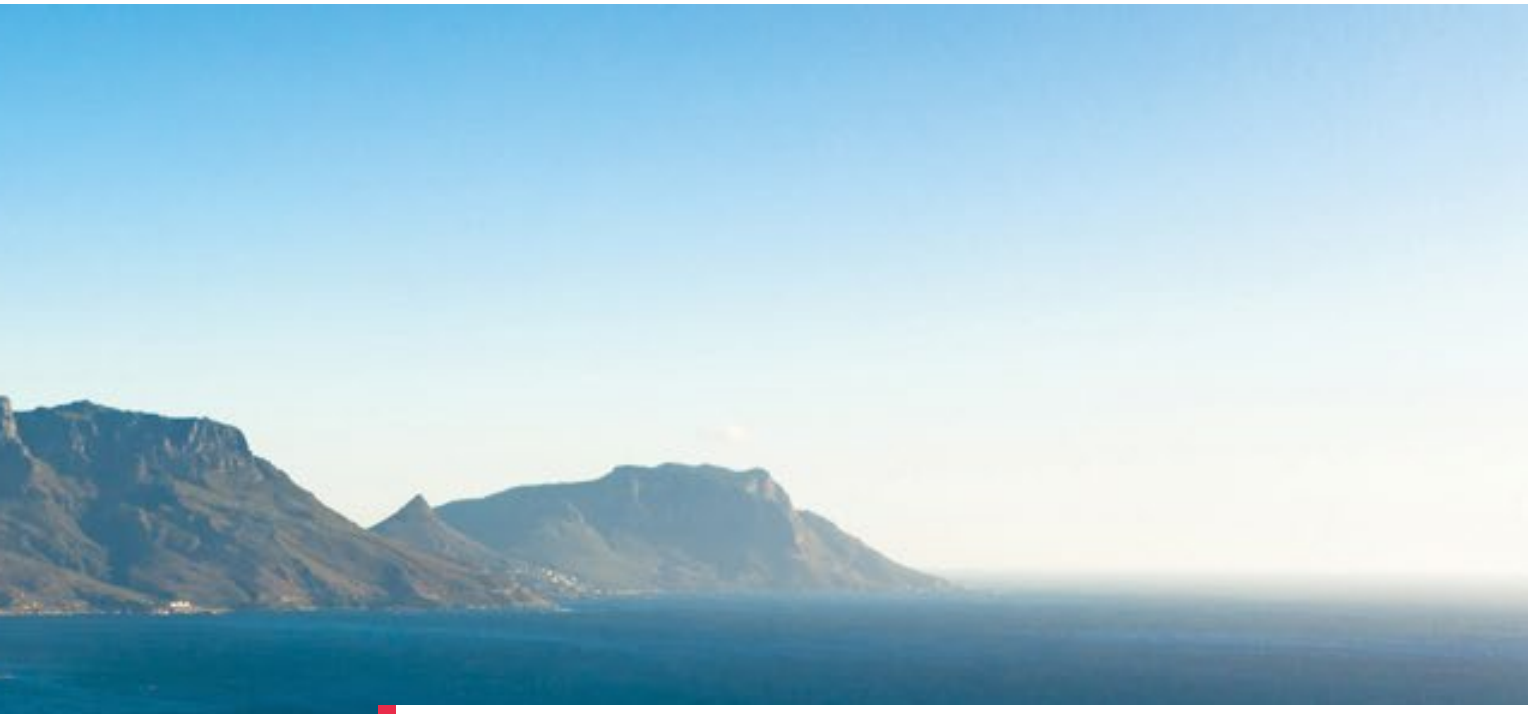
Murdoch University

The Murdoch Third Commission:

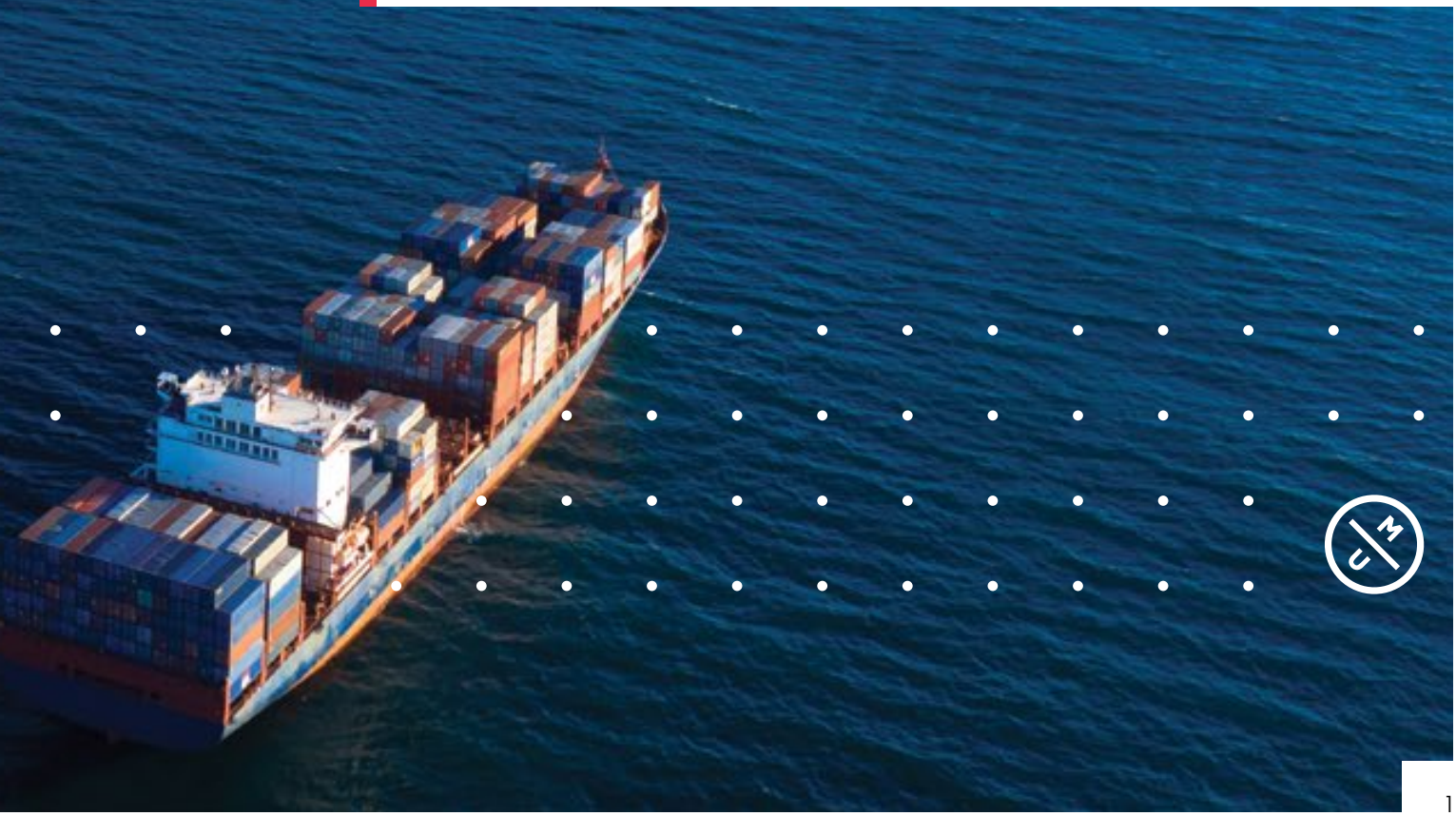
Inclusive Transitions on the Continent of Africa

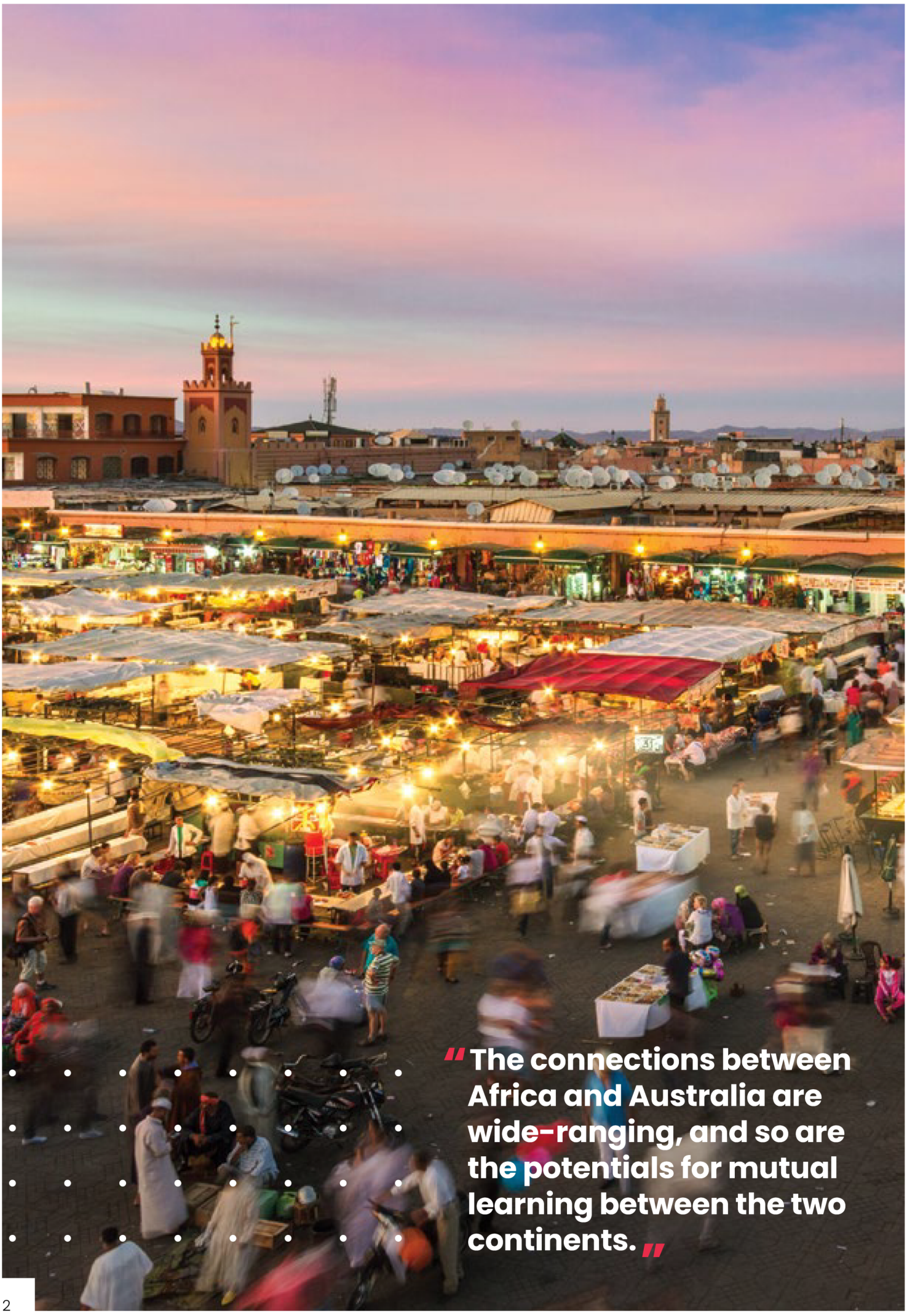
The Murdoch Third Commission:

Inclusive Transitions on the Continent of Africa



CONTENTS





"The connections between Africa and Australia are wide-ranging, and so are the potentials for mutual learning between the two continents."

INTRODUCTION

The Murdoch Commissions address cross-cutting policy challenges relevant to Australia and the rest of the world. They highlight today's essential priorities and propose solutions to ensure a better tomorrow. In keeping with the University's commitment to research translation for the global public good, the Commissions have been exercises in applied public policy informed by rigorous research and analytical thinking.

The University's latest and Third Commission tilts focus both thematically and geographically. Drawing lessons from the shared experiences and connection between Africa and Australia, two continents linked via the Indian Ocean, it explores viable transitions towards inclusive development globally.

The connections between Africa and Australia are wide-ranging, and so are the potentials for mutual learning between the two continents. Africa and Australia are linked by the Indian Ocean and have similar natural resource endowments and diverse geographic features. This makes both continents prime destinations for beneficial trade and technology/knowledge sharing, including sustainable agriculture, extractive industries, the blue economy, trade, education, and much more. The commonalities also provide a myriad of opportunities for enhanced research and innovation that can benefit both Africa and Australia and contribute significantly to global sustainability.

This Commission focuses on several African priorities linked to the Sustainable Development Goals (SDGs) and the African Union's Agenda 2063.[1] These priorities are of immense importance to current global transitions. The Commission heeds recommendations for action from the influential body of work from the Africa Progress Panel, chaired by the former United Nations Secretary-General, Kofi Annan[2] produced during its ten-year tenure (2007-2017). In that context, it also investigates and highlights globally relevant research and innovation produced by Murdoch University with African and other partners worldwide towards inclusive transitions in the global economy.

> **"Africa and Australia are linked by the Indian Ocean and have similar natural resource endowments and diverse geographic features."**

[1] African Union Commission. (2015) *Agenda 2063. The Africa We Want*. ISBN: 978-92-95104-23-5 Available at https://au.int/sites/default/files/documents/36204-doc-agenda2063_popular_version_en.pdf [accessed 30 June, 2021]

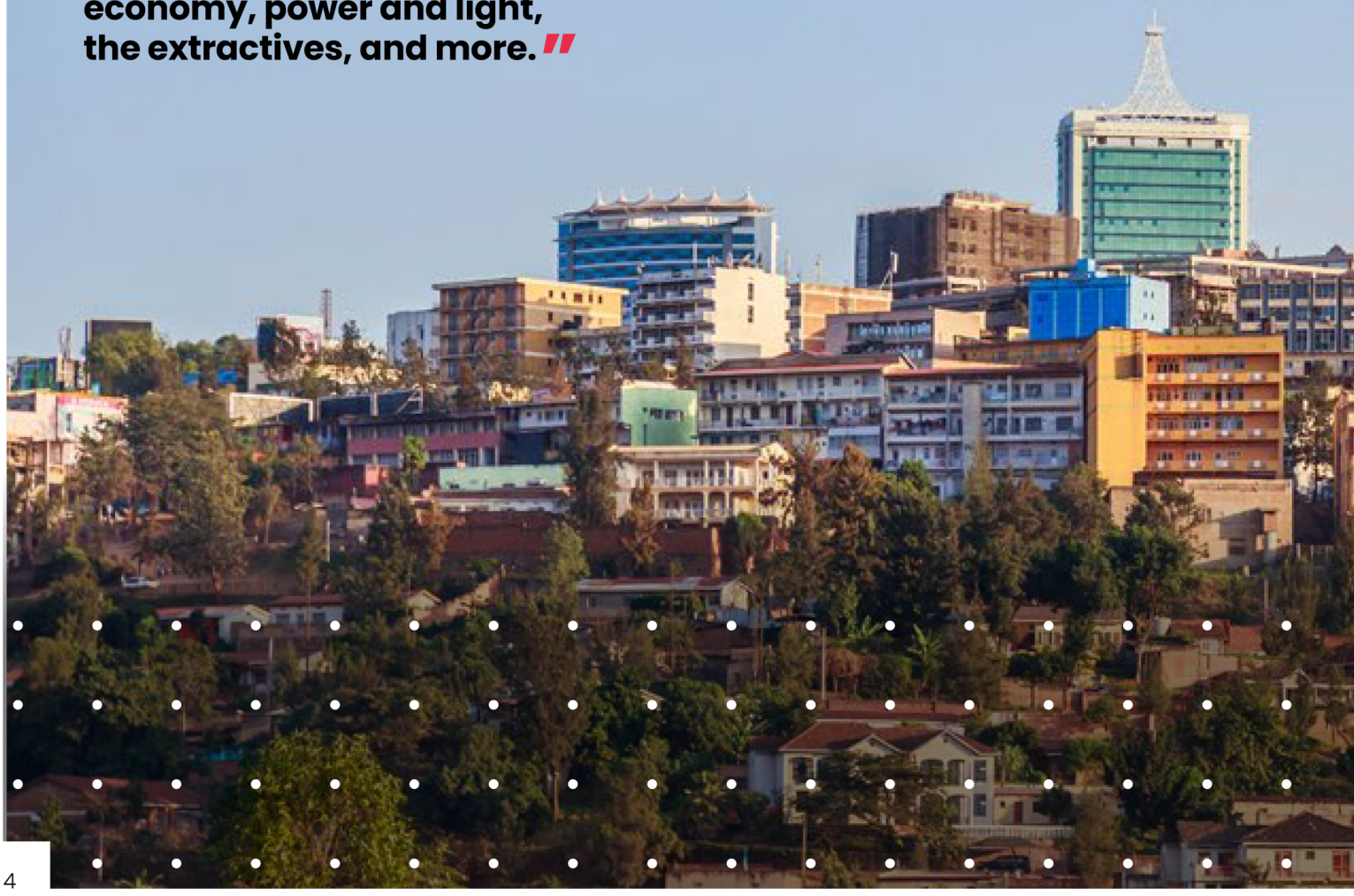
[2] https://www.kofiannanfoundation.org/tag/africa-progress-panel-45/

The year 2020 marked five years since the global community set the 2030 SDGs[3] in 2015. Achieving these global goals requires inclusive transitions – meaning transitions that leave no one behind. The year 2020 was also a once-in-a-century global pandemic with devastating socioeconomic impact. A pandemic predicted and anticipated only by a few and prepared for by almost no-one, the catastrophic health and economic ramifications continue to develop. The Third Commission has undertaken additional research during 2020 and into 2021 to glean insights from the African pandemic experience and reflect those throughout the volume. We offer a confident and optimistic view that like so many other global shocks, the COVID-19 pandemic lessons will be learned and incorporated into our collective policy work into the future rather than simply forgotten.

Africa, a continent of 54 countries and 1.3 billion people, indeed demands an exceptional and special focus in any discussion of inclusive transitions to achieve the SDGs for several reasons. Without success in Africa, these global development goals will not be achieved. Africa constitutes about 16 per cent of the world's population, holds about 65 per cent of the remaining arable land worldwide, and enormous potential in renewable and non-renewable resources in several sectors, including agriculture, the blue economy, power and light, the extractives, and more. With 41 per cent of its population currently under the age of 15 years (contrasted with 28 per cent in Central America, and 24 per cent in Asia and South America), Africa is the most youthful population of all continents today. More than half of the world's population increase over the next thirty years is forecast to be in Africa.[4] By 2100, 80 per cent of the world's population will be in Africa and Asia. How Africa's wealth of natural and human capital is managed will define our common future – the sustainability of the global economy and the environment. For example, if properly harnessed, Africa's demographic trends could present great opportunities for inclusive transitions with significant implications for sustainable development globally. On the other hand, it could present significant risks for increased population pressures in the African States, deepening rural poverty, social inequalities, and environmental degradation in rural communities. These will in turn, exacerbate unskilled youth migration and the attendant societal, economic, and environmental fragilities within and across national and continental borders.

"Africa constitutes about 16 percent of the world's population, holds about 65 percent of the remaining arable land worldwide, and enormous potential in renewable and non-renewable resources in several sectors, including agriculture, the blue economy, power and light, the extractives, and more."

Africa's macro-economic and fiscal policy governance has been improving steadily during the past two decades. Despite several global headwinds, African economies remain resilient, with average GDP growth above the global average through the period. In 2019, six of the ten fastest-growing economies in the world were in Africa. In 2020 the impact of the pandemic had seriously affected Africa's growth projections. However, it also appears that Africa may prove to be less affected than many other regions in the world. The 4th industrial revolution technologies are taking roots in Africa, disrupting known



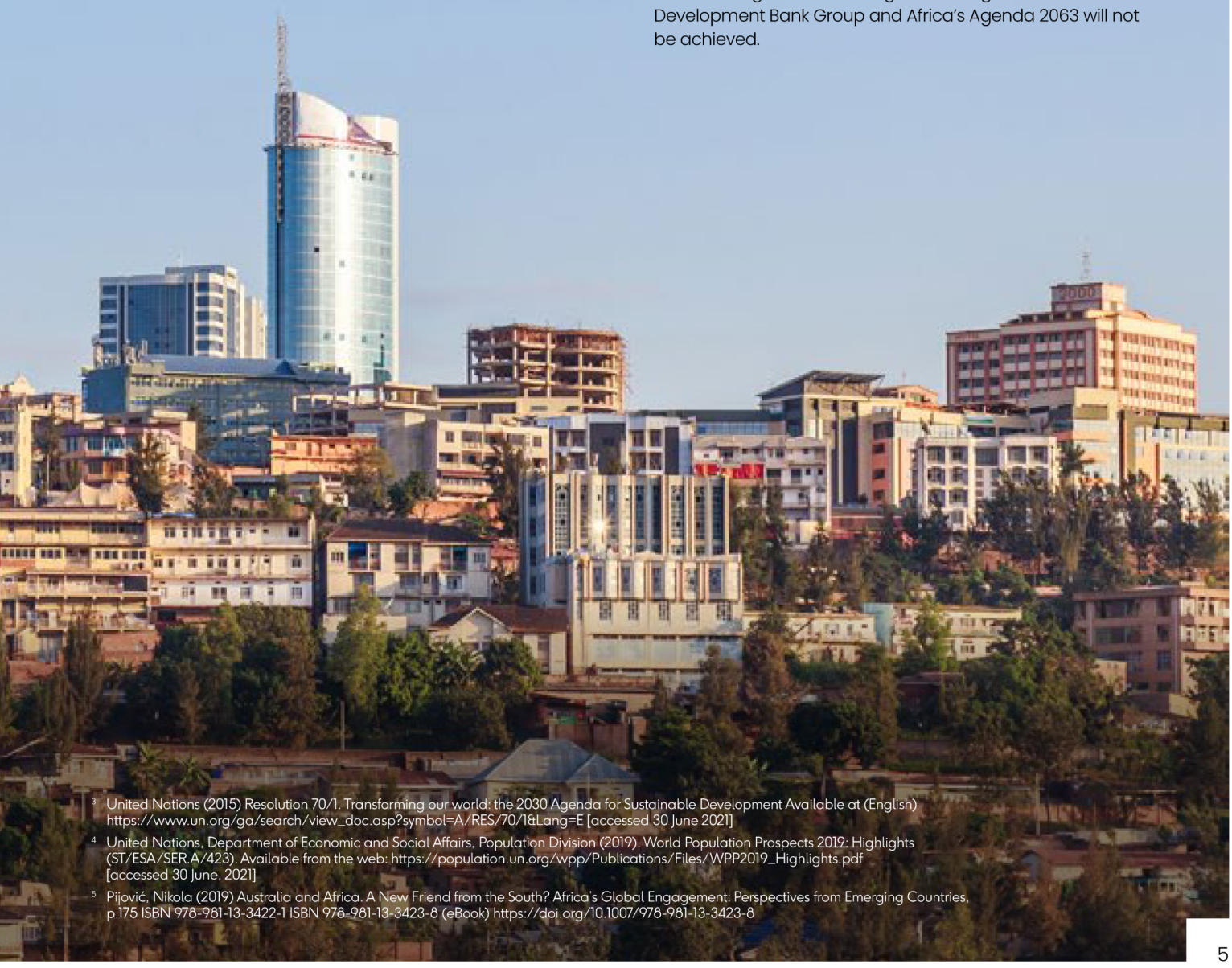
patterns of economic growth. Currently, Africa and Oceania are the only continents with projected positive annual market growth between 2019 – 2030. Although the rate of structural transformation in African economies remains marginal, the resilience of many African economies presents case studies for sustainable development scholars. Many scholars increasingly consider Africa as the next growth hub of the world.

With few exceptions, several of the African countries, which, like Australia, have geographic and historical links with the Indian Ocean region (including Egypt, Ethiopia, Tanzania, Kenya, Mozambique, Sudan, and South Africa) are either among the fastest growing economies in Africa or are facing challenges including sharp demographic transitions. These include growing youth unemployment and other socio-economic challenges such as migration and terrorism. Seen from an Indian Ocean rim perspective, these demographic and structural transformations present significant opportunities, including trade, technology sharing, and research for development. Alongside the many opportunities are also risks, such as unskilled migration and bio-insecurity.

In the above context, the Commission highlights the mutual benefits of a strengthened partnership between Africa and Australia in trade, research and development, technology sharing, and inclusive transitions globally. The time is ripe for establishing an enhanced, long-lasting, and synergistic partnership between the two continents, especially in sectors of common interest explored in this volume. Such a partnership could present significant opportunities for Perth (and the state of Western Australia) to become the gateway for trade, technology sharing and collaborative research for development between Africa and Australia and the Asia Pacific region. If well harnessed, this shift will realise the great potential for a new long-lasting enhanced synergistic partnership between the two continents addressing the accusation that Australia "punches way below its weight"[5] in its relations with Africa.

The Third Murdoch Commission focuses sharply on the key priority sectors of mutual interest that could accelerate the partnership between Africa and Australia and boost inclusive transitions in Africa without which the SDGs will not be achieved. These include: (i) achieving a uniquely African agricultural revolution for a healthy Africa. (ii) boosting the blue economy in Africa; (iii) lighting up and sustainably powering Africa; (iv) equitable natural resource management with a focus on the mining industry; and (v) delivering a demographic dividend across Africa. In addition, the report juxtaposes these sector-specific priorities with several cross-cutting issues that underpin inclusive and sustainable transitions. These include mainstreaming gender equity, human capital development, climate change mitigation and adaptation, COVID-19 adjustments, as well as addressing informal economies and the underpinning cultures of Indigenous peoples in Africa and Australia.

Through a critical assessment of these thematic and cross-cutting policy questions, the Commission seeks to provide recommendations to inform inclusive transitions in Africa and the Indo-African regions, without which the SDGs and other continental goals such as High 5s strategies of the African Development Bank Group and Africa's Agenda 2063 will not be achieved.



[3] United Nations (2015) Resolution 70/1. Transforming our world: the 2030 Agenda for Sustainable Development Available at (English) https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E [accessed 30 June 2021]

[4] United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019: Highlights (ST/ESA/SER.A/423). Available from the web: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf [accessed 30 June, 2021]

[5] Pijović, Nikola (2019) Australia and Africa. A New Friend from the South? Africa's Global Engagement: Perspectives from Emerging Countries, p.175 ISBN 978-981-13-3422-1 ISBN 978-981-13-3423-8 (eBook) https://doi.org/10.1007/978-981-13-3423-8

ACKNOWLEDGEMENTS

The Murdoch Third Commission commenced in 2018 and represents the work of dozens of deeply knowledgeable and skilled researchers and practitioners who graciously contributed their time and insights via authorship and review of both individual and multiple chapters.

Authors

Mr. David Doepel, Mr. Maximilian Jarrett, Dr. Mark P. McHenry, Prof. Kevin Urama, Dr. Lauren Johnston, Ms. Esther Harris, Ms. Susan Pendame, Prof. Jeremy Prince, Prof. Gavin Hilson, Prof. John Dixon, Mr. George Mburathi, Dr. Ben Roennfeldt, Dr. Gloria Rupf, Dr. Paul Jourdan, Dr. Athur Mabiso, Dr. Tilahun Amede, Mr. Christopher Auricht, Mr. Timothy Olalekan Williams.

Reviewers

Dr. Peter Johnston, Dr. Rochelle Spencer, Prof. Hudson Mtegha, Dr. Valeria Merino, Dr. André Standing, Dr. Jonathan Munguti, Mr. Mark Amechi, Ms. Bethelhem Belayneh Kassaye, Mr. Tunde Akerele, Mr. Tom Minney, Prof. Yacob Mulugetta, Mr. Wanjohi Kabukuru, Dr. Daniel Puig, Prof. Peter Lamptey.

The Third Commission also gratefully acknowledges the contributions of The Blue Economy Forum (2018, 2019), Africa Down Under (2019, 2020), Africa Professionals Association, Kenya Marine and Fisheries Research Institute (KMFRI), Blue Jay Communication, TransOcean Group, Minespider AG, Luma Holding Ltd. Carrières et Chaux du Mali, and the Global Community of Practice (G-CoP) of the African Development Bank and FiTI and the following individuals associated with these events and organisations and the MtM/SAIMM Forum at The University of Cape Town. Mr. Bill Repard, Ms. Christine Oelschlaeger, Ms. Cynthia Musafili, Mr. Tommy Adebayo, Dr. Akeem Lawal, M.D., Dr. Molapo Selepe, Dr. Bahati Moseti, Dr. Jonathan Munguti, Dr. Njeri Wabiri, Mr. Jamie Henderson, Mr. Nathan Williams, Dr. Madani Diallo, Ms. Aleksandra Cholewa, Ms. Jennifer Hoffman, Ms. Leila, Prof. Radosław Miśkiewicz, Ms. Alysha Lotter, Prof. Peter Elgen, Mr. Kojo Annan and Prof. James Njiru.

Finally, The Third Commission acknowledges the unwavering support of former Vice Chancellor Prof. Eeva Leinonen, and the continuing oversight and encouragement of Deputy Vice Chancellor Prof. David Morrison in the development and delivery of "Inclusive Transitions on the Continent of Africa".

Acknowledgement of Country

We acknowledge that Murdoch University is situated on the lands of the Whadjuk and Binjareb Noongar people. We pay our respect to their enduring and dynamic culture and the leadership of Noongar elders past and present. The boodjar (country) on which Murdoch University is located has for thousands of years, been a place of learning. We at Murdoch University are proud to continue this long tradition.

THE METHODOLOGICAL APPROACH OF THE THIRD COMMISSION

The Commission's approach was to base its work on a globally respected and acknowledged body of current thinking and advocacy. The Commission intentionally built on this and took it forward rather than 'reinvent the wheel' in an already crowded field.

The Commission framed its initial analysis within the context of the findings and core recommendations of the highly respected Africa Progress Panel (APP) and discussion of the global and regionally-specific reaction to it. In that context, the Commission undertook consultative expert reviews of the progress, or lack of progress, since the APP interventions in several SDG's relevant core areas and the most recent published academic literature.

Rather than addressing the entire decade of the APP operations, the Commission narrowed its focus to the action agenda emanating from the Africa Progress Reports and policy papers published in 2013, 2014, 2015, and 2017. These papers most closely aligned with the policy direction at the heart of the 2030 Global SDGs and the agenda of the African Union's Agenda 2063, hence endorsed at the highest political levels.

At the same time, other high profile related regional implementation initiatives, such as the High 5s agenda of the African Development Bank, were also essential guides to our work at the onset and throughout the Commission's term.

As a starting point and through the lens of the SDGs and Agenda 2063, the Commission investigated issues and actions highlighted by the APP:

1) a uniquely African green and blue revolution (in the agriculture and fisheries sectors) to boost productivity, smallholder farmer incomes, improved nutrition and health outcomes, the livelihoods of fishing communities, driving the transformation of the continent as a whole;
2) the need for rapid rollout of low carbon, efficient and universal power and light energy systems across the continent; and
3) improved equity and inclusive growth in the extractives sector using the mining industry as the focal point.

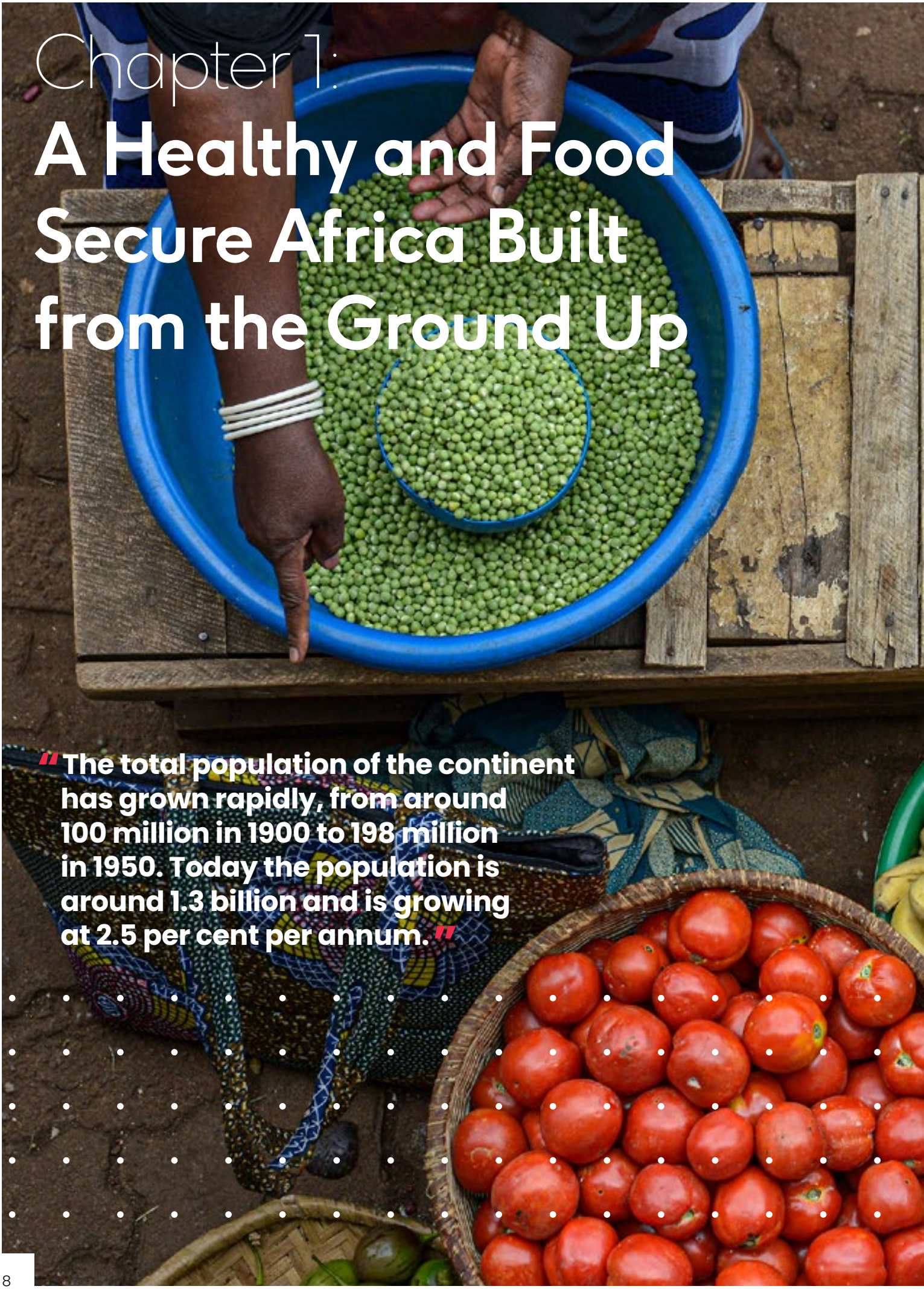
Additionally, the Commission selected cross-cutting themes of youth, gender, and climate change that spoke to a unique contribution Murdoch University, and, by extension, its peers and academic partners could make based on its decades of engagement on the continent.

Using the APP's action agenda as the springboard, the Commission developed summaries on each identified theme. These summaries catalysed discussion for the blue economy and extractives sector at a series of subject matter expert round tables conducted in 2018 and 2019, convened during international meetings on the relevant topic.

At these events, the Commission elicited feedback in an interactive Chatham House Rules style round table. This process was instrumental in providing input and feedback to develop draft chapters that were then further circulated to select 'subject matter experts' (invited by the University to serve as independent peer reviewers). The Commission modified its format during the COVID-19 pandemic and moved to a virtual program for the other chapters. By partnering with the African Development Institute (ADI) of the Africa Development Bank (AfDB) for their Eastern Hemisphere Global Community of Practice (G-CoP) seminars, the Commission was able to access a significant number of experts from Africa and the diaspora to join the discussions over six virtual meetings in 2020 and 2021.

Finally, the Commission considered and incorporated peer reviewer feedback and then circulated a penultimate draft to a select group of experts and influential individuals for final feedback before tabling with the Murdoch University Senate. The Third Commission on Africa was launched at the Africa Australia Research Forum in Perth as part of 'Africa Week' in August 2021.

"The Commission intentionally built on this and took it forward rather than 'reinvent the wheel' in an already crowded field."



Chapter 1:
A Healthy and Food Secure Africa Built from the Ground Up

"The total population of the continent has grown rapidly, from around 100 million in 1900 to 198 million in 1950. Today the population is around 1.3 billion and is growing at 2.5 per cent per annum."

INTRODUCTION

Viewed from space, the Earth shimmers with a thin blue layer that is our atmosphere. A dynamic concoction of gases and water vapour a few kilometres thick sustaining life as we know it on our planet. There is also a much thinner layer, in some places measured in centimetres, equally crucial for sustaining life. Over impossibly long periods of geological time, the rocks that agglomerated to form our world have weathered and become soils in a process known as pedogenesis. Africa's soils are complex, spatially varied, and teeming with biota. They are the foundation, literally, for terrestrial life and our food webs.

Africa has fed herself for millennia. Numerous trade and economic indicators suggest that today this is still occurring in many rural parts of Africa. However, in parallel, there are substantial food imports to many urban populations, partly driven by changing food habits and an increasing middle class. The total population of the continent has grown rapidly, from around 100 million in 1900 to 198 million in 1950.[1] Today the population is around 1.3 billion and is growing at 2.5 per cent per annum. Cities have grown enormously, but there is also a significant increase in rural population densities in more favourable lands, and substantial populations have been forced into more marginal areas. These patterns of migration create intense pressure on agricultural resources and food system stability.[2] These patterns also contribute to continued undernourishment of tens of millions of Africans with highly correlated poor health and wellbeing outcomes.[3]

Because of changing demography, technologies, markets, and policies, current African farming systems are very different from those of 100 or even 50 years ago. In fact, "pre-colonial African societies had evolved sophisticated techniques ranging from shifting cultivation and rotational bush fallow to rotational planted fallow, mixed farming and 'permanent' farming, which were suited to the needs of their people and their fragile environment, and which helped them to cope with cyclical droughts and crop failures due to other causes. Adequate food, security, and self-reliance were common before the imposition of European colonialism. Methods had been developed for storage of surpluses and complex patterns of trade had been developed around food availability. Patterns of redistribution and reciprocal relationships had been established between households and between communities, which in turn augmented or reinforced society's ability to withstand a crisis of food shortage."[4]

[1] Cameron (1993) *Concise Economic History of the World*. New York: O.U.P.

[2] Dixon J, Garrity DP, Boffa J-M, Williams TO, Amede T, Auricht C, Lott R, Mburathi G (eds) (2020) *Farming Systems and Food Security in Africa: Priorities for Science and Policy under Global Change.* Earthscan Food and Agriculture Series. Routledge.

[3] Samuel Ayofemi O. Adeyeye, Tolulope J. Ashaolu, Olusola T. Bolaji, Titilope A. Abegunde & Adetola O. Omoyajowo (2021): Africa and the Nexus of poverty, malnutrition and diseases, Critical Reviews in Food Science and Nutrition, DOI: 10.1080/10408398.2021.1952160.

[4] Darkoh MBK (1989) The Underlying Causes Of The Food Crisis In Africa. *Transafrican Journal of History*, Vol. 18, pp. 54-79. See also Allan W (1965) *The African Husbandman*. Oliver and Boyd, reprinted by International African Institute, on farming systems a century ago, and Ruttenberg H (1971) *Tropical Farming Systems*, Oxford University Press, on African farming systems of the 1950s and 1960s.

This Indigenous understanding of farming and food systems is still an indispensable asset for dealing with today's food and nutrition security challenges with double or treble the rural population density and surging urban growth. Adaptation of this local knowledge, in concurrence with adoption of critical external inputs, improved technologies and practices, will remain crucial for successful adoption of tomorrow's opportunities for farming and food systems as anthropogenic climate change bites, markets develop, and technologies evolve.[5] Selectively harnessing this 'hard earned' knowledge acquired by farmers over time with appropriate advances in science and technology can accelerate the stewardship of African farming systems towards greater food security and associated positive health outcomes locally, regionally, and to benefit from trade globally. Beyond the widely accepted definition of food security that "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life,"[6] elements of agency and sustainability have been added to the four core pillars of availability, access, utilisation, and stability.[7] A recent article by Fox and Jayne[8] from the Brookings Institution disaggregated the agricultural import and export data over the last two decades. They observed that "Sub Saharan Africa imported roughly $40 billion per year over the past four years while it exported roughly $35 billion. Moreover, the region's lower-middle-income countries, led by Côte d'Ivoire, Ghana, and Kenya, have become agricultural export powerhouses, with a net agricultural trade surplus of more than $5 billion per year." That said, analysis of agricultural produce indicates that much of the exports are commodity cash crops (including coffee, cotton, and cocoa), and the imports are dominated by food staples (and outside of the food sector, energy). In his acceptance of the World Food Prize in 2017, President Adesina of the African Development Bank drew attention to this contrast and called for increased value addition to commodity exports. "Africa produces 75% of cocoa but receives only 2% of the US $100 billion a year chocolate markets. The price of cocoa may decline, but never the price of chocolates. The price of cotton may fall, but never the price of garments and apparels. In 2014, Africa earned just £1.5 billion from exports of coffee. Yet Germany, a leading processor, earned nearly double that from re-exports."[9] Other analyses also draw attention to the major yield gaps (Africa has lower food crop productivity than other regions with only modest overall growth) and the great potential to intensify and diversify many African farming systems.[10]

Rural geographic differentiation by broad farming system/land use types is essential for the most useful analysis of technology, policy, and investment needs and for targeting and scaling of proven practices at regional or national levels. Such differentiation should include urban and peri-urban agricultural systems. The late Professor Michael Darkoh, the eminent economic geographer quoted above, described the food crisis in Africa in the 1980s as having its origins in the past: "...it has its roots in the history of Africa's relationship with the Western world. While not discounting the role of the geographical and internal factors". He argues that their "... consequences have been compounded because of the interaction with the historic patterns and external forces which are largely outside of control of African nations".

[5] Dixon et al. (2020) op cit.

[6] FAO (2001) *State of Food Insecurity*. FAO, Rome.

[7] FAO (2021) Food and Nutrition Security: Building a Global Narrative towards 2030. *High Level Panel of Experts Report 15*, Committee on Food Security, FAO, Rome.

[8] Fox L. and Jayne T. (2020) Unpacking the misconceptions about Africa's food imports *Africa in Focus* Available at: https://www.brookings.edu/blog/africa-in-focus/2020/12/14/unpacking-the-misconceptions-about-africas-food-imports/ [accessed 30 June, 2021].

[9] Available at: https://www.africaportal.org/features/africa-can-feed-itself-heres-how/#:~:text=Africa%20can%20feed%20itself%20%E2%80%93%20and,most%20important%20High%205%20priorities. [accessed August 9th, 2021].

[10] Dixon J, Gulliver A, Gibbon D (2001) *Farming Systems and Poverty: Improving Farmers Livelihoods in a Changing World*, FAO and World Bank. See also World Bank (2007) *World Development Report 2008: Agriculture for Development*. World Bank.

He went on to propose a clear philosophical approach for addressing resilience in Africa's food systems and called for an "...agricultural revolution that is pivoted on an indigenous science and technology that attempts to promote an organic link between the pattern and growth of domestic resource use and the pattern and growth of domestic demand." And without such an approach "...undernutrition, rural poverty, and political instability will increase." Prof. Darkoh's clarion call (penned over thirty years ago) for authentic African solutions has been picked up by many and is perhaps more relevant today, with continuing adaptations for prevailing climate, population, with new technological opportunities and market contexts. The late Kofi Annan, former UN Secretary General, who alluded to this concept of context-specific, home-grown solutions for Africa, advocated and spearheaded the creation of The Alliance for a Green Revolution in Africa (AGRA).

This opening chapter will outline and advance one approach that privileges smallholder and medium-scale family farming, taking into consideration the large youthful populations in rural areas with agricultural experience seeking both good working and living conditions and agribusiness opportunities. It is an approach that seeks to prioritise community-level resilience built on the application of local (and traditional) knowledge, agroecological capacity, judicious use of external inputs, and long-term adapted genetic resources concerning cost-effective input use efficiency and precision management. It is also a systems approach that advocates for regional and, more importantly, system-level scientific capacity underpinned by local extension services and village-based advisory services (VBAs) that prioritise soil health (rhizosphere), regreening of landscapes, rainwater management supplemented by small scale irrigation (growing in importance as an adaptation to anthropogenic climate change and increased variability), and crop resilience (to biotic and abiotic stresses). It is also a 'farming systems' approach incorporating 'Fourth Industrial Revolution principles' including appropriately scaled mechanisation, digital extension, smartphone-enabled market access with the active participation of youth and women.

The Third Commission fully recognises that agriculture and human nutrition are intrinsically linked, albeit in different ways for urban and rural populations, and in different ways for pastoral, semi-arid farmers with constrained market options, and those humid area farmers with good domestic and sometimes export markets. In recent decades agriculture and human nutrition have been poorly integrated in recent African planning or policy making—a major issue for Africa and the achievement of the SDGs. Therefore, this chapter integrates farming, food, and health-systems thinking, with consideration of energy, protein, and micro-nutrients, and the potential for health and wellbeing delivered by the same.

"The late Kofi Annan, former UN Secretary General, who alluded to this concept of context-specific, home-grown solutions for Africa, advocated and spearheaded the creation of The Alliance for a Green Revolution in Africa (AGRA)."

2. Farming Systems Underpin Food and Health

Farming systems zonation is a broad-based concept embracing resources and agricultural services, which determine rural livelihood patterns, including off-farm activities.[11] Rural food systems reflect the underlying farming system (a diverse diet depends on a diverse farming system) and are really an integral part of a broad concept of a farming system. The linkages to urban food chains also depend on the production surpluses supplied by the farming system. For these reasons, Prof. John Dixon and colleagues[12] referred to farming and food systems[13] in a recent study of COVID-19 impacts.

By many measures there has been considerable development progress in sub-Saharan Africa (SSA) since the turn of the 20th century. The further advancement of African smallholder farming systems is fundamental to overcoming food insecurity, health issues, and rural poverty in a diverse geographical, agroecological, historical, political, and cultural context, thereby supporting inclusive economies[14] more generally. Experience has shown context-specific multi-stakeholder, market-oriented and systems approaches focussing on farming households and dominant farming systems is essential.

The Commission has broadened the discussion to include the concept of food systems and health that extend the breadth and relevance of farming systems to reflect the inseparable links between food, nutrition, environment, health, and wellbeing. The 2003 definition of 'agroecology' from Francis *et al.*[15] is simply "ecology of food systems", which encompasses the connectivity and complexity of human food and fibre systems and the underpinning of natural systems to engender health and wellbeing, and updated and elaborated by FAO in 2019.[16] Therefore, food systems must be based on healthy, resilient, profitable, and productive farming systems that integrate processing and consumption decisions to ensure maximum benefits to rural and urban society. Systematic analysis of African food systems as 'agroecologies' or food/farming systems can facilitate the identification of policies and investments that target the development of sustainable and resilient systems at the household and national scale. Investments in food systems include forward and backward linkages and the associated economic investments that can improve food and food security. Such an approach is inherently pro-poor as it built on inclusive development strategies. The analyses presented and the framing of research questions and policy development is not simply maximising productivity of agricultural land, but instead prioritises the livelihoods, income, and health of those living and working within the various farming systems and associated value chains.

> **"Therefore, food systems must be based on healthy, resilient, profitable, and productive farming systems that integrate processing and consumption decisions to ensure maximum benefits to rural and urban society."**

[11] Dixon J (2019) Concept and Classifications of Farming Systems. In: Ferranti, P., Berry, E.M., Anderson, J.R. (Eds.), *Encyclopedia of Food Security and Sustainability*, vol 3, pp 71-80, Elsevier.

[12] Dixon J, et al. (2021). Response and resilience of Asian agrifood systems to COVID-19: An assessment across twenty-five countries and four regional farming and food systems. *Agricultural Systems* This research updated previous work of the FAO/World Bank Farming Systems and Poverty publication by Dixon et al. 2001.

[13] Farming system is often used as a shorthand for farming and local food system in this chapter.

[14] David Burch and Neil McInroy (2018) We need an Inclusive Economy not Inclusive Growth Published by CLES, December 2018 ISBN: 1 870053 90 7 https://www.cles.org.uk/wp-content/uploads/2018/12/Policy-Provocation_We-need-an-inclusive-economy-not-inclusive-growth_191218.pdf

[15] Francis, C et al. (2003) Agroecology: The Ecology of Food Systems, *Journal of Sustainable Agriculture*, 22:3, 99-118, DOI: 10.1300/J064v22n03_10.

[16] FAO (2019) Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. *High Level Panel of Experts on Food Security and Nutrition Report 14*, Committee on World Food Security, FAO, Rome. See also FAO knowledge base accessed from the web: http://www.fao.org/agroecology/overview/en/

2.1 Mapping and Characterising African Farming Systems

The heterogeneous nature of African agriculture requires differentiated investments responsive to the needs of different food and farming system agroecologies. Research co-led by Prof. John Dixon et al. [17] differentiated fifteen farming systems in Africa, each comprising millions of farming households with broadly similar livelihood patterns and development opportunities within this formidable heterogeneity. This meso scale was considered the most suitable for large scale investment and major policy decisions.[18]

As noted, the investment discussion integrating the concepts of food systems and health systems reflect the inextricable links between food, nutrition, environment, health and wellbeing. Such an 'agroecological approach' emphasises the connectivity and complexity of human food and fibre systems to engender health and wellbeing. Systematic analysis of African food systems as agroecologies can facilitate the identification of policies and investments that target the development of sustainable and resilient farming systems at the household and national scale.

The fifteen farming systems framework of Dixon et al. 2020[19] facilitates the organisation of data and expert knowledge to characterise and broadly differentiate the agricultural populations and resource bases of each of the farming systems. It enables identification of trends over the coming decades for strategic development investments. Importantly, most of these systems are supra-national or regional. Therefore, the strategic interventions including policy changes apply equally to individual regions, the national level, multiple nations, and potentially pan-African in nature.

This classification and analysis on the African continent are pragmatic and differentiate farming system areas spatially, which allows presentation of the analytical results to policymakers for the assessment and targeting of investment, agricultural services, and rural development policies. The approach illuminates contrasting investment opportunities between systems and populations that live within areas of rainfed cereal production (the current food bowls of East, Central and West Africa), large scale irrigation schemes (as in North Africa), pastoral and oasis farming systems. The fifteen distinct farming systems[20] are shown in Figure 1 and characterised in Table 1., which describe the levels of resource and service endowments and the poverty, population, and farming patterns within each farming system. Most farming systems have a high proportion of extremely poor households; nearly 150 million extremely poor farming children, women and men live in the four most-populated farming systems (maize mixed, agropastoral, highland perennial, and root and tuber crop farming systems). Table 1 (page 16) lists farming systems in approximate descending order of extremely poor households.

These variously classified farming systems enable better targeting of investments and the strengthening of institutions for the advancement of food and nutrition security, wealth, health, wellbeing, governance, and inter-generational equity.

Food production and consumption in rural areas of SSA are closely related to community and household food habits, health and wellbeing, as many households grow and process much of their own food, often by necessity. Rural foods consumed are a reasonably diverse range of locally produced plant-based diets (cereals and starchy roots), with animal protein providing less than 25 per cent of dietary protein, and fruit and vegetables important sources of vitamins and minerals. Household investments in farming systems are interdependent with household investment and consumption, as many people in rural areas earn off-farm income that is also re-invested within food systems or reserved for food purchasing during times of shortage. Individual households and farms ranging from small to large within a community are also interdependent with each other. However, within the same farming system, households tend to have similar livelihoods and development constraints and opportunities to improve wellbeing. Most countries will contain several different farming systems with very different investment needs. For example, several West African countries contain both the commercial tree crop farming system and the cereal-root crop mixed farming system, with dramatically different needs related to infrastructure, credit, market development, and research. As food and farming systems share broadly similar agroecological and other conditions, interventions customised to the farming system will have a higher likelihood of being appropriate. The geographic extent of each of the 13 continental non-urban farming systems as of 2015 are presented in Figure 1.

"These variously classified farming systems enable better targeting of investments and the strengthening of institutions for the advancement of food and nutrition security, wealth, health, wellbeing, governance, and inter-generational equity."

[17] Dixon, J, et al. (2020) *Farming Systems and Food Security in Africa: Priorities for Science and Policy under Global Change.* Earthscan Food and Agriculture Series. Routledge.

[18] National farming systems characterisation and mapping has also been undertaken, for example in Ethiopia. See Abede et al. (2017) *A farming systems framework for investment planning and priority setting in Ethiopia.* ACIAR.

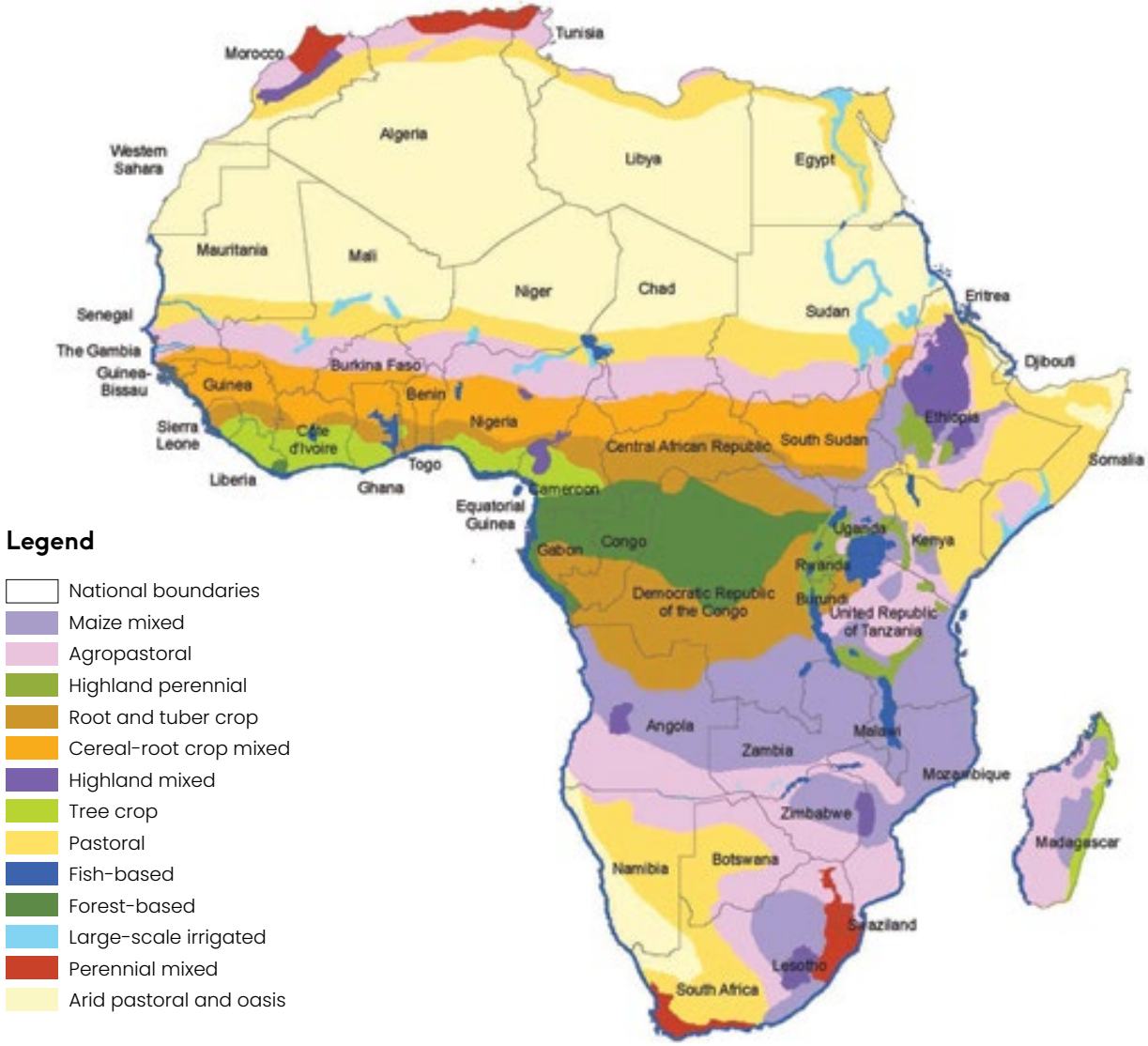
[19] Dixon, J, et al. (2020) op cit.

[20] Dixon et al. (2020) op cit.

The extent of farming systems is determined by the core livelihood patterns, which are mainly determined by resource endowment (notably agroecology and farm size), access to agricultural services (notably markets and infrastructure), and historical/cultural/institutional factors (including prices). The focus is on the dominant livelihood pattern at the meso scale, sometimes called the central tendency. At the local/community scale, heterogeneity is widely recognised; and most farming systems transition gradually into the next farming system, mainly due to internal (e.g. population) and external (e.g. market forces) drivers. These livelihood patterns, trends, and common development needs are of great assistance to planners and policymakers.

Each broad farming system listed in Table 1 has a set of recognisable and distinct development constraints and opportunities, and would benefit from a particular set of policies, investments, and research products. A number of principles guide the identification of African farming systems, which include: support science leaders and policymakers to accelerate the improvement of food and nutrition security; equal weight is given to quantitative national, survey, and spatial data, and key informant knowledge when delineating, characterising, and analysing farming systems. Farming systems are characterised by their median characteristics, which subsumes local heterogeneity (including mapping of geography, population, the prevalence of poverty, resource endowments, access to markets, cultivation, livestock data, etc.); Table 1 lists the dominant livelihood patterns. Additionally, each farming system contains some minor plant and animal activities that contribute to its biodiversity, the ecosystem function, and notably the common diets of the resident populations—whether agricultural or non-agricultural. In this sense, the rural food system reflects the underlying farming system, without ignoring the import of relatively small volumes of foodstuffs into each farming system (cities excepted).

Figure 1: African principal farming systems 2015.[21]



[21] Dixon, J, et al. (2020) *Farming Systems and Food Security in Africa: Priorities for Science and Policy under Global Change.* Earthscan Food and Agriculture Series. Routledge.

Table 1: Key characteristics of African farming systems

Farming system	Agricultural population (millions)	Key characteristics of livelihoods
Maize mixed	**107**	Mixed farming dominated by maize with medium access to services in subhumid areas of East, Central, and Southern Africa. Other livelihood sources include legumes, cassava, tobacco, cotton, cattle, goats, poultry, and off-farm work.
Agropastoral	**98**	Mixed crop-livestock farming found in semiarid (medium rainfall) areas of Africa, typically with low access to services. It includes the dryland mixed farming system of North Africa, often depending on wheat, barley, and sheep. In SSA the main food crops and livestock are sorghum and millet, and cattle, sheep, and goats. In both cases, livelihoods include pulses, sesame, poultry, and off-farm work.
Highland perennial	**61**	Highland mixed farming is characterised by a dominant perennial crop (banana, plantains, enset/false banana or coffee) and good market access, and is found in humid East African highlands. Other livelihoods derive from diversified cropping including maize, cassava, sweet potato, beans, cereals, livestock, and poultry augmented by off-farm work.
Root and tuber crop	**50**	Lowland farming dominated by roots and tubers (yams, cassava) found in humid areas of West and Central Africa. Other livelihood sources include legumes, cereals, and off-farm work.
Cereal-root crop mixed	**43**	Mixed farming with medium-high access to services dominated by at least two starchy staples (typically maize and sorghum) alongside roots and tubers (typically cassava) found in the subhumid savannah zone in West and Central Africa. Other livelihood sources include legumes, cattle, and off-farm work.
Highland mixed	**45**	Highland mixed farming above 1700 m dominated by wheat and barley, found predominantly in subhumid north-east Africa with pockets in Southern, West, and North Africa. Other livelihood sources include teff, peas, lentils, broad beans, canola, potatoes, sheep, goats, cattle, poultry, and off-farm work.
Humid lowland tree crop	**30**	Lowland farming dominated by tree crops (> 25% cash income from cocoa, coffee, oil palm or rubber) found in humid areas of West and Central Africa with good access to agricultural services. Other livelihood sources include citrus, yams, cassava, maize, and off-farm work.
Pastoral	**38**	Extensive pastoralism (dominated by cattle), found in dry semiarid (low rainfall) areas with poor access to services. Other livestock include camels, sheep, and goats, alongside limited cereal cropping, augmented by off-farm work.
Fish-based	**22**	Found along coasts, lakes, and rivers across Africa with medium-high access to services. Other livelihood sources include coconuts, cashew, banana, yams, fruit, goats, poultry, and off-farm work.
Forest-based	**12**	Lowland, heavily forested humid areas in Central Africa with low access to services and subsistence food crops (cassava, maize, beans, coco-yam, and taro). Other livelihood sources include forest products and off-farm work.
Irrigated	**48**	Large-scale irrigation schemes associated with large rivers across Africa, e.g. Nile, Volta. Often located in semiarid and arid areas but with medium-high access to services. Includes the associated surrounding rainfed lands. Diversified cropping includes irrigated rice, cotton, wheat, faba, vegetables, and berseem clover augmented by cattle, fish, and poultry.
Arid pastoral and oasis	**8**	Extensive pastoralism and scattered oasis farming associated with sparsely settled arid zones across Africa, generally with very poor access to services. Livelihoods include date palms, cattle, small ruminants, and off-farm work, irrigated crops and vegetables.
Perennial mixed	**12**	Semi-commercial and commercial farming with good access to services, dominated by perennials such as vines, fruit, and eucalypts, found in Mediterranean (subhumid) climates in the coastal areas, and hinterlands in Southern and North Africa. Other livelihoods include sugarcane, maize, legumes, cattle, and small ruminants.
Island	**4**	Mixed cropping, horticulture, sugarcane, and fishing in the principal islands associated with Africa. Other livelihoods include livestock and seaweed farming. Often there is medium access to domestic and tourist resort markets, but limited exports.
Urban and peri-urban	**Na**	Located within cities, or on their fringes with high population density and medium-high access to services and markets, often informal. Livelihoods include fruit, vegetables, dairy, cattle, goats, poultry, and off-farm work.

Source: Adapted from Dixon et al. (2020). Off-farm work can be found in all systems, although is only noted where it is a main livelihood.

2.2 Five Household Strategies for Inclusive Growth

Understanding the typical household strategies of each farming system should form the basis of agricultural policies and public investment.[22] Farm women and men decide on the management of natural resources, farm production, family consumption, and associated investments. These investments are made in the context of formal and informal institutions, cultural values, social norms, public policies, and knowledge. Increased wellbeing from increased food crop productivity often drives opportunities for diversification to commercial livestock or higher value cash crops. Additional off-farm wage income augments purchasing power for food and farm inputs, especially for the poorest smallholders. Population density, farm size, and available infrastructure and cultural and social norms (for example, gender roles) also influence the mix of household strategies.

In broad terms, there are five main strategies to improve livelihoods and household food security for extremely poor small farm households who form a significant proportion—sometimes more than half—of the population in any farming system. These strategies are not mutually exclusive, and any household will generally pursue a mix of the following strategies:

1) intensification of existing production and processing patterns;
2) diversification of production and processing patterns;
3) expansion of farm, enterprise, or herd size;
4) increased off-farm income, both agricultural and non-agricultural;
5) exit of the whole family from farming in the particular farming system.[23]

Of course, these strategies shape both production and family food consumption. **Intensification** results in increased physical or economic productivity (therefore greater outputs) of agricultural enterprises of existing activity patterns. It is of particular importance where yield gaps are large such as in Africa where smallholder food crop yield gaps are of the order of three-quarters, i.e., actual yields can be as low as one-quarter of potential yields. Note that calculation of productivity can be based on land, water, labour, or any other scarce resource; and can result from greater use of external inputs such as fertiliser, mechanisation, or technology, but also may arise from improved farm management to save inputs and increase 'eco-efficiency'.[24] improved irrigation practices, or control of biotic stresses. Across the diverse continental non-urban farming systems listed in Table 1, intensification is expected to account for 5-30 per cent of the reduction in extreme poverty and improvement in livelihoods during the coming 15 years.[25] However, in practice the access to productive technologies, input and output markets often drives intensification. In the short term, urban food systems may gain more from farm intensification than rural food systems through greater volume and lower food prices. It should also be noted that intensification and diversification are very different development pathways, requiring different policies and investment by governments, and have different outcomes for nutrition and health. Also note that some analyses combine intensification with diversification, especially diversification to high value crops.

Diversification of on-farm activities represents a change in the farm production pattern to improve livelihoods, such as the introduction of a new crop, livestock type, bees, trees, off-farm work, or value-adding activities such as produce grading. Successful on-farm diversification requires access to new produce or labour markets. Knowledge, technology, and access to markets often drive diversification, which is one of the most effective household strategies for improving livelihoods in Africa. Across the 13 diverse continental non-urban farming systems, from arid to humid tree crop, on-farm diversification is expected to account for 10-30 per cent of the reduction in extreme poverty and improvement in livelihoods during the coming 15 years.[26] Diversification strategies also improve population health by increasing the availability of a diverse range of foods that reduce malnutrition.

Expansion of farm or business size enables households to increase income or reduce poverty. More than 25 per cent of the available potential land for agricultural expansion is in Africa. Expansion of the cropping frontier may arise through conversion of forest or rangeland to cropping, with implications for GHG emissions, especially where population pressure on existing cropland is high and non-agricultural land is available nearby. However, increased herd size where grazing land is available also increases the farm business and is prevalent in pastoral areas where capital is available. Public or private extension of local irrigation infrastructure can expand farm irrigated area and be construed as growth of the business. Especially in semi-arid areas, the conversion of marginal or remote areas to cropland is common, but in practice may not offer sustainable pathways out of poverty. However, in aggregate this is a relatively limited pathway for African smallholders at this stage of economic development, accounting for 0-15 per cent of the expected reduction in extreme poverty and livelihood improvement in any regional farming and food system, although the opportunities for expansion in particular countries would be larger.[27]

[22] Pender J, Place F, Ehui S (eds) (2006) *Strategies for sustainable land management in the East African highlands. IFPRI,* Washington DC.

[23] Dixon et al. (2020) op cit.

[24] Keating BA, Carberry PS, Dixon J. (2013). Agricultural intensification and the food security challenge in Sub Saharan Africa. In; Vanlauwe B, Van Asten P, Blomme G (eds) *Agro-ecological intensification of agricultural systems in the African Highlands*. Earthscan, UK.

[25] Dixon et al. (2020) op cit.

[26] Dixon et al. (2020) op cit.

[27] Dixon et al. (2020) op cit.

Increasing off-farm income is increasingly important with seasonal migration a traditional household strategy for reducing poverty, as well as local trading and distant work in cities or wealthier countries. This strategy is relevant in every farming system, and it is nearly as important as intensification or diversification, and is expected to provide 10-40 per cent of the reduction in extreme poverty and livelihood improvement (and 80 per cent in the special case of the tree crop farming system).[28] Remittances are often invested in land or livestock purchases, with households augmenting the family income with part-time or full-time off-farm employment. Depending on the proximity of mining resources, seasonal artisanal mining can be a very compatible activity, or even coping strategy during droughts. This is articulated more fully in the Mining in Africa chapter.

Exiting the whole family from farming occurs where they perceive an opportunity for improved livelihoods in alternative economic sectors. A proportion of farm households will abandon their land and/or herds altogether and relocate them into other rural or urban locations with economically attractive off-farm activities. However, this is highly dependent on opportunities in other farming systems or employment in other sectors. With increased growth of towns and cities in Africa, this sector is expected to play a very important role. Whereas Asian agricultural development often paralleled labour-intensive industrial development, which facilitated the productive transfer of labour from agriculture to other sectors, this is not the case in many Africa countries. However, exit from agriculture is expected to account for 0-50 per cent of the reduction of extreme poverty and livelihood improvement. It is noteworthy that exit is the most important, at around 40-50 per cent, in the densely populated highland perennial and the pastoral and arid pastoral farming systems that are also characterised by intensive pressure on agricultural resources. Notably, these three systems lack opportunity for expansion of farm size.[29]

There are four key points to bear in mind. Firstly, improvements in livelihoods generally translate into dividends in household food security, increased income and reduction in malnutrition. Secondly, the most effective strategy mix varies significantly between farming systems. Importantly, the combination of intensification and diversification account for more than half of total expected livelihood improvements in seven (of the fifteen) farming systems, which account for more than two-thirds of the African rural population—for which agricultural technology, markets, and policies are critical drivers. Thirdly, rural development policies, transport, market, and water infrastructure should be targeted to selected farming systems because of different development priorities. Finally, national (and regional) rural development strategies can be mapped onto the effective household strategies reported above.

[28] Dixon et al. (2020) op cit.

[29] Dixon et al. (2020) op cit.

2.3 Drivers, Trends, and Opportunities for Farming Systems Development

Seven universal medium-term drivers frame the evolution of each farming system along relatively predictable pathways.[30] The drivers correspond in general terms with the various drivers identified by other authors. For example, in relation to Asia, authors identified[31] five 'transformations' of the agrifood economy (urbanisation, diet changes, food system transformation, rural factor markets, and capital-led farm technology intensification); these apply in part within Africa. Other authors[32] describe similar sets of mega-drivers outlined in Table 2.

Table 2: Principal drivers, trends, and implications for farming system development

Drivers/trends	Example metrics	Example influences on farming decisions	Example influences on structure and function of farming system
Population, food security and poverty (increased pressure)	Population density, migration, urbanisation, diet, under-nutrition	Labour availability and productivity, farm practice adoption decisions, schooling, risk avoidance	Labour-saving technologies, reduced herding/expanded stall feeding, low investment
Natural resources and climate (reduced availability and quality)	Farm size, herd size, irrigation, land tenure, land degradation, changes in rainfall and temperature	Scarcity of land and nutrients creates incentives for irrigation and soil management, increased climate risk	Reduced farm and herd size, reduced land/labour ratios, shift from extensive to intensive practices, stronger integration of crops, trees, and livestock
Energy availability and use (increased availability, volatile prices)	Energy availability and use, firewood use, electrification	Timeliness of operations, replacement of labour	Earlier planting, better weeding, post-harvest processing, appropriate mechanisation, small-scale irrigation
Human capital, knowledge and gender (improved education, information and benefit sharing)	Education and skill level, mobile phone ownership, extension/farmer ratio	Improved farm decisions and management, improved benefit sharing, adoption of new practices or enterprises, greater involvement of women in decisions	Diversification, increased eco-efficiency (water and nutrient use efficiency), greater market orientation, improved gender equity, better farm-household management and increased total factor productivity
Science and technology (increased technology choices)	Productivity, technology adoption	Adoption of better practices and enterprises	Increased eco-efficiency, expanded production, improved quality of produce
Markets and trade (expanding access and reduced marketing costs)	Input use, market surplus, supply chain length, food system structure, competition, investment	Increased productivity, diversification, value-adding	Stronger market orientation and commercialisation, reduced capital and transaction costs, greater intensification, and diversification
Institutions and policies (strengthening institutions)	Expenditure on agriculture (incl. research, input subsidies, infrastructure), new regulations	Adoption of institutional innovations (markets, finance, risk sharing, conditional prepayment rate management)	Improved resource management, farmer group and cooperative coordination for marketing and resource management

Source: Adapted from Dixon et al. (2020). Note the book provides the analysis of the drivers and trends for each of the fifteen farming systems.

[30] Dixon et al. (2001) op cit; Dixon et al. (2019) op cit.

[31] Reardon, T., and Timmer, P. (2014) Five inter-linked transformations in the Asian agrifood economy: Food security implications, *Global Food Security,* Volume 3, Issue 2, Pages 108-117, ISSN 2211-9124, https://doi.org/10.1016/j.gfs.2014.02.001.

[32] Jayne, T.S. (2016) Megatrends transforming Africa's food systems: Getting ahead of the puck on policymaking. In African farmers in the digital age: Overcoming isolation, speeding up change, and taking success to scale. *Foreign Affairs,* Special Issue, New York.

2.3.1 Population, hunger and poverty

Between 2010 and 2050 the African rural population is projected to increase by 56 per cent, as is the population directly engaged in agriculture, albeit by a slightly lower proportion. Concurrently, the SSA urban population is expected to surpass the rural population in about 2035. Recent evidence points to some reduction in fertility, especially in large cities and other regions, which could moderate population estimates after 2040. Nevertheless, such population growth is critical for policymakers. While the total population in Africa is expected to double, the rural population is still expected to grow only by about 150 million people over the next 40 years.[33] The implication is that the increment will be much smaller. At the same time, it will be important to stem the growth of mega-cities that are expensive to feed and provide water and power and run the risk of becoming ungovernable.

At a minimum, farm intensification and diversification are required for each farming household to feed themselves well. Likewise, two additional urban households with increased disposable incomes and evolving consumption preferences will demand a wider range of high value nutritious foods. Ironically, without adequate mechanisation, farming system intensification and diversification would be significantly hampered by labour shortages (for example wide-spread adoption of irrigation). With increasing anthropogenic climate change and variability, mechanisms are required for promoting the stability of food production over years including better green water (soil moisture) management, storage, and transport infrastructure. It is important to note that the proportion of off-farm food purchases by African smallholders will increase as livelihoods improve, although most purchased foods are at present locally sourced.

"With increasing anthropogenic climate change and variability, mechanisms are required for promoting the stability of food production over years including better green water (soil moisture) management, storage, and transport infrastructure."

2.3.2 Natural resources and climate

Unsurprisingly, as rural populations more than doubled over the past century, the availability of land, especially fertile land, for crop expansion has become limited in many systems and countries. Fallowing has reduced and land competition increased, especially between croppers and livestock herders. Land degradation is widespread, reflected in part in decreasing biomass productivity of many farming systems, including the forest systems and evolving land management strategies.[34] There are some areas of success, for example in West African savannas where farmer managed natural resource management has increased tree density, boosted crop yields, and improved livestock turnoff. Sustainable land management investments in Ethiopian highlands reversed millions of hectares of degraded lands to productive use. Livestock populations are expanding steadily and will require additional risk management strategies as increasing pressure on agricultural resources such as land, water and residues that could otherwise be used for crops manifest themselves. Poultry and goat numbers have nearly trebled over the four decades from 1970 to 2010, and cattle, sheep, and camel populations have nearly doubled—with no indication of a slow-down. Fishing is also expanding, unsustainably in many coastal locations (see further The Blue Economy Chapter for an expanded discussion on coastal fisheries and strategies for intensification via aquaculture, including inland aquaculture). There is great scope for improved technological and institutional innovations for better grazing, reducing yield gap, climate adaptation strategies, and crop-livestock integration. Climate change is a critical factor in African farming systems development. Already temperatures and evaporation are rising, along with rainfall variability and increased frequency of extreme weather events. Farmers need not only better access to seasonal forecasting, but also Climate Smart Agriculture (CSA) practices.[35] Better policy settings are needed that reduce deforestation and land degradation and decouple the various competing uses of biomass (soil fertility, cooking and heating).

2.3.3 Energy and food

Most farmers are net purchasers of energy, for example for tillage (depending on whether manual, animal draught or mechanised) and water pumping for small-scale irrigation. Transportation is the dominant use of energy for input and produce chains. The intensification of food production will require greater use of energy for traction, inputs, and processing of outputs—unless there is widespread adoption of the sustainable minimal or no-till practices such as Conservation Agriculture for Sustainable Intensification (CASI).[36] Energy and food markets are now interlinked and energy efficiency in food production, processing, and marketing will be critically important in future decades. There is enormous potential in Africa for distributed renewable generation of energy through solar, wind, hydro, and likely biomass, which could be quite easily mapped across the fifteen farming systems described above. Deployment of energy systems in rural and regional Africa is described in detail in the chapter Power and Light at a pan-African level. The Commission advocates here for research to map agroecological systems specific requirements and solutions.

[33] BREMNER, J. (2012) POPULATION AND FOOD SECURITY: AFRICA'S CHALLENGE Population Reference Bureau, Aspen Institute, Available at https://www.aspeninstitute.org/wp-content/uploads/files/content/docs/ee/Population_Reference_Bureau_Population_and_Food_Security_Africa_Bremner.pdf

[34] Pender J, Place F, Ehui S (eds) (2006) *Strategies for sustainable land management in the East African highlands. IFPRI*, Washington DC.

[35] Girvetz E. et al. (2019) Future Climate Projections in Africa: Where Are We Headed?. In: Rosenstock T., Nowak A., Girvetz E. (eds) *The Climate-Smart Agriculture Papers*. Springer, Cham. https://doi.org/10.1007/978-3-319-92798-5_2

[36] Dixon, J., et al. (2019). Producing food while protecting the environment: Inter-disciplinary research methods for international research on Conservation Agriculture Based Sustainable Intensification (CASI). *Agricultural Science*, 30/31(2/1), 64–81. https://search.informit.org/doi/10.3316/ielapa.792503237904687

2.3.4 Human capital, knowledge sharing, gender

A key trend is the 'feminisation' of farming as young males seek off-farm seasonal and longer-term employment in cities and other countries, leaving women as the de facto farm managers. It has in fact been a common practice for many decades in Southern Africa where men left their farms for work on the mines. Improved farm household decision-making, increasingly by women, requires education and training supported by knowledge sharing. There are also major initiatives to create rural youth employment, including but not limited to, on farm activities such as value addition or processing of crop products at source. Digital tools will play a significant role over the coming decades, augmenting knowledge as a powerful driver of inclusive farming systems development in many ways. Therefore, information, human capital, and inclusive approaches merit the close attention of policymakers. The importance of these drivers will grow over coming decades to yield benefits of investing for a 'demographic dividend'.

A 'demographic dividend' implies your society has wisely invested, and that in time younger people are enabled to be healthy, productive, and wealthy (discussed in detail in the Chapter: A Youthful Africa). The investment context matters, as geographies alongside social and environmental conditions are highly heterogeneous, as will be the investments in associated policy frameworks and governance in their implementation. As can be seen from the farming systems framework introduced in this chapter, geographically differentiated agroecosystem challenges are significant. Examples include areas that are more impacted by climate change/drought (southern or western African agropastoral farming systems), locust plagues (many cropping areas of eastern and northern Africa), and conflict issues. So how are investments made to yield a demographic dividend with geographic differentiated contexts—such as the above farming systems—of environmental, natural, cultural and security (etc.) complexities within African societies with significant youthful populations?

In rural Africa most of the youth are engaged in the farming sector and the absolute numbers are increasing. This contrasts starkly to industrialised nations with challenges of an aging farm population alongside rural depopulation, particularly in Europe, Australia, US, and Canada. One of the biggest misconceptions in rural policy circles is that the rollout of telecommunication infrastructure will attract 'digital savvy' youth into the agricultural sector. However, this has clearly not been a priority globally, with even industrialised nations failing to allocate resources to address the currently poor level of investment in digital connectivity in rural areas relative to urban areas –the digital divide. Here, therefore, is a clear opportunity for Africa to chart its own course and prioritise investment in rural telecommunications. In this way African youth already engaged in the rural and agricultural sector can take advantage of the burgeoning agri-tech sector and be part of shaping unique African-centric offerings.

We know 'hard infrastructure' needs investment in very poor rural and remote areas. A lot of investment can come from the private sector. In Sub-Saharan Africa, "3G coverage in 2019 expanded to 75 per cent compared to 63 per cent in 2017, while 4G doubled to nearly 50 per cent compared to 2017."[37] However, the private sector needs to be profitable and have assurances and confidence in the stability of the area/region they invest in. Therefore, the dual challenges rural populations face are simultaneously economic and technical constraints. It is both the high cost for poor services and antiquated technology, particularly relative to the rest of the world. Pragmatic investments in African rural areas will need to target youth and be geographically/farming systems differentiated due to the high degree of contextual heterogeneity while addressing pervasive inequality.

Rural SSA regions are some of the most inequitable in the sense of opportunities, particularly for young women because of various cultural nuances. The occurrence of young women prematurely exiting the education system for early motherhood/marriage/dowries needs to be challenged at every level.[38,39] In some countries, for example "Sierra Leone, Nigeria and Senegal there have been significant improvements, with rates of young marriage declining. Conversely, in other countries, including Benin and Burkina Faso, rates of child marriage have increased in the last decade."[40] There are well-known direct health risks to them and their infant children, in addition to numerous cascading challenges for a family with the associated poor social and economic capital. Young women who raise a family in Africa are also often expected to be productive farm labourers.[41] When comparing urban and rural young women, rural women are on average always more disadvantaged with much greater burdens than their urban counterparts.

The multiple layers of economic, geographical, and cultural constraints on these young women necessitates a combination of investments dealing with the complex and intersectional challenges. Access to land is one major challenge for women, particularly in areas where chiefs and chiefdoms have the authority. The cultural issues that are challenging girls who have already prematurely left school, and investments to empower them require political leadership; the political will to support investments in improving gender equity can be successful. These investments include self-help groups for women, access to financial capital, and technical education for micro-enterprises. However, due to prevalent patriarchal cultural structures in Africa, to really empower young women it is necessary to include young and older men in the process. Engaging men and women in a 'gender transformative approach' can change the social norms of men dominating agency and holding ultimate control in rural communities.[42]

[37] Available from https://www.mobileconnectivityindex.com/ as reported in: Wyrzykowski, R. (2020) Mobile connectivity in Sub-Saharan Africa: 4G and 3G connections overtake 2G for the first time [accessed from the web august 9, 2021] https://www.gsma.com/mobilefordevelopment/blog/mobile-connectivity-in-sub-saharan-africa-4g-and-3g-connections-overtake-2g-for-the-first-time/

[38] Chaaban, J. and W. Cunningham (2011). *Measuring the Economic Gain of Investing in Girls: The Girl Effect Dividend*, Policy Research Working Paper 5753, Washington, DC: World Bank.

[39] M.C. Nguyen, Q. Wodon (2014) *Impact of child marriage on literacy and education attainment in Africa* The World Bank, Washington, D.C.

[40] Hodgkinson, K et al. (2016) *Understanding and addressing child marriage A scoping study of available academic and programmatic literature for the 'Her Choice' Alliance* Commissioned by the Amsterdam Institute for Social Science Research of the University of Amsterdam Accessed from the web: http://www.her-choice.org/wp-content/uploads/2016/07/Her-Choice-Scoping-Study-Final-July-16-1.pdf

[41] Odile Mackett (2021): *Female farm holding in Botswana's agriculture industry*, Agrekon, DOI: 10.1080/03031853.2021.1940222

[42] Spencer, R. (2021) AfDB COP: Building Resilience in Food Systems and Agricultural Value Chains: Agricultural Policy Responses to COVID-19 in Africa.

Prospective investments in 'hard infrastructure' are often related to 'connectivity'. Connectivity can be thought of as enabling infrastructure in rural areas. They often include such connectivity investments as feeder roads, irrigation systems, electricity and telecommunication networks, etc. These connectivity investments in turn can connect people both locally and globally, and this is where the largest opportunities are created. There are significant opportunities surrounding telecommunication businesses incentivised to both connect and employ people in rural Africa. For example, policies that confer free or subsidised data or telecommunications for businesses located in rural poor regions can be a sufficient incentive for businesses to relocate, providing significant rural development outcomes as a result.

In addition, with improved investments in connectivity come the formidable potential of formally harnessing the African diaspora to connect with rural youth on the continent. An opportunity with significant potential is investments that engage the African diaspora who have the knowledge, experience, capital, and opportunity to enhance learning and offer mentorship to rural Africans who have the same passion.

2.3.5 Science and technology

The gaps between typical farm yields and potential yields are very large for most African crops and livestock production (far larger than most other regions of the world). Sometimes this contrast is explained by the overly simplistic notion that the 'Green Revolution' has not yet reached Africa.[43] The drivers of the yield gap vary from farming system to farming system which calls for a farming system-specific yield gap decomposition. Moreover, the reality reflects the combination of land types, population pressures, poverty, institutions, markets, and especially the lack of investment in R&D. Africa has lower public and private research intensities than other developing regions or the developed world. The public agricultural research intensity (research expenditure in relation to the AgGDP) has declined over recent decades from 0.6 per cent to about 0.5 per cent, whereas at least 1 per cent research intensity is recommended by many observers and the New Partnership for African Development (NEPAD). There is increasing potential for harnessing spillovers from other sectors, including biotechnology and digital tools, and also critically important opportunities for connections within farming systems that extend across several countries (as most systems do). Thus, the extensive work of the Alliance for a Green Revolution in Africa (AGRA) in agricultural transformation in the continent, research collaboration at sub-regional levels, e.g. Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), and regional level, e.g. Forum for Agricultural Research in Africa (FARA) would generate high payoffs.

Accordingly, science and technology have a very important role in resource management, scaling, mobilisation of finance, sustainable farming and agricultural productivity growth. Investment in agricultural research, shows consistently high economic high returns in Africa and elsewhere in the world.[44] AGRA, FARA and the Sub-Regional Organisations (SROs) are valuable institutions for encouraging forward-looking frameworks for agricultural innovation. The incorporation of the farming systems framework into the Science Agenda[45] offers a template for the management of spillovers between countries sharing the same or similar farming systems.[46]

[43] AGRA (Alliance for a Green Revolution in Africa) (2011) *Driving Real Change*. AGRA in 2010. Alliance for a Green Revolution in Africa (AGRA), Nairobi, Kenya.

[44] Lynam J, Beintema NM, Roseboom J, Badiane O (2016) *Agricultural Research in Africa: Investing in Future Harvests.* IFPRI, Washington, DC.

[45] FARA, 2014. Science agenda for agriculture in Africa (S3A): *"Connecting Science" to transform agriculture in Africa.* Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

[46] FARA (Forum for Agricultural Research in Africa) 2014. Science agenda for agriculture in Africa (S3A): *Connecting Science to transform agriculture in Africa*. Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

2.3.6 Markets and trade

Farming system intensification and diversification require an increasing volume and diversity of services, especially markets (as well as training, infrastructure, information dissemination and innovation systems). Access to services and markets fundamentally influences the directions of farming systems development—seen during the export-oriented colonial agricultures. Looking to future decades, markets and trade, particularly within the African continent, may well be more fundamental drivers of farming system directions than the natural resources–population nexus. At the farming system and farm household levels, access to markets is mediated by local institutions, social norms, and traditions, and infrastructure. Access to markets can be measured simply by the travel time or travel cost to market, but many other factors influence the effectiveness and quality of market function. In the year 2000, SSA had only 8 km of rural roads per 100 km² of land, which naturally limited market access for many farmers.[47]

The African Continental Free Trade Area AfCFTA is a landmark achievement in the continent's history of regional integration. Data from current Regional Trade Networks (RTNs) built on Regional Trade Agreements (RTAs) indicate that, particularly in the case of those aggressively embracing regional tariff reduction, are "trade-creating in most of the sub-regions but equally provide a platform for non-members to increasingly trade in these regions. This conclusion stems from the finding that overall, African RTAs create trade amongst member-states without diverting trade with non-members."[48] While countries are beginning to trade more and more with one another, it is anticipated that food security will continue to be dependent upon imports in the short to medium term. However, the experience during COVID-19 highlights the absolute necessity for greater local productivity as well as strengthening of intra-African trade in food staples and agricultural products. For instance, the African Rice Initiative in Burkina Faso, Ghana, Nigeria, and Tanzania is aiming at satisfying most of their rice demands through local sourcing.[49] Ratification of The AfCFTA Agreement and commitment by countries to focus on several specific areas "including tariff liberalisation, reduction of non-tariff barriers, rules of origin and improved market information systems"[50] can facilitate the growth of intra-African trade in agricultural commodities and services in an orderly and predictable manner. The jointly published "Framework for Boosting Intra-African Trade In Agricultural Commodities And Services"[51] by the African Union Commission and the Food and Agriculture Organization of the United Nations codifies a pan-African approach to be delivered at a regional and local level.

The Third Commission argues that analysis at the level of farming systems may inform the development of novel and efficacious approaches to trade facilitation that in turn delivers pro-poor and smallholder farmer wellbeing benefits. For example, the role of agribusiness plays out differently in pastoral areas with a strong livestock orientation compared with the annual crop-livestock integrated systems of the maize mixed and cereal root crop mixed farming systems. With a combined agricultural population of 150 million in 2015, these two systems are the engines of agricultural growth in Africa, which could be enabled by the development of markets and other infrastructure. It is not simply a matter of handling surplus production: both intensification and diversification depend on investment in a wide range of input chains and agricultural services. There are often high returns to investment in weak input markets such as finance, knowledge, seed, fertiliser and machinery. Not only are 'business-friendly' policies required but also mechanisms to mitigate business risk stemming from anthropogenic climate change and variability in rainfed farming systems that will dominate African agriculture for the coming decades. In African contexts, it can be argued that micro and small rural enterprises could underpin the next agricultural development revolution. The opportunities for value addition at the farm can help to increase incomes, and reduce wastage and transport costs, thereby increasing employment and wellbeing of people in rural and remote agricultural areas.

[47] Dixon, John & Garrity, Dennis & J.-M, Boffa & Williams, T & Amede, Tilahun & Auricht, Christopher & Lott, Rosemary & GK, Mburathi. (2020). Farming Systems and Food Security in Africa: Priorities for science and policy under global change.

[48] Ngepah, Nicholas, and Maxwell C. Udeagha. "African Regional Trade Agreements and Intra-African Trade." *Journal of Economic Integration*, vol. 33, no. 1, 2018, pp. 1176–1199. *JSTOR*, www.jstor.org/stable/26418780. Accessed 27 June 2021.

[49] Arouna, A., Fatognon, I. Saito, K., Futakuchi, K. (2021) Moving toward rice self-sufficiency in sub-Saharan Africa by 2030: Lessons learned from 10 years of the Coalition for African Rice Development, *World Development Perspectives,* Volume 21,100291,ISSN 2452-2929, https://doi.org/10.1016/j.wdp.2021.100291.

[50] FAO and AUC. 2021. *Framework for boosting intra-African trade in agricultural commodities and services*. Addis Ababa. https://doi.org/10.4060/cb3172en

[51] Ibid

2.3.7 Policies and institutions

The perspectives shaping African agricultural policies have evolved since the food self-sufficiency goal of state-led modernisation in the 1960s, the basic needs and intensification initiatives in the 1970s, and the integrated rural development programs and public infrastructure and institutional investments in the 1970s and 1980s. At the time, multidisciplinary farming systems research was promoted and explored the needs of farm women and men in relation to food energy and nutrients, especially in relation to the dry 'hungry season' and effective technologies and market linkages are a good fit to the local systems.[52] Naturally, social aspects of technologies and market linkages are essential considerations in such complex smallholder systems. However, in the 1980s-90s structural adjustment led to reduced investment in public research and extension capacity and other agricultural services. Contrary to planners' hopes for private sector investment to replace the public provision of agricultural services, this did not materialise.[53]

Today, liberalisation reform targeting economic growth needs to be complemented by food and nutrition security measures through agriculture and smallholder intensification, diversification of production and diets, and expansion of income.[54] Agricultural development policy across Africa has been principally shaped by the endorsement of the strategic framework of the Comprehensive Africa Agriculture Development Programme (CAADP)[55] in Maputo in 2003; this aligned with the Millennium Development Goals (MDGs) and later with the SDGs. The CAADP development agenda aimed to increase agricultural growth rates to 6 per cent per year, supported by at least 10 per cent of national budgets devoted to agriculture. CAADP focuses on four key pillars: expanding sustainable land management and reliable water control systems; improving rural infrastructure and trade-related capacities for market access; increasing food supply, reducing hunger and improving responses to food emergency crises; and improving agriculture research, technology dissemination and adoption.[56] Institutions, incentives (for private and appropriate collective action) and policies must be aligned with the specific farming systems growth potentials of different farming systems.[57] Land and water policies used to lie at the heart of effective resource management and rural development: now other forms of infrastructure and investment are also critical, including effective extension, mechanisation and market support and other agricultural interventions, especially for women, as women smallholder farmers often lack access to financing, land tenure, and input supplies and extension training.

Irrespective of the investment intervention, the policy context is fundamental. Smallholders will still be the dominant agricultural production and food suppliers to many African cities in most African countries for the coming decades. Therefore, policies must support their needs for intensification of staple food crops, diversification of farm activities for better nutrition, wellbeing, and livelihoods generally.[58] When creating opportunities for youth in rural areas regardless of the investments chosen, or the location selected, the broader and local policy environment needs to be considered. For each location the broader policy context will likely manifest in different ways with various associated risks. If risks are not addressed, for example insurance for SMEs, an investment will likely not yield a return. Like any private sector investor, an assessment of the existing policies will preface asking the question; 'what does the policy context mean for my business?' Policies with a focus on equity can create a significant opportunity for the poorest in society at an insignificant cost to wealthier individuals and consumers who indirectly fund the opportunity. Investments ideally will be profitable businesses, and from a social perspective they must be fiscally sustainable and deliver positive social impacts in terms of equitable job opportunities, reducing poverty, increasing food security, etc. While such investments sound simple, the 'devil is in the detail'; they require information and data to better understand market dynamics, production details, and all the constraints and risks. Clearly, 'pre-investment' data and analytics for the location will provide information on where best to invest and what policy settings to adopt and adapt to enable inclusive development.

[52] Dixon J. (1978) Farming Systems Research in Ethiopia, Proceedings of ORSTOM/CVRS Symposium on `Land-use and Development in Africa South of the Sahara -- Smallholder's Logic and Technical Rationality' (April 1978), Ouagadougou. See also Matata J, Anandajayasekeram P, Kiriro F, Wandera E, Dixon J. (2001) Farming Systems Approach to Technology Development and Transfer: *Source Book for East and Southern Africa*, FARMESA, Harare.

[53] Mburathi pers. comm.

[54] Leakey RRB, Mabhaudhi T, Gurib-Fakim A. (2021) African Lives Matter: Wild Food Plants Matter for Livelihoods, Justice, and the Environment—A Policy Brief for Agricultural Reform and New Crops. *Sustainability* 13, 7252. https://doi.org/10.3390/su13137252. See also Dixon (2020) op cit.

[55] CAADP Agricultural Development (2021), CAADP - Agriculture Development - Boosting crops productivity (nepad-caadp.net).

[56] New Partnership for Africa's Development (NEPAD) (2003) Comprehensive African Agriculture Development Programme. Africa Union, Maputo.

[57] Dixon, J. 2000. A Farming Systems Contribution to Agricultural Policy Analysis, in: M. Collinson (ed.), *A History of Farming Systems Research*, CAB International, Wallingford and FAO, Rome, pp 152-60.

[58] Leakey (2021) op cit.

2.3.8 Operationalisation of the farming system model

Although the farming system model presents an opportunity to drive context specific policy, investment, knowledge and technological transformation, its operationalisation model is yet to be developed by, yet to be identified, lead African institutions in consultation with the target countries. There is a wide recognition that there are differences among farming systems, even within the farming systems, in terms of state capacity, institutional arrangement, policy directions, intensification levels and development pathways. This calls for identification of the most plausible entry points, with highest dividend to facilitate long term system change. The entry points in the tree-based farming systems could be completely different to the pastoral farming systems. This model also calls for a different set of partnerships among countries sharing similar farming systems, for ease of exchange of information and knowledge. The research and education systems in the respective countries would also need to reorganise their curricula to address the major constraints of the farming systems in their ecosystems and develop targeted technologies and practices to address them. These reorganisations would need to consider current and future trends of climate change and other risks.

2.4 Assets for Successful Rural Investment Approaches

Rural investment approaches are clearly not simply focussed on increasing farm yields and productivity, but also should underpin the wellbeing of rural communities by creating productive 'assets'. Investments in assets include a diversity of 'hard' and 'soft' assets, such as new skills including gender transformative approaches, greater agency, improved agricultural processing, improved trading, better public infrastructure, access to finance, and improved market information to connect supply with demand. Investment in improving soil health, livestock health and land quality are also important household assets. These investments will often take time to achieve a social dividend and need a long-term focus. For example, successful entrepreneurship often occurs on average well above the age of 40, largely due to gained experience. While this relatively advanced age is clearly outside of the 'youth' category, greater opportunity for youth can ensue if more experienced elders in successful businesses are engaged in youth mentorships or apprenticeships.
The issue is the more inequity and vulnerability a person faces, the more likely they are to not attain any mentorships/ apprenticeships, and subsequently endure further inequity with lower skills and capital. Being realistic in an investment means understanding the cultural specificity, is the context and the constraints; particularly for these young people who have access to very little. Furthermore, with such pervasive poverty many microenterprises have necessarily very short-term foci. Compounding successful investments in these poorer regions is insufficient knowledge of the key drivers of microenterprise profitability. How then can we maximise the chances of successful business activity, and target community-wide investments that can improve wellbeing? It is here we need to return to the literal foundations for terrestrial life, agroecologies, health, and food webs: the soils.

"The issue is the more inequity and vulnerability a person faces, the more likely they are to not attain any mentorships/ apprenticeships, and subsequently endure further inequity with lower skills and capital. Being realistic in an investment means understanding the cultural specificity, is the context and the constraints; particularly for these young people who have access to very little."

3. Health and Wellbeing for all Africans

3.1 Soil-plant-nutrition complex

Our knowledge of soils and their primary role in delivering plant health and productivity has grown exponentially in recent decades. This knowledge is no longer focused only on nutrients and micro-nutrients; a model derived from reductionist chemical equations of subtraction by plants as 'miners' and addition by farmers via application of synthetic fertilisers or composts or manures. This knowledge instead embraces a more extensive and growing understanding of the root zone (rhizosphere), the bioavailability of nutrients, soil microbiome, soil carbon, and the complex interaction over time between successive growing cycles, farming systems (both plant and animal) and the sustainability of the soil. At the opening of a recent agroecological conference, the former FAO Director-General José Graziano da Silva stated "We need to promote a transformative change in the way that we produce and consume food. We need to put forward sustainable food systems that offer healthy and nutritious food, and also preserve the environment. Agroecology can offer several contributions to this process."[59] Agroecology also supports a 'one health' approach that understands that "between animal and human medicine there are no dividing lines—nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine."[60]

Recent advances in our understanding of the various microbiomes (whether plant, insect, animal, human) also point to a one health model and their inseparable role in maintaining health, both in terms of the absence of disease and the presence of a robust immune system. Again, the role of diet in this equation is central. The continental-wide efforts to address human malnutrition (Figure 2 a and c), food-borne illness, and related basic sanitation and access to affordable potable water continue to demand the attention of government policymakers and the global donor community, and rightly so. However, notwithstanding the critical importance of the public health and infrastructure projects built around these efforts, Africa is perhaps uniquely positioned to advance agroecological principles specific to each farming system to deliver healthy, affordable, and nutritious food that will have the most significant effect on ensuring the creation and maintenance of high levels of human health.

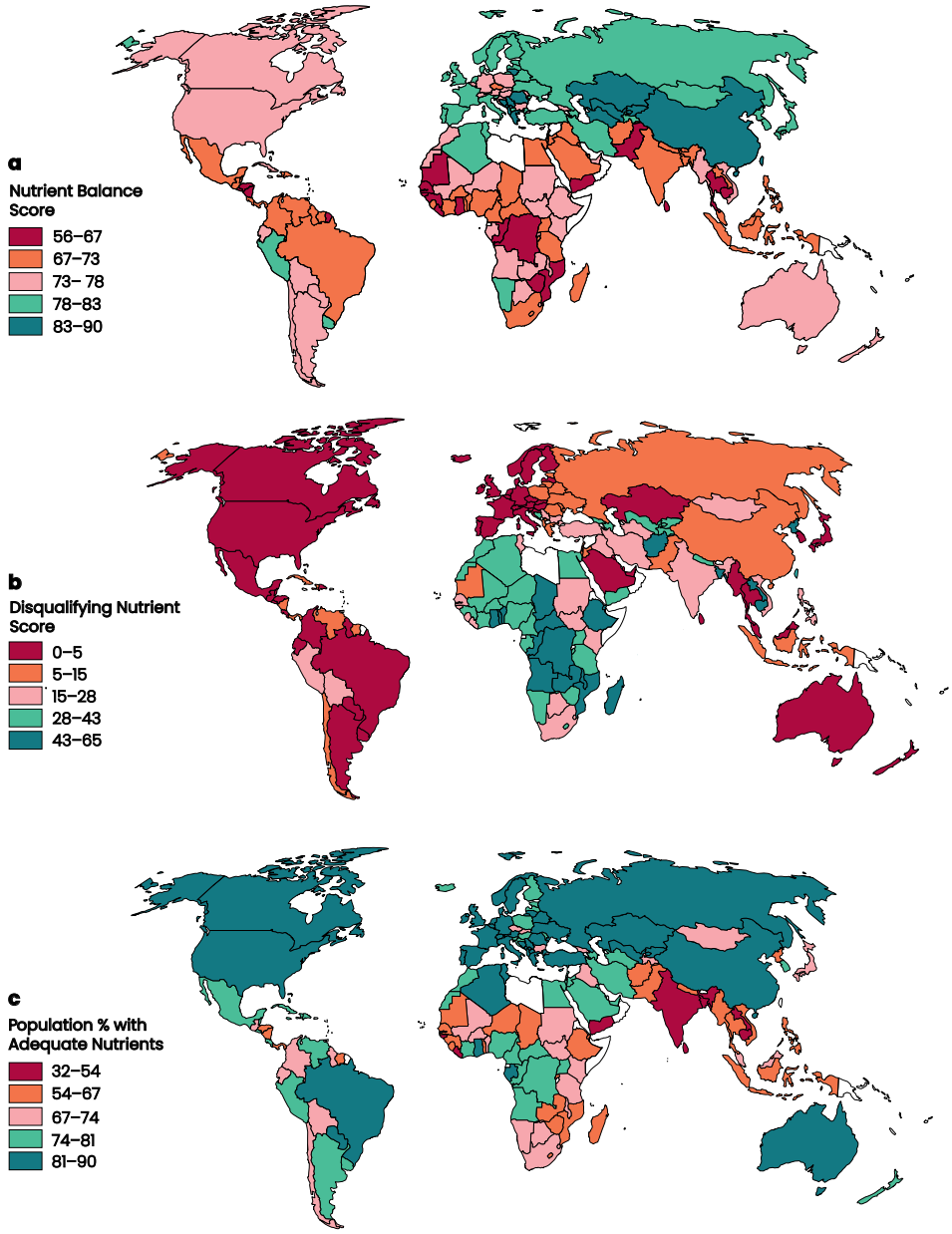
[59] Opening remarks of FAO Director-General José Graziano da Silva at the Second International Symposium on Agroecology, 2018, Rome.

[60] Saunders LZ. Virchow's contributions to veterinary medicine: celebrated then, forgotten now. *Vet Pathol.* 2000 May;37(3):199-207. doi: 10.1354/vp.37-3-199. PMID: 10810984.

At a continental level, by one crucial measure, the populations within African nations are way ahead of the rest of the world. The "Disqualifying Nutrient Score" (DNS)[61] measures the total daily intake of four public health-sensitive food nutrients (sugar, cholesterol, saturated fat, and total fat) with their Maximal Reference Values (MRVs). Figure 2 visualises 156 countries on this measure, with continental Africa scoring the best.

Simply put, the opportunity and challenge for Africa is to simultaneously turn the Nutrient Balance Score and the Population % with Adequate Nutrients 'green' while also keeping the Disqualifying Nutrient Score 'green'. This is something that the rest of the world has failed to do with catastrophic consequences[63,64] (type-2 diabetes, cardiovascular disease, certain cancers, etc.). In this scenario, the vision for a healthy Africa, is for a more nuanced and integrated investment that helps build human wellbeing beyond disease control and treatment. Of course, it is challenging to disentangle health from several factors, including regional issues, local infrastructure, population age, employment, education, environment, sanitation, and quality of life. It is not just related to medicine availability and healthcare, although this is also critical. The term 'health' itself is often misused and is often assumed to be the opposite of illness. Whereas health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity.[65]

Figure 2. Nutrient balances and Disqualifying Nutrient Scores by countries[62]



[61] Chaudhary, A., Gustafson, D. & Mathys, A. Multi-indicator sustainability assessment of global food systems. *Nat Commun* 9, 848 (2018). https://doi.org/10.1038/s41467-018-03308-7

[62] Figure 2 is sourced from Chaudhary, A., Gustafson, D. & Mathys, A. Multi-indicator sustainability assessment of global food systems. *Nat Commun* 9, 848 (2018). https://doi.org/10.1038/s41467-018-03308-7
And has not been modified. The creative commons license is available here: https://s100.copyright.com/AppDispatchServlet?title=Multi-indicator%20sustainability%20assessment%20of%20global%20food%20systems&author=Abhishek%20Chaudhary%20et%20al&contentID=10.1038%2Fs41467-018-03308-7&copyright=The%20Author%28s%29&publication=2041-1723&publicationDate=2018-02-27&publisherName=SpringerNature&orderBeanReset=true&oa=CC%20BY

[63] GBD 2019 Diseases and Injuries Collaborators, & Hankey, G. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet, 396*(10258), 1204-1222. https://doi.org/10.1016/S0140-6736(20)30925-9

[64] Einarson TR, Acs A, Ludwig C, Panton UH. Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017. *Cardiovasc Diabetol* 2018; 17: 83.

[65] From the preamble to the constitution of the World Health Organisation https://www.who.int/about/who-we-are/constitution

3.2 Farming Systems and Nutrition

African household nutritional intake is strongly linked to their respective farming systems and the crop and livestock commodities within the farming system. Household nutritional demands could be improved through combination of various farming system practices namely, enriching food crops through application of micronutrients, selection of farming systems specific crop species and varieties with high micronutrient content, use of indigenous high nutrient value crops and improvement of nutrient density of foods including improve micronutrient supplies through advances in localised understanding of the phytobiome[66] and further supplemented by animal products. Nutritional quantity and quality could be also improved through maneuvering the existing production systems by expanding the land allocated for high yielding and nutrient rich crops.[67] Modeling the farming system could offer a better household nutrition by readjusting crop (and animal) combinations. Grain Ca, Fe, Se and Zn concentrations varied substantially between and within cropping systems. For instance, communities relying on maize-based diets, which is a dominant farming system in Africa, are therefore likely to have the lowest micronutrient intakes compared to millet-based diets, with almost two orders of magnitude of Ca greater than in maize.[68] This strategy demands a thorough analysis of the current farming systems to identify nutrients in excess or in deficit and to modify the production strategy so as to fulfill nutritional demands with or without considering cash incomes. In situations where farmers are keen to exploit market opportunities while producing enough food there is a need to develop a responsive model that encompasses nutrition and cash generation and flexible enough to respond to farmers' priorities and forthcoming opportunities. However, the adoption of improved practices largely depends on the possible effect of the crop or animal adjustment on cultural value, food habit, labour cost, input demands and soil fertility management options.

"This strategy demands a thorough analysis of the current farming systems to identify nutrients in excess or in deficit and to modify the production strategy so as to fulfill nutritional demands with or without considering cash incomes."

3.3 Health Systems

Health systems must invest more in creating and sustaining health and wellbeing, rather than treating disease. "Despite tremendous progress on medical diagnosis and treatments, health systems remain predominantly sick care systems - disconnected from the broader upstream forces influencing health."[69] Health systems should be understood as a series of interlocking foundational components. These were categorised by the World Health Organisation (WHO) as: (i) service delivery; (ii) health workforce; (iii) health information systems; (iv) access to essential medicines; (v) financing; and (vi) leadership/governance. They can also be thought of analogously as a combination of both hardware (infrastructure and supplies and transport) and software elements. Software elements are fundamentally important social interactions. People in the health system possess skills for effective interactions with individuals and communities to develop mutual trust and confidence in each other and the health system as a whole. Increasing the software element of a health system is not just about individual skills and expertise but unleashing the potential that is often constrained by inappropriate organisational processes and environments.

Equity across health system functions is also of critical importance, including between rural and urban environments. Health systems have curative functions, health promotion functions and preventive health functions. The Third Commission call for each of these "three legs of the stool" to be equitably resourced based on rigorous cost-benefit analyses. The Third Commission also understands primary health care (PHC) as the embodiment of this vision. It is not just delivering curative procedures but also health education, health promotion, disease prevention services and an understanding of how our environment impacts health negatively and positively.[70] Health systems have better outcomes for a population when they are built on PHC.[71] Primary healthcare models (captured under the Alma-Ata Declaration in 1978)[72] emphasise locally appropriate actions across a range of social determinants of health, including prevention, promotion, and a balance between investments in curative strategies and interventions. However, "strengthening PHC is a hard grind challenge involving multiple and disparate actors often taking years or even decades to implement successful reforms. Despite major health system adaptation during the pandemic, change is unlikely to be lasting if underlying factors that foster health system robustness are not addressed."[73]

[66] Kumari B., Mani M., Solanki A.C., Solanki M.K., Hora A., Mallick M.A. (2020) Phytobiome Engineering and Its Impact on Next-Generation Agriculture. In: Solanki M., Kashyap P., Kumari B. (eds) *Phytobiomes: Current Insights and Future Vistas*. Springer, Singapore. https://doi.org/10.1007/978-981-15-3151-4_15

[67] Amede, T and Delve, R., (2008). Modelling crop livestock systems for achieving food security and increasing production efficiency in the Ethiopian highlands. *Experimental Agriculture* (4) 44: 441-452.

[68] Gashu et al., (2021). The nutritional quality of cereals varies geospatially in Ethiopia and Malawi. *Nature*. https://doi.org/10.1038/s41586-021-03559-3

[69] Sixth Global Symposium on Health Systems Research (HSR2020) Re-imagining health systems for better health and social justice accessed from the web: https://healthsystemsglobal.org/wp-content/uploads/2021/06/HSR2020-Theme.pdf

[70] M.J. Azevedo, (2017) Historical Perspectives on the State of Health and Health Systems in Africa, Volume II, DOI 10.1007/978-3-319-32564-4_1.

[71] Mash, Robert, et al. "The contribution of family physicians and primary care doctors to community-orientated primary care." *South African Family Practice*, vol. 63, no. 1, 2021.

[72] Rifkin SB (2018) Alma Ata after 40 years: Primary Health Care and Health for All—from consensus to complexity *BMJ Global Health*; 3:e001188.

[73] Peiris D, et al. (2021) Strengthening primary health care in the COVID-19 era: a review of best practices to inform health system responses in low- and middle-income countries. WHO South-East Asia *J Public Health* 2021;10, Suppl S1:6-25.

3.3.1 Comparisons between health systems and relative inequity

Higher-income countries spend more government resources on the health sector. "Across low-income countries, the average health spending was only US$ 41 a person in 2017, compared with US$ 2,937 in high income countries—a difference of more than 70 times. High income countries account for about 80% of global spending".[74] The era of believing the donor sector in Africa will 'do it all' is far gone and if a health agenda is dependent on external support, it will remain fragmented, incoherent, and unable to withstand shocks. "Most fast-growing countries embarked on the health financing transition, increasing their domestic public spending per capita, as a share of public expenditure and as a share of total health spending. In 17 of these countries, however, public spending on health fell as a share of current health spending, even as the economy was growing. Giving priority to health—or not—is clearly a political choice."[75] There is a need for a "simultaneous triple transition in global health procurement: the transition from donor aid as poorer countries grow wealthier, the epidemiological transition from infectious diseases to noncommunicable conditions, and the transition of health system organisation from vertical disease programs to integrated Universal Health Care (UHC)."[76,77]

3.3.2 Building Resilient Health Systems

Resilient health systems are absorptive, adaptive, and transformative.[78] Resilient health systems are not just about absence of disease. Human health and wellbeing are shaped by the whole human experience; the socioeconomic, the psychological, the environmental interactions within the human genome and the human phenome (genetic expression plus environmental influence). Resilient health systems strengthen human health and wellbeing. It detects and interprets local warning signs, quickly mobilises to absorb shocks, isolate the threats, and transform itself to adapt to shocks. Resilient health systems organically evolve to be able to maintain their core functions for tomorrow and manage health and wellness throughout the life cycle.

How is a resilient health system constructed? It is by creating a radical shift. It will require integration of the basics, such as the food we eat and the water we drink. Resilient health systems require consideration of not only pest and disease control and management, but also food systems, water and sanitation systems, the social environment, the education systems and the environment—all working together to produce the health and wellbeing we seek.[79]For the poorest stratum of African societies, "98% of these households use biomass fuels and few (14%) have access to electricity, increasing their exposure to household air pollution and putting them at risk of pneumonia as well as a variety of chronic diseases." Biomass collection has also been a major driver of deforestation and land degradation, which in turn reduced the ecosystem services in terms of getting clean water and air.[80] "More than 90% are deprived of decent sanitary facilities and almost 60% do not have reliable access to safe drinking water, putting them at risk of diarrhoea and malnutrition. The vast majority of the poorest live on dirt floors (88%), exposing them to faecal material and parasites. Many of the poorest households have children out of school (around 40%) or have nobody in the house who has completed a minimal 5 years of education (48%). The association between limited maternal education and childhood mortality is well established. Few (28%) of the poorest households have more than one of a set of substantial assets such as radios, telephones, bicycles, motorcycles, or cars, with implications for patterns of injury and access to health care."[81]

Investing in health systems saves lives and protects economies. For example, investments in clean water and sanitation are health system investments. New thinking can transform existing infrastructure and production systems to enhance the resilience of health systems.

For the world's poor who are disproportionately located in Africa 'non-communicable diseases and injuries' (NCDIs) contribute more than a third of their burden of disease. "This burden includes almost 800,000 deaths annually among those aged younger than 40 years, more than HIV, tuberculosis, and maternal deaths combined. Despite already living in abject poverty, between 19 million and 50 million of the poorest billion spend a staggering amount of money each year in direct out-of-pocket costs on health care as a result of NCDIs. Progressive implementation of affordable, cost-effective, and equitable NCDI interventions between 2020 and 2030 could save the lives of more than 4.6 million of the world's poorest, including 1.3 million who would otherwise die before the age of 40 years."[82] Importantly, many African countries are not well equipped to monitor and evaluate (M&E) many of the NCDIs with "weak institutional capacity; fragmentation of M&E functions; inadequate domestic financing; inadequate data availability, dissemination and utilisation of M&E products... with countries lay greater M&E emphasis on service delivery, health systems, maternal and child health as well as communicable diseases with a seeming neglect of the non-communicable diseases (NCDs)."[83]

[74] Global Spending on Health: A World in TransitionWHO/HIS/HGF/HFWorkingPaper/19.4, 2019

[75] Ibid

[76] Simfukwe, K. et al. (2021) "The role of health service delivery networks in achieving universal health coverage in Africa", *South Eastern European Journal of Public Health (SEEJPH)*. doi: 10.11576/seejph-4470.

[77] Silverman, R. et al. (2019) Tackling the Triple Transition in Global Health Procurement
FINAL REPORT OF CGD'S WORKING GROUP ON THE FUTURE OF GLOBAL HEALTH PROCUREMENT accessed from the web https://www.cgdev.org/sites/default/files/better-health-procurement-tackling-triple-transition.pdf

[78] Béné, C., Cornelius, A., & Howland, F. (2018). Bridging Humanitarian Responses and Long-Term Development through Transformative Changes—Some Initial Reflections from the World Bank's Adaptive Social Protection Program in the Sahel. *Sustainability, 10*(6), 1697. and see: Béné, C., Headey, D., Haddad, L., & von Grebmer, K. (2016). Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. *Food Security, 8*(1), 123-138.

[79] Bukhman G, Mocumbi AO, Atun R, et al. (2020) The Lancet NCDI Poverty Commission: bridging a gap in universal health coverage for the poorest billion. *Lancet*; 396(10256):991-1044. doi:10.1016/S0140-6736(20)31907-3.

[80] See Chapter 2 The Blue Economy in Africa and the case study of Mud Crab Ecotourism in Kenya: A Successful Community-Driven Model for a program that has successfully curtailed charcoal harvesting in Mangrove Forest via economic opportunity substitution.

[81] Bukhman, G. et al. (2019) The Lancet NCDI Poverty Commission: Bridging a gap in universal health coverage for the poorest billion, *The Lancet* Vol 396 October 3, 2020 991-1044.

[82] Ibid

[83] Nabukalu, J., Asamani, J., Nabyonga-Orem, J. (2020). 'Monitoring Sustainable Development Goals 3: Assessing the Readiness of Low- and Middle-Income Countries', *International Journal of Health Policy and Management*, 9(7), pp. 297-308. doi: 10.15171/ijhpm.2019.134.

3.4 Challenges for Health Policy, Science, Research, and Innovation

There are a seemingly infinite number of questions to be answered when developing successful health systems. For example, what are the short, medium, and long-term health policies from governments and the private sector at regional, national, and global levels? How operational are these policies? When the African continent has one of the smallest Tax-to-GDP ratios globally (16.5 per cent African average compared to 34.3 per cent for the OECD),[84] how are funds raised equitably when an economy is primarily informal? How are allocation efficiencies to be measured? How do we measure inequitable misallocations due to governance shortcomings;[85] medicine costs;[86] health hardware versus software investment optimisation decisions? What innovations make health systems more flexible, more people-centred, as opposed to being disease-specific?[87] These are fundamental questions that need answers to justify the policy decisions and investments to be made.

Strengthening the extant formal partnerships between research institutions and the various institutions that influence health already underway in many countries in Africa will go a long way to deliver science capacity and evidence that are the foundations on which good advice stands. "The current structures, where these exist, cannot adequately foster knowledge translation. Knowledge translation platforms need to be viewed as sector-wide platforms and mainstreamed in routine health sector performance reviews and policymaking processes. Funds for their functionality must be planned for as part of the health sector budget. Dissemination of evidence needs to be viewed differently to embrace the concept of 'disseminate for impact'. Further, funding for dissemination activities needs to be planned for as part of the evidence generation."[88] Scientific capacity must be harnessed to enable the least developed nations in Africa to move freely into the digital age to provide health decision-makers the best tools available to collect, manage, use, and inform their conclusions. Without a science capacity, even policymakers—who are positively disposed to scientifically-informed decision-making—are left guessing. Investments in data systems able to generate data-driven decisions can put equity at the centre of Africa's health systems.

The questions are many and a systemic approach on the continent is required. Fundamental to a systematic approach is understanding how governments and the private sector can successfully invest in health systems to advance equity of access, affordability, and efficiency. "In the context of evolving population health needs, additional considerations include the need for contextualised evidence to generate local solutions, innovation to improve efficiencies, and the development of more effective treatment regimens given the increasing resistance to commonly used medicines."[89,90] A further threat is the impact of anthropogenic climate change on vector-borne and other diseases (exacerbated by flooding for example), as well as heat stress and food security related health issues. Any planning and investment that ignores these, mostly unknown and largely unpredictable threats, is failing to approach the health sector's challenges in a holistic way.

Low-income countries (LIC) transitioning to middle-income countries (MIC) need to create the conditions for health system financing from development assistance, while also expanding their own domestic revenue generation, and pooling resource and purchasing power. How do these countries along with middle-income countries increase local production of critical equipment and supplies without compromising quality? The experiences of 2020-21 have highlighted the lack of expertise and capacity available on the continent in dramatic and life-threatening ways. Precisely because of the global nature of the COVID-19 pandemic medical supply chains were shown to be grossly inadequate for medical devices and equipment, medicines, and personal protective equipment.[91] This has also disproportionately affected the continent. "COVID–19 has magnified Africa's reliance on imported pharmaceuticals (both final and intermediate products) and amplified the urgency to build competitive, resilient and robust value chains in this sector."[92] While pharmaceutical products are currently manufactured in South Africa, Kenya, Morocco, and Egypt, more than 80 per cent of pharmaceutical and medical consumables use in Africa are imported.[93]

> **"Scientific capacity must be harnessed to enable the least developed nations in Africa to move freely into the digital age to provide health decision-makers the best tools available to collect, manage, use, and inform their conclusions."**

[84] OECD/ATAF/AUC(2020), *Revenue Statistics in Africa 2020*, http://oe.cd/revstatsafrica.

[85] Nabyonga-Orem, J., Asamani, J.A. & Makanga, M. (2021) The state of health research governance in Africa: what do we know and how can we improve?. *Health Res Policy Sys* **19**, 11. https://doi.org/10.1186/s12961-020-00676-9

[86] Silverman, R. et al. (2019) Tackling the Triple Transition in Global Health Procurement FINAL REPORT OF CGD'S WORKING GROUP ON THE FUTURE OF GLOBAL HEALTH PROCUREMENT, accessed from the web https://www.cgdev.org/sites/default/files/better-health-procurement-tackling-triple-transition.pdf

[87] De Man J, Mayega RW, Sarkar N, et al. (2016) Patient-centered care and people-centered health systems in Sub-Saharan Africa: Why so little of something so badly needed. *International Journal of Person Centered Medicine*. 6 (3) : 162–173.

[88] Asamani and Nabyonga-Orem (2020) Knowledge translation in Africa: are the structures in place? *Implementation Science Communications* 1:111 https://doi.org/10.1186/s43058-020-00101-w

[89] Nabyonga-Orem, J., Asamani, J.A. & Makanga, M. (2021) The state of health research governance in Africa: what do we know and how can we improve?. *Health Res Policy Sys* **19**, 11. https://doi.org/10.1186/s12961-020-00676-9

[90] Rusakaniko, S., Makanga, M., Ota, M.O. et al. (2019) Strengthening national health research systems in the WHO African Region – progress towards universal health coverage. *Global Health* **15**, 50. https://doi.org/10.1186/s12992-019-0492-8

[91] Mutangili K., S. (2021): Supply Chain Management in Times of COVID-19: Challenges and Lessons Learnt. *Journal of Procurement & Supply Chain*, Vol 5(1) pp. 1-12.

[92] Ibid

[93] Byaruhanga, J. (2020) How Africa can manufacture to meet its own pharmaceutical needs: The Pharmaceutical Manufacturing Plan for Africa provides a roadmap. *Africa Renewal*: September https://www.un.org/africarenewal/magazine/september-2020/how-africa-can-manufacture-meet-its-own-pharmaceutical-needs.

Furthermore, a recent study identified that up to 18.7 per cent of those imported drugs were falsified or sub-standard.[94] The dire consequences of this fraud are truly heartbreaking. One study estimated that approximately 122,000 children under the age of five die each year in SSA alone because of consuming falsified or substandard anti-malarials.[95] The current critical shortage experienced during the pandemic is an extension of "a persistent deficit of affordable, high-quality pharmaceutical drugs in developing countries"[96] whose chronicity is reflective of the multitude of barriers hindering the development of local manufacturing. The African Union recognised this and in 2008 adopted the Pharmaceutical Manufacturing Plan for Africa (PMPA), which has since been incorporated into the Accelerated Industrial Development of Africa (AIDA) Plan of Action[97]; this has translated into African innovation stepping up to meet immediate needs of critical shortages during the pandemic. "Some notable ones include a digital inventory to monitor the availability of ventilators and respirators in hospitals, developed by Lifebank (a Nigerian health-care technology and logistics start-up), a contactless solar-powered handwashing station developed by a young entrepreneur in Ghana, a mobile sprayer produced by Nigeria's Agency for Science and Engineering Infrastructure (NASENI), and a ventilator produced in Egypt using designs developed originally by Medtronic that had been released (complete with technical information, printed circuit board drawings and 3D CAD files) via a stylised open-source license."[98]

One significant barrier to the creation of a pan-African pharmaceutical and medical device sector has been the fragmented nature of the market. A successful implementation of the AfCFTA will address this challenge, and create the enabling environment needed to address the long-time disincentives for investors in pharmaceutical manufacturing. The pandemic has furthermore "highlighted that a robust supplier management system that takes into account sub-tier dependencies and proximity is a prerequisite for today's supply chain, and in turn has underlined the need to use the AfCFTA as a springboard for developing Africa's industrial [and manufacturing] base."[99] A second barrier to success is the need for capacity building for specific skillsets that cannot be taught even at universities, although biomedical and scientific degrees are prerequisites. Bayer currently offer such an 'apprenticeship' program,[100] and Fisher et al. [101] have proposed a global scaleup of such a program in service of developing country capacity building. "Working alongside the firms' managers and scientists, the apprentices would absorb crucial technical knowledge and then return to their own countries of residence to set up and run similar production facilities. They would be replaced by another cohort of apprentices, who would in turn return to their country of origin, and so forth. In this way, firms in developing countries would have access to the most current knowledge concerning how best to produce safe and efficacious drugs."[102] Such a program could also create a conduit for Africa's biomedical diaspora to potentially return to the continent with the promise of placement in advanced pharmaceutical manufacturing with pay and working conditions equivalent to those enjoyed in their adopted countries.[103] Fisher and colleagues have also suggested a comprehensive five tier framework that is worthy of serious consideration that can support the creation of a robust and commercially viable domestic drug and medical device industry. In addition to addressing scientific and technical capacity, the framework also suggests legal reforms necessary for transfer of appropriate intellectual property.[104]

Analysis of previous epidemics including Ebola and the HIV pandemic highlight the devasting impacts on health in Africa.[105] A healthy Africa will not be realised unless the continent is better equipped for future epidemics. Such capacity includes improved surveillance and health communication as well as interventions such as immunisation, clinical care, and supportive equipment and drug infrastructure. Lessons learned from the COVID-19 pandemic would suggest that Africa would need to excel at discovering and responding early to new epidemics. As has been learned, late responses such as hospitalisation, treatment of severely ill patients with equipment such as ventilators are expensive and not easily accessible and affordable by the continent. We need to invest in local industries to produce vaccines, life-saving medical equipment, personal protective equipment, as well as drugs.

3.5 African Traditional Medicine

Creating an enabling environment for the introduction of a continental-based pharmaceutical and medical device industry, as well as robust and geographically dispersed PHC, is central to achieving the SDG 3 suite of health-related indicators. It is also imperative that the important role that African traditional medicine (ATM) plays in African culture be recognised, as well as acknowledge the significant acceptance and reliance by many Africans of both ATM and traditional health practitioners (THPs).[106] It can be argued that there exists already in Africa a pharmaceutical industry based on the pharmacopeia present in the traditionally identified and utilised medicinal plants of the continent.

[94] Sachiko Ozawa et al., (2018) "Prevalence and Estimated Economic Burden of Substandard and Falsified Medicines in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis," *JAMA* Network Open 1, no. 4.

[95] John P. Renschler et al., (2015) "Estimated under-Five Deaths Associated with Poor-Quality Antimalarials in Sub-Saharan Africa," *American Journal of Tropical Medical Hygiene* 92, no. 6.

[96] Fisher, William W. and Okediji, Ruth and Gehl Sampath, Padmashree, (2021) Fostering Production of Pharmaceutical Products in Developing Countries (April 12, 2021). *Michigan Journal of International Law*, Vol. 43, No. 1, Available at SSRN: https://ssrn.com/abstract=3825165

[97] "United Nations. Economic Commission for Africa; United Nations. Economic Commission for Africa (2020-05). *Review of policies and strategies for the pharmaceutical production sector in Africa: policy coherence, best practices and future prospective.* Addis Ababa. © UN. ECA. https://hdl.handle.net/10855/43788"

[98] Fisher, William W. and Okediji, Ruth and Gehl Sampath, Padmashree, (2021) Fostering Production of Pharmaceutical Products in Developing Countries (April 12, 2021). *Michigan Journal of International Law*, Vol. 43, No. 1, Available at SSRN: https://ssrn.com/abstract=3825165

[99] Mutangili K., S. (2021): Supply Chain Management in Times of COVID-19: Challenges and Lessons Learnt. *Journal of Procurement & Supply Chain*, Vol 5(1) pp. 1-12.

[100] https://karriere.bayer.de/sites/g/files/kmftyc1001/files/2019-05/EB_A4_Biowissenschaftler_180212_EN_Preview.pdf

[101] Fisher, William W. and Okediji, Ruth and Gehl Sampath, Padmashree, (2021) Fostering Production of Pharmaceutical Products in Developing Countries (April 12, 2021). *Michigan Journal of International Law*, Vol. 43, No. 1, Available at SSRN: https://ssrn.com/abstract=3825165

[102] Ibid

[103] See further 3.7 for a more thorough-going discussion of the African medical diaspora.

[104] Ibid

[105] Institute of Medicine (US) Committee on Envisioning a Strategy for the Long-Term Burden of HIV/AIDS: African Needs and U.S. Interests. Preparing for the Future of HIV/AIDS in Africa: A Shared Responsibility. Washington (DC): National Academies Press (US); (2011). 4, *The Burden of HIV/AIDS: Implications for African States and Societies.*

[106] Kasilo OMJ, Wambebe C, Nikiema J-B, et al. (2019) Towards universal health coverage: advancing the development and use of traditional medicines in Africa. *BMJ Global Health* 2019;4:e001517. doi:10.1136/bmjgh-2019-001517.

Traditional medicine is defined as "the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses."[107] The WHO has developed a framework for how the relevant medical bodies of countries systemically integrate, analyse, and advance successful elements of Africa's traditional ethnomedical sector into modern medical faculties at the university level. "The Declaration of Astana, adopted at the Global Conference on Primary Health Care in October 2018, made clear that the success of primary health care will be driven by applying scientific as well as traditional knowledge, and extending access to a range of health care services, which include traditional medicines."[108] It is important to note that the WHO led declaration is global in nature and not just African. World-wide the role of complementary medicine along with traditional medical practices is being re-examined, and in several cases incorporated into contemporary Western practices. "Scientific validation of the safety and efficacy of plant extracts derived from African medicinal plants based on African Indigenous medical knowledge has been facilitated by the use of WHO technical support tools."[109] Research into the traditional medicine formulation for Sickle Cell Disease (SCD) in Nigeria, for example, led to the development of the new 'Western drug' and patent for NIPRISAN. NIPRISAN significantly reduced the frequency of SCD crisis associated with severe pain. [110] Unfortunately the drug's patent expired before being successfully commercialised, and the story itself is illustrative of the complexities of drug commercialisation in general and for Africa in particular.[111] Although recent efforts are underway for the off-patent formulation to be commercialised in Nigeria, other investigations of West African traditional 'anti-sickling' medicines have been reported.[112] Another review paper has comprehensively examined "10 promising medicinal plants from the African biodiversity, which have short- as well as long-term potential to be developed as future phytopharmaceuticals."[113]

Rigorous research into traditional medicine efficacy and suitability for standardisation and regulation has been a prospective activity within modern medicine for many decades. Recent examples, include research evidence that the Japanese traditional medicine 'Hochuekkito' promotes negative conversion of vancomycin-resistant enterococci.[114] However, within the African context, it is also important to acknowledge that traditional medicine discussions occur in a post-colonial and post-apartheid era. There is an unfortunate legacy regarding a Western cultural and scientific imperialism, suppression, and eradication of ATM and the associated healers (as well as 'witchcraft').[115,116] At the same time, just because a traditional medicine exists does not mean that it is efficacious or safe. Medical pluralism will continue to play a vital role in the delivery of primary health care in Africa. Both allopathic and traditional medicine will co-exist in the foreseeable future. However, there is an urgent need to determine quality as well as the deficiencies of both systems. Modern research is fundamental to elucidating how a non-efficacious treatment and remedy can arise and persist.[117] The lack of traditional medicine standardisation and regulation has been shown over numerous validated studies to increase risk of heavy metal,[118] and many other contaminant exposures, and produce numerous associated severe complications including death, particularly when combined with modern medicines. Finally, there is emerging evidence to suggest that the role of the microbiome is an important factor in relation to the efficacy of traditional medicines (world-wide),[119] Western medicines,[120] as well as for the metabolism of bioactive ingredients of food more generally.[121] African-specific research into these complex interactions will be a prospective field of investigation to improve health and wellbeing for many years to come. How an enabling environment for the introduction of a continental-based pharmaceutical and medical device industry interrogates and integrates ATM and knowledge is a major challenge and opportunity, particularly in making PHC more attainable and effective. Traditional medicine often offers accessible primary health care based on the culture and needs of local communities. At the same time, access to government-run and private health care is often poor, with varying quality of service. The goal should be expanding access to PHC as well as improving quality by qualified providers.

However, delays by traditional healers and birth attendants in referring patients with serious and complicated health issues for modern medical care do, sadly, lead to avoidable deaths. Traditional medicine may have a role to play in universal health coverage (UHC) but we need more research on the effectiveness and safety of traditional therapies. Challenges to address include -1) determining the active and effective ingredients of traditional medicine preparations, 2) matching diagnosis with specific therapies, 3) standardisation of dosing, 4) reducing contaminants in medication, 5) minimising side effects, and 6) early referral when needed.

[107] World Health Organization. Traditional, complementary and integrative medicine (2019) [Definitions. Brazzaville Congo, 2019. https://www. who. int/ traditional-complementary- integrativemedicine/about/ en/

[108] WHO global report on traditional and complementary medicine (2019). Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO.

[109] Kasilo OMJ, Wambebe C, Nikiema J-B, et al. (2019) Towards universal health coverage: advancing the development and use of traditional medicines in Africa. *BMJ Global Health* 2019;4:e001517. doi:10.1136/bmjgh-2019-001517.

[110] Wambebe C, Khamofu H, Momoh JA, et al. (2001) Double-Blind, placebo controlled, randomised cross-over clinical trial of NIPRISAN in patients with sickle cell disorder. *Phytomedicine* 2001;8:252–61.

[111] https://qz.com/africa/1547079/nigerian-scientists-patented-a-sickle-cell-drug-using-a-traditional-herbal-remedy-then-it-all-fell-apart/

[112] Ameh SJ, Tarfa FD, Ebeshi BU. (2012) Traditional herbal management of sickle cell anemia: lessons from Nigeria. *Anemia.* 2012;2012:607436. doi: 10.1155/2012/607436. Epub 2012 Nov 8. PMID: 23198140; PMCID: PMC3502758.

[113] M. Fawzi Mahomoodally, (2013) "Traditional Medicines in Africa: An Appraisal of Ten Potent African Medicinal Plants", Evidence-Based Complementary and Alternative Medicine, vol. 2013, Article ID 617459, 14 pages. https://doi.org/10.1155/2013/617459

[114] Kohno, J., Kawamura, T., Kikuchi, A. et al. (2021) A Japanese traditional medicine Hochuekkito promotes negative conversion of vancomycin-resistant Enterococci. *Sci Rep* **11,** 11300. https://doi.org/10.1038/s41598-021-90890-4

[115] Adam Ashforth (2005) *Muthi*, Medicine and Witchcraft: Regulating 'African Science' in Post-Apartheid South Africa?, *Social Dynamics*, 31:2, 211-242, DOI: 10.1080/02533950508628714.

[116] Annie Devenish (2005) Negotiating Healing: Understanding the Dynamics amongst Traditional Healers in Kwazulu-Natal as they Engage with Professionalisation, *Social Dynamics*, 31:2, 243-284, DOI: 10.1080/02533950508628715.

[117] Tanaka MM, Kendal JR, Laland KN (2009) From Traditional Medicine to Witchcraft: Why Medical Treatments Are Not Always Efficacious. *PLoS ONE* 4(4): e5192. doi:10.1371/journal.pone.0005192.

[118] R.A. Street, (2012) Heavy metals in medicinal plant products — An African perspective, *South African Journal of Botany*, Volume 82, Pages 67-74, ISSN 0254-6299, https://doi.org/10.1016/j.sajb.2012.07.013.

[119] Zhang, R., Gao, X., Bai, H., & Ning, K. (2020) Traditional Chinese Medicine and Gut Microbiome: Their Respective and Concert Effects on Healthcare. *Frontiers in Pharmacology*, *11*, 538. https://doi.org/10.3389/fphar.2020.00538

[120] Enright, E. F., Gahan, C. G., Joyce, S. A., & Griffin, B. T. (2016). The Impact of the Gut Microbiota on Drug Metabolism and Clinical Outcome. *The Yale journal of biology and medicine*, *89*(3), 375–382.

[121] Aedín Cassidy, Anne-Marie Minihane (2017) The role of metabolism (and the microbiome) in defining the clinical efficacy of dietary flavonoids, *The American Journal of Clinical Nutrition*, Volume 105, Issue 1, January, Pages 10–22, https://doi.org/10.3945/ajcn.116.136051

3.6 Universal Health Coverage (UHC)

Many African governments have substantially committed to UHC[122] which is fundamental to a strong and resilient health system.[123] The way to achieve UHC is to improve access to quality health services at the local community level at an affordable price. With equity as the determinant of need in a health system a person can access what they need when they need it.[124] Achieving inclusive health systems necessitates equitable access and full participation based on trust. If there is no trust in the system, people are unlikely to access it. Observations from healthcare delivery in high-income countries show that reliance on private user-pay models at the expense of single payer 'universal' delivery models while achieving a high standard of care does so very unevenly. "In contrast, healthcare delivery has been more cost-effective in advanced economies that have adopted universal single-payer models."[125]

UHC commitments need to reflect per capita expenditures. Populations do not want to increase out of pocket expenses (OOP) as the growing component in a UHC system. Therefore, governments need to incrementally increase per capita expenditure and find new ways of incentivising private investment by people and businesses that can positively influence health and equity. For most African countrie, to achieve true universal health coverage would require unprecedented investments in health care services beyond what can be compensated for by economic growth and what governments can justifiably afford. Consequently, a different approach is imperative to flatten the trajectory of the healthcare needs across the continent.

In many low- and middle-income countries, where progress toward UHC remains limited, essential health products may be available only in the private sector—purchased through OOP spending and at prices unaffordable for many families. In LICs and MICs, private sources of spending account for 36 per cent and 81 per cent of health commodity expenditure, respectively.[126] Therefore, as countries transition to greater self-reliance, which includes increased domestic spending on health services and products, there is a risk of a corresponding reduction in foreign aid support. Mis-managing such transitions has the potential to drive OOP medical expenses even higher thereby endangering equitable distribution of healthcare benefits.

"Current projections show that many health-related SDG indicators, NCDs, NCD-related risks, and violence-related indicators will require a concerted shift away from what might have driven past gains—curative interventions in the case of NCDs—towards multisectoral, prevention-oriented policy action and investments to achieve SDG aims."[127] Furthermore the continental diversity and complexity of natural and social systems demand contextualisation and localisation of healthcare interventions. "This complexity accentuates the importance of strengthening national health research systems that generate timely knowledge and innovations to address local health challenges and progress towards UHC and health security for countries."[128] Indeed "failure to prioritize local research will result in the roots and triggers of poor health in Africa being misinterpreted, the soundest interventions for addressing them unarticulated, the strategies for optimizing the effectiveness of health actions remaining elusive and SDG3 remaining a mirage."[129] Additionally, numerous studies and reports have identified inadequacy of resource allocation to be a primary determinant to the slow pace of change. However increased resource allocation without simultaneously addressing associated corruption of allocation and mis-allocation of those same resources will continue to be major impediments to UHC success.[130,131,132,133]

> **"For most African countries, to achieve true universal health coverage would require unprecedented investments in health care services beyond what can be compensated for by economic growth and what governments can justifiably afford."**

[122] United Nations A/RES/74/2 10 October 2019 Political declaration of the high-level meeting on universal health coverage available at: https://undocs.org/en/A/RES/74/2

[123] World Health Organisation. (2013) The World Health Report 2013: Research for Universal Health Coverage. Geneva: WHO.

[124] World Bank *Universal Health Coverage (UHC) in Africa : a framework for action : Main report (English). (2016)* Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/735071472096342073/Main-report

[125] Peter R. Lamptey (2020) The Future of Health in Africa Post-COVID-19 *Contemporary Issues in African Trade and Trade Finance* CIAT Volume 6 • Number 1 December 2020 ISSN 2409-3688.

[126] Rachel Silverman, Janeen Madan Keller, Amanda Glassman, and Kalipso Chalkidou (2019) Tackling the Triple Transition in Global Health Procurement *FINAL REPORT OF CGD'S WORKING GROUP ON THE FUTURE OF GLOBAL HEALTH PROCUREMENT.*

[127] GBD 2017 SDG Collaborators. (2019) Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: a systematic analysis for the Global Burden of Disease Study 2017 [published correction appears in Lancet. 2019 Jun 22;393(10190):e44]. *Lancet.* 2018;392(10159):2091-2138. doi:10.1016/S0140-6736(18)32281-5.

[128] Rusakaniko, S., Makanga, M., Ota, M.O. et al.(2019) Strengthening national health research systems in the WHO African Region – progress towards universal health coverage. *Global Health* **15,** 50. https://doi.org/10.1186/s12992-019-0492-8

[129] Ibid

[130] Worku EB, Woldesenbet SA. Universal Health Coverage - A Tool to Fight Health Inequity Battles: The Need from Aspiration to Decisive Action in African Countries. J Public Health Dev Ctries. 2017; 3(1): 318-326.

[131] Michel J, Datay MI, Motsohi TJ, et al. Achieving universal health coverage in sub-Saharan Africa: the role of leadership development. *Journal of Global Health Reports*. 2020;4:e2020037. doi:10.29392/001c.12855.

[132] Transparency International (2020) "Corruption Perception Index." https://images.transparencycdn.org/images/2019_CPI_Report_EN_200331_141425.pdf

[133] United Nations Economic Commission for Africa (2016) "Measuring Corruption in Africa: International Dimensions Matters." African Governance Report IV https://www.uneca.org/sites/default/files/PublicationFiles/agr4_eng_fin_web_11april.pdf

3.7 The African Medical Diaspora

Within Africa there are hundreds of thousands of courageous health care workers striving to provide basic health care under extremely challenging workplace conditions. This is particularly so during the current pandemic, although the same courage was evident during many previous epidemics, including HIV-AIDS, Ebola and Marburg. This needs urgent attention. What is more, while migration patterns are complex,[134] each year there is a significant net loss[135] of trained health care workers from Africa to primarily developed countries, despite increasing output of new graduates from African universities. For example, the outflow of African-educated physicians to the US has increased from 10,684 in 2005 to 13,584 in 2015 (27.1per cent increase).[136] At the same time the number of African-educated physicians who graduated from medical schools in SSA countries was 2014 in 2005 and 8,150 in 2015 (304.6 per cent increase).[137] Simple arithmetic shows that counting only emigration to the US (and not to other developed countries) SSA lost 5,434 more physicians than were trained in that year. The seriousness of the global situation is encapsulated in the WHO Global Code of Practice on the International Recruitment of Health Personnel.[138] "Also, the UK, remembering in an ethical manner its colonial legacy, created its own Code of Practice for international nurse recruitment.[139] In 2003, the UK was the first nation to adopt a Code of Practice for International Recruitment of Health Workers that was designed to promote ethical employment and mitigate the impact on former UK dependencies. Based on the principles of transparency, fairness, and mutuality of benefits, this Code addresses Commonwealth countries regarding migrant worker rights and warns against depleting health systems abroad."[140] At the same time other countries recruited during the 2020 pandemic year with some well publicised campaigns in response to 'health nationalism'.

On March 27th, the US Government tweeted an opportunity for health professionals to apply for visas to work in the US. The US Embassy in Cairo received over 1,600 visa applications within 48 hours, according to a source who did not want to be identified. The applications are almost entirely from medical professionals, including doctors, pharmacists, and dentists, the source added, in light of an announcement from the US State Department.[141] "So far, responses to migration have focused on restrictive work contracts or immigration policies; however, those measures failed to stem the exodus and mostly targeted the pull factors."[142]

It is well understood and well documented that the African diaspora want to (and do) contribute to bridging positive changes in health in the region.[143] There are numerous ways people are doing this: sending medical or research equipment to colleagues in Africa; establishing collaborative linkages between African research institutions and institutions elsewhere for clinical progress etc.; sending 'missions' for targeted projects; hosting African fellows to acquire new skills/knowledge, and; advocating for effective international investment in research and health in Africa. However, African countries need to think more strategically about how to facilitate leveraging the skills and knowledge of the diaspora when they seek to contribute towards improving health systems in African nations. Frehywot and colleagues[144] inventoried the activities of low- and middle-income countries' (LMIC) medical diaspora organisations in four destination countries (the US, the UK, Canada, and Australia). They identified 89 separate medical diaspora organisations, with 8 specifically African: Cameroon, Egypt, Ethiopia, Ghana, Nigeria, Sierra Leone, Sudan, and Tanzania. They also found sixty-eight LMIC countries have established a diaspora office within their government office.

One emerging avenue for direct engagement with the African medical diaspora has been pioneered during the COVID-19 pandemic. Ironically, it involved a Kenyan diaspora physician living in Australia who worked as a telemedicine emergency physician for the Western Australian Health Department servicing the regional and remote regions. At a certain point during the pandemic he had returned to Kenya to support his family but continued to offer services via telemedicine to remote and rural Western Australia from Kenya.[145] This formalised service delivery suggests that with the appropriate regulatory and technological systems in place the reverse can also occur. African diaspora physicians servicing African communities from anywhere in the world.

[134] Adovor E, Czaika M, Docquier F, Moullan Y.(2021) Medical brain drain: How many, where and why? *J Health Econ*. Mar;76:102409. doi: 10.1016/j.jhealeco.2020.102409. Epub 2020 Dec 30. PMID: 33465558.

[135] Naicker S, Plange-Rule J, Tutt RC, Eastwood JB. (2009) Shortage of healthcare workers in developing countries- Africa. *Ethn Dis*. 2009; 19: S1-64.

[136] Duvivier, R. J., Burch, V. C., & Boulet, J. R. (2017). A comparison of physician emigration from Africa to the United States of America between 2005 and 2015. *Human resources for health*, *15*(1), 41. https://doi.org/10.1186/s12960-017-0217-0

[137] Ibid

[138] World Health Organization . WHO global code of practice on the international recruitment of health personnel. Sixty-Third World Health Assembly. Geneva: World Health Organization, http://www.who.int/hrh/migration/code/practice/en/ (May 2010)

[139] Commonwealth Secretariat . *Commonwealth code of practice for the international recruitment of health workers*. London: The Commonwealth, https://www.odi.org/sites/odi.org.uk/files/odi-assets/events-documents/2440.pdf

[140] Stievano A, Hamilton D, Bakhshi M. (2021) Ethical challenges and nursing recruitment during COVID-19. *Nursing Ethics*;28(1):6-8. doi:10.1177/0969733021989180.

[141] https://english.alaraby.co.uk/news/hundreds-egypts-medical-workers-apply-us-visa

[142] Silvia Wojczewski, Annelien Poppe, Kathryn Hoffmann, Wim Peersman, Oathokwa Nkomazana, Stephen Pentz & Ruth Kutalek (2015) Diaspora engagement of African migrant health workers – examples from five destination countries, *Global Health Action*, 8:1, 29210, DOI: 10.3402/gha.v8.29210.

[143] Ibid

[144] Frehywot, S., Park, C. & Infanzon, A. (2019) Medical diaspora: an underused entity in low- and middle-income countries' health system development. *Hum Resour Health* **17,** 56. https://doi.org/10.1186/s12960-019-0393-1.

[145] This case study was presented as part of the African Development Bank Community of Practice (G-CoP) Building Resilient Health Systems: Policies for Inclusive Health in Post-COVID-19 Africa held virtually on June 22-23, 2020.

3.8 Harnessing Telemedicine and Digital Platforms

Telemedicine offers a major opportunity to harness medical expertise from the African diaspora and other foreign professionals. While its use in developing countries has been explored for more than a decade[146] serious adoption of the technology and realisation of its promise has come to the fore during the COVID-19 pandemic,[147] initially out of necessity, then out of efficacy. Even within the African continent, neighbouring African countries with specific expertise who are willing and able to assist other African nations may be enabled via expansion of telehealth investments. A systematic review of the role of telemedicine in the US during the pandemic is equally relevant for Africa: "The advantages of telemedicine moving forward include its cost-effectiveness, ability to extend access to specialty services and its potential to help mitigate the looming physician shortage. Disadvantages include lack of available technological resources in certain parts of the country, issues with security of patient data, and challenges in performing the traditional patient examination. It is critically important that changes are made to fully immerse telemedicine services into the healthcare landscape to be prepared for future pandemics as well as to reap the benefits of this service in the future."[148]

Data systems that digitise medical records combined with telemedicine can be deployed across Africa at scale. Such systems have already started in many places, including Nigeria, Ghana, Kenya, Rwanda, and more. The same pool of doctors can securely reach millions of people across Africa in a way like the US's Health Insurance Portability and Accountability Act (HIPAA); storing data in the cloud, synchronised within all the levels of care from primary to secondary to tertiary. This creates a continuity of care. It can enable midwives to develop rapport and trust, and records arising can avoid retelling of medical journeys to various practitioners and specialists. However, for an equitable system the ICT infrastructure needs to reach everyone, even in remote areas. Africa's internet connectivity and mobile coverage is good, and comparable to industrialised nations with large remote populations. In terms of emergency telemedicine, even very remote health workers have access to a doctor or specialist via telephone or video to assist with diagnosis and management. With telemedicine, trained healthcare workers, doctors, and specialists can transform healthcare using command centres that direct people to whom they need to consult in an efficient, effective, and equitable manner. There has been a meaningful reduction in the coverage gap for mobile internet in SSA. Two important milestones were achieved in 2019: 1) the first year with more mobile broadband (3G and 4G) connections than 2G; and 2) the coverage gap halved from 50 per cent in 2014 to 25 per cent in 2019.[149] Despite such improvements, SSA still has the highest coverage gap globally, most strikingly (and not surprisingly) it is in rural and remote areas. It is into this scenario that analysts have identified various intervention strategies to increase coverage including innovative technologies (RAN, backhaul, energy).[150] The Third Commission highlights the emerging role of telehealth as a driver for enhanced coverage as well as a consumer of the same. Indeed, providing mobile phone coverage particularly access to data should be understood as an integral component of health infrastructure into which national governments must play an enabling role.

Telemedicine need not engage patients at the outset. Many countries have healthcare professional to healthcare professional consultation and can evolve into doctor to patient modalities. With solving concomitant issues of jurisdictions and quality of care, the technology enables a global medical diaspora in profound and innovative ways that do not require physical relocation. There are related opportunities for researching non-invasive diagnostic tools, labs on a chip, and the 'internet of things' to enable a revolution in health systems and service delivery globally.

At the present time there is no pan-African policy for the adoption of telemedicine; no guidelines and no blueprints. There are many questions that arise that need answering; what should it look like? What kind of doctors should be licensed to consult? What patient record confidentiality and data protection exists? These and many other questions need careful consideration so an expeditious wide rollout of telemedicine can occur. What is known is that consistent government-to-business policy coordination and public-private investment partnerships are required. Appropriately deployed ICT solutions can achieve greater efficiency and improve medical treatment affordability and accessibility.

> **"Even within the African continent, neighbouring African countries with specific expertise who are willing and able to assist other African nations may be enabled via expansion of telehealth investments."**

[146] Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth 2009. (Global Observatory for eHealth Series, 2) ISBN 978 92 4 156414 4

[147] Monaghesh, E., Hajizadeh, A. The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. *BMC Public Health* **20**, 1193 (2020). https://doi.org/10.1186/s12889-020-09301-4

[148] Kichloo A, Albosta M, Dettloff K, et al. (2020) Telemedicine, the current COVID-19 pandemic and the future: a narrative review and perspectives moving forward in the USA. *Fam Med Com Health*;8:e000530. doi:10.1136/fmch-2020-000530.

[149] Data reported by Wyrzykowski, R. (2021) https://www.gsma.com/mobilefordevelopment/blog/mobile-connectivity-in-sub-saharan-africa-4g-and-3g-connections-overtake-2g-for-the-first-time/#edn2

[150] https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/07/GSMA-Closing-The-Coverage-Gap-How-Innovation-Can-Drive-Rural-Connectivity-Report-2019.pdf

3.9 Urban Planning and the Living Environment

The confines of the environment where individuals and families live, work, and play can determine their health status. What kinds of local food is available? Is it affordable, nutritious, and healthy? Are the air and water clean? Is the built environment conducive to being safe, fit, and healthy? For example, recent global estimates ascribe 8.9 million deaths per year to airborne particulate matter smaller than 2.5 µm (PM2.5).[151] Unfortunately, Africa, a continent undergoing rapid urbanisation with an extreme shortage of air pollution data, will have an increasing share of that grim statistic.[152] Perhaps even more, unfortunately, the insights gained from matched pollutant data and health metrics from industrialised nations will not assist decision-makers in Africa, as the pollutant sources include significant amounts of airborne particulate matter from burned biomass for cooking.[153] Given that reducing the negative health impacts of air pollution is a clearly stated SDG 3.9 target, the trend of increasing harm is alarming.[154] Furthermore "estimates of its impact on the region are possibly underestimated due to a lack of air quality monitoring, a paucity of air pollution epidemiological studies, and important population vulnerabilities in the region. The lack of ambient air pollution epidemiologic data in SSA is also an important global health disparity."[155]

Globally, poor urban planning is a failure of education and imagination. A significant proportion of African urban infrastructure and development is private sector driven, which plays a considerable role in influencing health. Consciously considering the private sectors' influence on health is an opportunity to measurably create positive health outcomes equitably and reduce contributions to the disease burden.

It is possible to imagine residents of a neighbourhood empowered with data of trends of childhood hospitalisations with asthma and the data on the air quality in their neighbourhood. Good health does not just happen. If we do not consider unintended consequences in urban planning, we will continue to harm the inhabitants of those urban centres. What if infrastructure development had legislation requiring it to become a positive investment contributing to improving human and planetary health? What if it were mandatory for built environments to deliver on targets for safe and equitable access to physical activity, as advocated by the American Heart Association[156] and influenced behaviour to reduce obesity and high blood pressure risks? How will our refocused urban planning investment impact our teaching in schools and universities and the need for professionals with this expertise? And particular African-centred expertise that "African urbanisation is—and will possibly continue to be—simultaneously driven and cushioned by informalisation"[157]

Will we retrain health professionals across all systems or educate urban planners, engineers, architects, economists, for example, to integrate considerations of unintended consequences of urban environments on health and disease? How can we foster innovation so other sectors can create health? By exploring new ways to construct our built environments, we can minimise negative impacts on our health from all sectors. Because the origin of poor health is often not from the healthcare sector, for example, challenges with transportation (travel time to emergency rooms) within Africa's mega-cities also can impact outcomes in health impacts.[158]

Finally, there is considerable research into the deleterious health consequences of informal urban and peri-urban settlements. Often these findings have been used to support 'slum clearance' rather than immediate improvement of lives in these communities, thereby exacerbating impoverishment of already marginalised communities. In such communities, "children are especially vulnerable, and that the combination of malnutrition and recurrent diarrhoea leads to stunted growth and longer-term effects on cognitive development."[159] Finally, literature on 'slum health' is underdeveloped compared to urban health, and poverty and health. This shortcoming is important because health is affected by factors arising from the shared physical and social environment, which have effects beyond those of poverty alone and that "slum health should be promoted as a topic of enquiry alongside poverty and health."[160]

[151] Burnett R, Chen H, Szyszkowicz M, Fann N, Hubbell B, et al. (2018). Global estimates of mortality associated with long-term exposure to outdoor fine particulate matter. *PNAS* 115:9592–97.

[152] Wetsman N. (2018). Air-pollution trackers seek to fill Africa's data gap. *Nature* 556:284.

[153] Coker, E. & Kizito, S. (2018) A narrative review on the human health effects of ambient air pollution in Sub-Saharan Africa: An urgent need for health effects studies *Int. J. Environ. Res. Public Health.* 15, 427.

[154] Peter Rafaj, P et al. Outlook for clean air in the context of sustainable development goals, Global Environmental Change, Volume 53, 2018, Pages 1-11, ISSN 0959-3780, https://doi.org/10.1016/j.gloenvcha.2018.08.008.

[155] Coker, E. & Kizito, S. (2018) A narrative review on the human health effects of ambient air pollution in Sub-Saharan Africa: An urgent need for health effects studies *Int. J. Environ. Res. Public Health.* 15, 427.

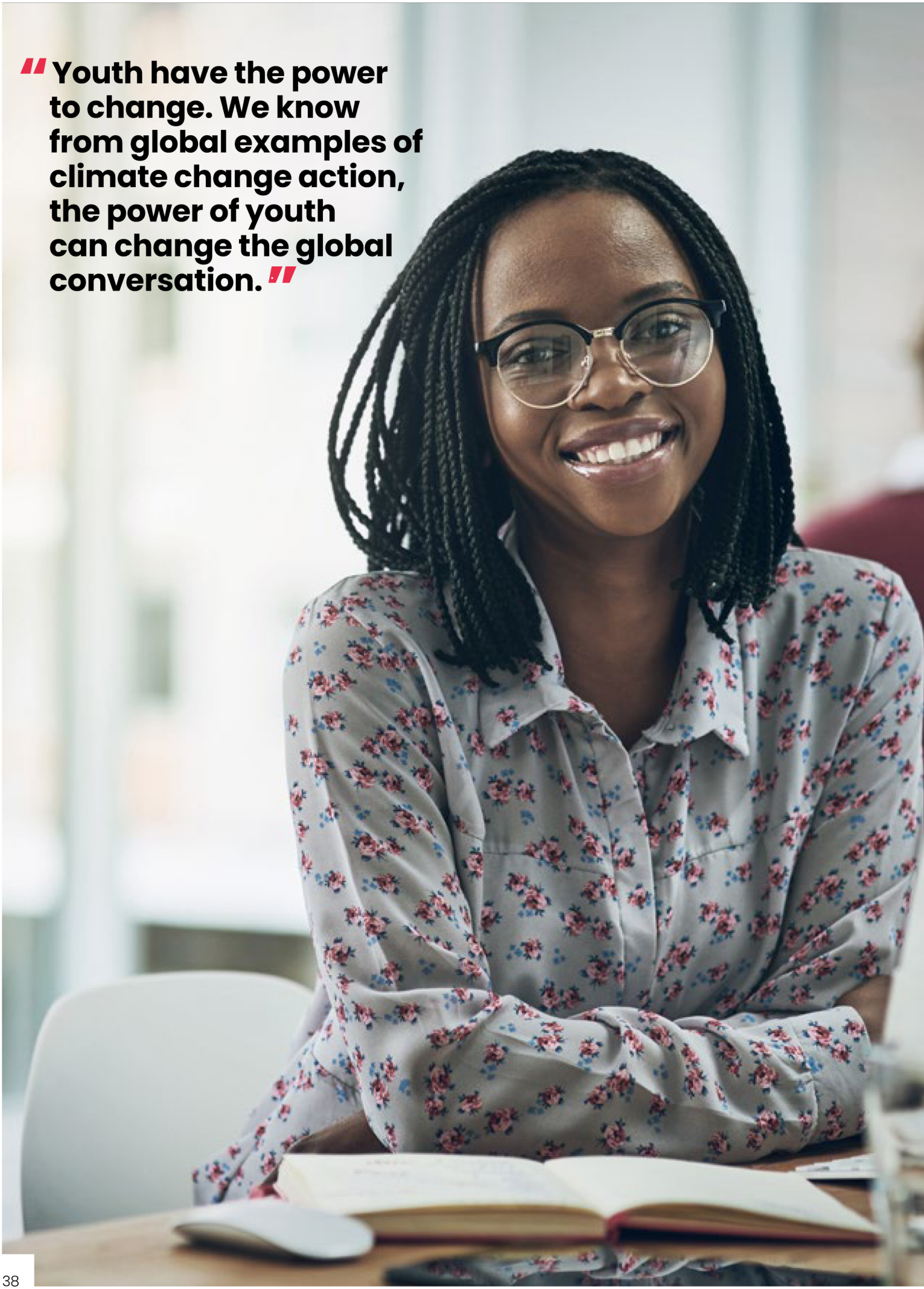
[156] Young, D. et al. (2020) Creating Built Environments That Expand Active Transportation and Active Living Across the United States: A Policy Statement From the *American Heart Association*, Circulation Volume 142, Issue 11, 15 September; Pages e167-e183 https://doi.org/10.1161/CIR.0000000000000878

[157] Kamete, A. Missing the point? Urban planning and the normalisation of 'pathological' spaces in southern Africa *Transactions of the Institute of British Geographers* Volume38, Issue4 October 2013 Pages 639-651.

[158] Banke-Thomas, A., Balogun, M., Wright, O. et al. Reaching health facilities in situations of emergency: qualitative study capturing experiences of pregnant women in Africa's largest megacity. *Reprod Health* **17,** 145 (2020). https://doi.org/10.1186/s12978-020-00996-7

[159] Ezeh A, Oyebode O, Satterthwaite D, Chen YF, Ndugwa R, Sartori J, Mberu B, Melendez-Torres GJ, Haregu T, Watson SI, Caiaffa W, Capon A, Lilford RJ. (2017) The history, geography, and sociology of slums and the health problems of people who live in slums. *Lancet.* Feb 4;389(10068):547-558. doi: 10.1016/S0140-6736(16)31650-6. Epub 2016 Oct 16. PMID: 27760703.

[160] Lilford RJ, Oyebode O, Satterthwaite D, Melendez-Torres GJ, Chen YF, Mberu B, Watson SI, Sartori J, Ndugwa R, Caiaffa W, Haregu T, Capon A, Saith R, Ezeh (2016) A. Improving the health and welfare of people who live in slums. *Lancet.* 2017 Feb 4;389(10068):559-570. doi: 10.1016/S0140-6736(16)31848-7. Epub 2016 Oct 16. PMID: 27760702.


"Youth have the power to change. We know from global examples of climate change action, the power of youth can change the global conversation."

CONCLUSION

On a continent with stunning diversity, one homogenous characteristic is youthfulness. Africa's youth is perhaps her greatest resource. Within the youth, we are creating tomorrow's health today. Youth have the power to change. We know from global examples of climate change action, the power of youth can change the global conversation. If we ensure that young people are living in healthy environments and staying healthy themselves, youth can drive the changing of norms to think long term, and they need to be 'at the table'. However, today's youth are already exhibiting a rising burden of chronic disease. Epidemiological research demonstrates that an underweight child will have an increased risk of adult heart disease and obesity. Reducing the 'Westernisation' of diets that create obesity and other non-communicable diseases is crucial.

The role of pre-emptive legislation and regulation around the availability and price of healthy foods can protect African countries from comparable political pressures in the food industry seen else globally. "Current projections show that many health-related SDG indicators, NCDs, NCD-related risks, and violence-related indicators will require a concerted shift away from what might have driven past gains—curative interventions in the case of NCDs—towards multisectoral, prevention-oriented policy action and investments to achieve SDG aims."[161] Furthermore the continental diversity and complexity of natural and social systems demand contextualisation and localisation of health and wellbeing interventions. "This complexity accentuates the importance of strengthening national health research systems that generate timely knowledge and innovations to address local health challenges and progress towards UHC and health security for countries."[162] Indeed without local research and sound interventions for addressing health challenges, SDG 3 will remain a mirage.[163]

New approaches, initiatives, and technologies are now able to be deployed at scale. However, without accountability and transparency, there is no trust. Measurement of basic indicators is a strong component of accountability that also enables effective regulation. An unregulated health or food system cannot be strengthened. Ineffectiveness, inefficiencies, leakage, at both the professional and financial levels thrive where regulation remains weak. If the governance of health or food systems remains weak, entrepreneurial activity remains weak. Crucially, if there is corruption in the health or food sectors, people die. Adhering to laws and regulations, and courageously exposing corruption will enact positive change.

Taking a leaf from the history of African pandemics have long shown us; 'If we all do not have health, none of us do'. In past epidemics, we've seen that resilient systems with strong public capacities tend to perform better, resulting in less disruption. This requires citizens to engage with their health and food systems by contributing planning and management decision-making. This requires consideration of public good investments in communities and their broader environment. Investing in public goods is another means to 'level' the metaphorical 'playing field' to provide equitable long-term outcomes. Much centres around simple education to enact behavioural change for healthy and safe decision-making with food and sanitation. It can be as simple as; "to be healthy you need healthy food, and healthy food requires a good environment."[164] Basic knowledge about sanitation can avoid food sold in open markets from the floor/road in the 21st century, and investments in education can save many people from needing to come to the hospital or see a doctor at all.

Public awareness campaigns can immediately impact our health and food systems. Interrelationships between health, food, and the environment can become very scientific in its orientation, but these research findings need to be adapted and adopted by the community. A multidisciplinary systems approach using psychologists and behavioural scientists, the sociologists and anthropologists, the legislators can enable policies that deliver real social change. Policies to incentivise positive environmental, agricultural, and health practices will lead to the elimination of many common diseases very quickly. Effective policies to change people's attitudes and behaviours can be very personal and bring high impacts in the short term. To sustain them in the medium and long term, you require reliable information from trusted sources to enact change. You also need timely, reliable, and understandable feedback as that is what humans respond to. However, many fragmented initiatives lead to confusion and poor adoption.

Securing major benefits from rapid adoption of new frontier technologies requires government buy-in. Cost-effective solutions include competitive innovation platforms that lead to promotion, partnerships, and official endorsement. We know social innovations from local entrepreneurs can transform Africa. Without government support and policy frameworks, the private sector is unable to move the innovative ideas forward to market. Without risk, there is no reward. We cannot leave the fate of Africa in the hands of those who are not stakeholders on the continent. Africa needs to invest her own wealth and capacity for innovation for her own health and wellbeing. Africans can take leadership of agricultural and health system development. If foreign opportunities or development partners come on board, they need to support Africa's own institutions, agendas, and visions. It cannot be over-emphasised that there is a need to invest in locally-driven solutions to build local capacity. Therefore, Africa needs to retain its best minds because it is attractive for them to stay. Is it realistic to expect that the person that is the best educated and innovative chooses not to live where their skills and expertise are not valued or rewarded? We need to invest in African people and institutions to be able to create knowledge to address the many and varied challenges and opportunities.

[161] GBD 2017 SDG Collaborators. (2019) Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: a systematic analysis for the Global Burden of Disease Study 2017 [published correction appears in Lancet. 2019 Jun 22;393(10190):e44]. *Lancet*. 2018;392(10159):2091-2138. doi:10.1016/S0140-6736(18)32281-5.

[162] Rusakaniko, S., Makanga, M., Ota, M.O. et al. (2019) Strengthening national health research systems in the WHO African Region – progress towards universal health coverage. *Global Health* **15**, 50. https://doi.org/10.1186/s12992-019-0492-8

[163] Ibid

[164] Murdoch University Research and Innovation Plan 2018–2023 available at: https://www.murdoch.edu.au/docs/default-source/research/research-and-innovation-plan-2018-2023.pdf?sfvrsn=27b53247_8

Chapter 2:
The Blue Economy in Africa

"The meaning of the Blue Economy will become clearer the more that it is used, but for me a working definition is that it is about sustainable use of the sea to meet human needs. To be successful the concept must embrace environmental as well as economic interests". Rethinking the Oceans: Towards the Blue Economy,"[1]

James Alix Michel former President of the Republic of Seychelles.

INTRODUCTION

The concept of the Blue Economy, or at least the definition of the collection of activities and identification of sectors started to gain traction around 2012. After some intense discussion in international policy circles over whether to frame the concept as the 'Ocean Economy' or 'Marine Economy' eventually the term Blue Economy—a phrase actively promoted by James Alix Michel former President of the Republic of Seychelles—won the day. Additionally, the African Union's Blue Economy Strategy "integrally captures the relevant Africa blue economy components that include activities, implementation timelines, intended outputs, mean of verification and actors."[2]

While The Commission acknowledges the broad and all-encompassing definition of the Blue Economy, it has chosen to narrow its focus in this treatment of the topic to the central role of fisheries both in terms of livelihood and contribution to food security. In this way a more thoroughgoing exploration of the pivotal role that fisheries play and can play in the development of inclusive economies, health and wellbeing.

Within the context of the Sustainable Development Goals (SDGs) mission to 'leave no one behind', Africa's Blue Economy (fisheries and maritime sector) is demanding ever greater attention.[3] For very justifiable reasons the Blue Economy is directly related to SDG 14,[4] 'Life below water' and closely linked to nine other SDGs. For marine fisheries, the international community has set the SDG target 14.4[5] with the indicator set to measure the 'proportion of fish stocks within biologically sustainable levels.' Another target (14.7) seeks to increase the economic benefits to small island developing states and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism by 2030. The objective of Goal 14.b, meanwhile, is to 'provide access for small-scale artisanal fishers to marine resources and markets.

"Waves of challenges within an ocean opportunity."

1 Michel, James Alix (2016) Rethinking the Oceans: Towards the Blue Economy USA Paragon House.

2 AU-IBAR, (2020). Africa Blue Economy Strategy Implementation Plan, 2021-2025.

3 The Commonwealth Secretariat It is possible to leverage ocean wealth, while protecting ocean health 2021 Available at https://thecommonwealth.org/media/news/it-possible-leverage-ocean-wealth-while-protecting-ocean-health [Accessed: 24 June 2021]

4 United Nations Sustainable Development Goals 14 Life below Water (2015) available at https://sdgs.un.org/goals/goal14 [Accessed: 24 June 2021]

5 Ibid. "By 2020, effectively regulate harvesting and end overfishing, illegal, unreported, and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics".

"African aquaculture accounts for 16-18 per cent of total African production, and African total fishery production is 7 per cent of global production."

The UN's 2020 'State of World Fisheries and Aquaculture'[6] report emphasised the huge significance of aquaculture and fisheries to the food consumption, livelihoods, nutrition, and employment of millions of people. In 2018, there were 5.4 million people in Africa working in fish capture and aquaculture industries. Of these, 93 per cent were involved in fish capture and 7 per cent in aquaculture. In this regard Africa looks quite different to the rest of the world where 34 per cent are engaged in aquaculture (it is 38 per cent for people in Asia). According to the Food and Agriculture Organization (FAO), an all-time high of 179 million tonnes (Mt) of fish was produced in 2018, with human consumption constituting 87 per cent of the total. Furthermore, nearly all the growth in fish consumption in the human diet in the last 20 years is a direct result of aquaculture. Of course, because a significant portion of aquaculture feed is still derived from wild-caught fish, albeit a decreasing per centage and often from fisheries waste streams,[7] the world's population is still indirectly fed by wild-capture fisheries. African aquaculture accounts for 16-18 per cent of total African production, and African total fishery production is 7 per cent of global production. Africa also produces 25 per cent of the global total inland capture fishery industry.[8]

These trends underscore the sector's immense potential contribution to improving food security on the planet, and particularly in Africa. Unfortunately, Africa to date has not benefitted as effectively from its aquatic resources as other regions, such as Asia and Europe. The spotlight now is on actions to maximise Africa's vast untapped aquatic potential and associated challenges.[9] The Blue Economy is also closely linked to action agenda of the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC).[10] The Agreement recognises the fundamental nexus between climate change, the health of oceans, the protection of marine environments, and the need to safeguard human food and nutrition security.

[6] Food and Agriculture Organisation (FAO). The State of World Fisheries and Aquaculture 2020 – Sustainability in action. (2020). Rome. Licence: CC BY-NC-SA 3.0 IGO. Available at https://doi.org/10.4060/ca9229en [Accessed: 24 June 2021]

[7] https://www.fisheries.noaa.gov/insight/feeds-aquaculture

[8] Ibid

[9] Africa Union Africa's Integrated Maritime (AIM) Strategy 2050, 2012 Available at https://au.int/sites/default/files/documents/30928-doc-2050_aim_strategy_eng.doc [Accessed: 24 June 2021]

[10] United Nations Climate Change Paris Agreement 2015 available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement [Accessed: 24 June 2021]

The Indian Ocean links the continents of Africa and Oceania, and for this reason, the Blue Economy[11] was selected early on as a core thematic chapter of this Third Commission report. The robust policy advocacy of the Africa Progress Panel (APP)[12] within the Blue Economy provided a useful context and launch pad for the Commission's work. This chapter has been framed and guided by the deliberations of the 2018 and 2019 Murdoch University symposiums on the Blue Economy (held in London and Tunisia, respectively), a collaborative research mission to Kenya in 2019, as well as ongoing work of Murdoch University researchers and their network of partners. Given the vast scope of the field, the Commission took the decision, following initial consultations on the Blue Economy symposium in June 2018, to take a 'people centred approach'.[13] As a result, this chapter focuses on the human security nexus between the environment, food production, nutrition, and equity promoting livelihood aspects of the sector.

The Third Commission is also cognisant of the severe socioeconomic impact of the COVID-19 pandemic upon those who depend upon the Blue Economy for their livelihoods. This is most starkly represented in the effective total collapse of the global cruise-line industry, and the effect upon the tourism sector more generally that has impacted coastal towns and small island nations disproportionately. Again, looking to the Seychelles as an exemplar, at the 75th General Assembly of the United Nations former President Danny Faure stated (in an e-statement) "Everything Seychelles has done to date to minimise the impact of COVID-19 will not be sustainable in the long term because of the depletion of our foreign exchange reserves. It took us 44 years since Seychelles' independence to attain the quality of life we enjoyed before COVID-19, and just four months for COVID-19 to paralyse our tourism industry and with it much of our economy".[14]

"As a result, this chapter focuses on the human security nexus between the environment, food production, nutrition, and equity promoting livelihood aspects of the sector."

[11] Economic Commission for Africa (UNECA) Africa's Blue Economy: A policy handbook, (2016) available at: https://www.un.org/africarenewal/sites/www.un.org.africarenewal/files/Africa%27s_Blue_Economy_A_policy_handbook.pdf [Accessed: 24 June 2021]

[12] Following the publication of the 2014 Africa Progress Report "Grain, Fish, Money."

[13] Cleary, D. (2003) PEOPLE-CENTRED APPROACHES A brief literature review and comparison of types The Livelihood Support Programme Working Paper 5, CHAPTER 5: COMPARING SOME PEOPLE-CENTRED APPROACHES available at: http://www.fao.org/3/ad682e/ad682e08.htm [Accessed: 24 June 2021]

[14] Faure, D. (2020) Statement for the General Debate by President Danny Faure, available at https://estatements.unmeetings.org/estatements/10.0010/20200922/T3qdozGNpyYp/HjmyXtoUoxw8_en.pdf [Accessed: 24 June 2021]

The impacts of the COVID-19 pandemic have severely disrupted some fishery industries, including a complete cessation of some due to social distancing and curfew requirements, in addition to the complexity of reduced international demand and an increase in illegal, unreported, and unregulated fishing. COVID-19 has generally negatively impacted the small-scale fishing industry, including fishers, processors, communities, and vulnerable consumer groups, particularly those who rely on fish as an affordable protein source.[15] The impacts of COVID-19 for small-scale fishers include a narrowing of intervals of time spent fishing, resulting in smaller distances travelled. Large reductions in fish caught have led to fish prices increasing to multiples of their former cost, significantly reducing the ability of the large number of artisanal processors (primarily women) to cost-effectively value-add and on-sell processed fish to the community at a reasonable profit. The high cost of fish in some places will impact the nutritional status of vulnerable groups, such as women and young children.[16] At the same time efforts are ongoing to determine what is happening with the price of fish in international markets. It is unclear now how lower prices of imported fish affect the price of fish caught locally. Additionally, "further downstream, demand for packaged and frozen products has spiked as households look to stock up on non-perishable food at the expense of fresh seafood options. Online distributors are reporting increased interest as house-bound consumers explore retail alternatives. But overall global demand has been sharply reduced and prices have fallen for many species, particularly those that are important for the hotel, restaurant and catering industries."[17] This has resulted in the "evaporation of foodservice demand in many important markets."[18]

Therefore, it is imperative for governments, NGOs, donors, the private sector, and researchers to support small-scale fishers, associated communities, and civil organisations so they are better able to respond to the negative outcomes of the COVID-19 pandemic.[19] The pandemic has also brought about some positive responses in some areas, including additional food sharing, increased local sales, collaboration between communities, and reduced fishing pressure.[20] There has also been a greater focus on sanitation and health for fishers, processors, transporters, and the community, leading towards a reduction in conventional seafood diseases.[21]

The United Nations Decade of Action on Nutrition for 2016-25,[22] coordinated by FAO and the WHO, is raising greater awareness about the role of fish in food security and nutrition policy. A study published shortly before the start of the 'Decade of Action' found that fish was "strikingly missing from strategies for reduction of micronutrient deficiency, precisely where it could potentially have the largest impact".[23,24] Despite the nutritional value of fish and its historical prevalence in the diets of a range of societies worldwide, numerous challenges still remain to incorporating the fisheries sector more into the global food security and nutrition agenda.[25]

"There has also been a greater focus on sanitation and health for fishers, processors, transporters, and the community, leading towards a reduction in conventional seafood diseases."

[15] Bennett, N.J., Finkbeiner, E.M., Ban N.C., Belhabib, D., Jupiter, S.D., Kittinger, J.N., Mangubhai, S., Scholtens, J., Gill, D. & Christie, P. (2020). The COVID-19 Pandemic, Small-Scale Fisheries and Coastal Fishing Communities, Coastal Management, 48:4, 336-347, DOI: 10.1080/08920753.2020.1766937.

[16] Vilata, J & Cederström T. (2020) COVID-19 jeopardises the artisanal fish supply and trade in Senegal. Agrilinks. available at https://www.agrilinks.org/post/covid-19-jeopardises-artisanal-fish-supply-and-trade-senegal. [Accessed: 24 June 2021]

[17] http://www.fao.org/3/cb1436en/cb1436en.pdf

[18] http://www.fao.org/state-of-fisheries-aquaculture/en/

[19] Bennett, N.J., et al. (2020) The COVID-19 Pandemic, Small-Scale Fisheries and Coastal Fishing Communities, Coastal Management, 48:4, 336-347, DOI: 10.1080/08920753.2020.1766937.

[20] Ibid

[21] Vilata, J & Cederström T. (2020) op. cit.

[22] UN Decade on Action on Nutrition Resolution adopted by the General Assembly on 1 April 2016 available at https://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/259 [Accessed: 24 June 2021]

[23] Allison, E.H., et al. (2013) Integrating fisheries management and aquaculture development with food security and livelihoods for the poor. Report submitted to the Rockefeller Foundation. Norwich, UK, School of International Development, University of East Anglia.

[24] FAO The State of World Fisheries and Aquaculture (2018) - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

[25] FAO & EU. (2017) Strengthening sector policies for better food security and nutrition results: fisheries and aquaculture. Policy Guidance Note 1. Rome. Available at http://www.fao.org/3/i6227e/i6227e.pdf [Accessed: 24 June 2021]

In Africa, absolute levels of fish consumption (9.9 kg per capita in 2017) remain relatively low compared to the global average.[26] There is also a wide regional diversity with a maximum per capita of *circa* 12 kg per capita (26 kg per capita in Ghana, 15 kg per capita in Liberia) in western Africa to 5 kg per capita in eastern Africa. In countries south of the Sahara, fish consumption per capita has remained static or decreased in some countries.[27] This trend needs to rapidly improve if Africa is to meet the SDGs targets. Fish has an important role to play in the design "of nutrition-sensitive agriculture and food-based approaches to food security and nutrition."[28]

More reliable statistics, targeted studies, including enhanced household consumption surveys and value-chain analyses of fish products, can highlight the vital importance of fish in diets. It can consequently influence the need for greater public and private sector investment in the fishery sector. The FAO notes that policy frameworks have been successfully modified and data collection systems improved because of better appreciation of the role of fisheries in meeting national food security and nutrition objectives in only a handful of African and Caribbean countries.[29] This is a clear indication that there remains a huge information and knowledge gap, as well as a need for a comprehensive new research agenda. Both are essential to enable the scaling up of data collection systems to inform policy making and investment decisions for the entire Blue Economy in Africa.

In response to these priorities for fisheries, this chapter focuses on the following action areas:

1) Prioritising a significant enhancement in small-scale coastal, estuarine, river, and lake fisheries;
2) Understanding and promoting the need, as well as advocating for delivery of appropriate level of resources, for protection of natural wetlands/mangrove forests/lagoons;
3) Tackling illegal, unreported, and unregulated (IUU) fishing and fish crime through promoting greater transparency, innovations in monitoring and enforcement, and applied technology;
4) Promoting sustainable growth in aquaculture with a focus on biosecurity, compatibility with natural systems, and capacity building for scale-up of commercial opportunities (both for food security and high-value exports supporting balance of trade).

[26] FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. 2018 Licence: CC BY-NC-SA 3.0 IGO.

[27] FAO. The State of World Fisheries and Aquaculture 2020 – Sustainability in action. Rome. 2020 Licence: CC BY-NC-SA 3.0 IGO.

[28] Kawarazuka, N. & Béné, C. (2010) Linking small-scale fisheries and aquaculture to household nutritional security: an overview. *Food Security*, 2: 343–357.

[29] FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. 2018 Licence: CC BY-NC-SA 3.0 IGO.

1. Too Big to Ignore: Prioritising Managing and Rebuilding Small-Scale Fisheries

A major component in any region's Blue Economy is the wealth of its fisheries. However, much of the discussion about fisheries in this context has emphasised offshore and industrial-scale oceanic fisheries resources at the expense of small-scale coastal and artisanal fisheries.[30]

Small-scale coastal and inland fisheries are the traditional fisheries that exploit species living in shallow (<100m depth) coastal, estuarine, river, and lake species that lend themselves to local management, rather than regional and international. In many regions they are not as strongly ecologically linked, as commonly portrayed, to the international industrial scale fisheries which tend to target deeper and more oceanic species.

Referred to collectively as 'small-scale fisheries' (SSF) because of the size of component fish populations, vessels, individual catches, and supply chains, rather than their overall production. They have historically been under-appreciated due to a combination of the low status of artisanal fishers, catch underreporting, difficulty of assessment and management, and being the responsibility of poorly resourced national governments. In most African fishing nations, the vast majority (75-95 per cent) of potential seafood production comes from SSF. 'The Sea Around Us'[31] project of the University of British Columbia, has been synthesizing sources of information and reconstructed time series of seafood catches for all countries and regions, including subsistence and un-reported international industrial catches and discards. Their results indicate the crucial importance of SSF for Africa's Blue Economy. For example, on the East coast they estimate that SSF land 91 per cent of catches from in Kenyan waters,[32] 97 per cent in Tanzania,[33] and 76 per cent in Mozambique.[34] Similarly, for the Indian Ocean island states of Madagascar[35] and the Seychelles,[36] for which the pelagic tuna caught by the industrial pelagic fleets are more important, the small-scale coastal fleets comprise 76 and 75 per cent of the catch from their waters, respectively. While the West coast of Africa's extensive upwellings of oceanic productivity results in a greater scale of the offshore oceanic industrial extraction by the deep-water trawl fisheries, small-scale fisheries still dominate catches in several countries; 52 per cent in Ghana[37] and 79 per cent in the Côte d'Ivoire.[38]

Due to their large populations the communities engaged in the SSF could collectively be politically influential if harnessed for change. They provide food security for millions and support local tourism and infrastructure. However, almost universally these vitally important fisheries are seriously threatened, are in steep decline, or have already collapsed. Working with fishing communities and agencies to develop the human capacity needed to stabilise and rebuild coastal and lake fisheries, and then fostering value adding through supply chains, will both reverse the negative trend and add tremendous value to Africa's Blue Economy. Thus, the small-scale fishers should be seen as 'too big to ignore', and their collective experience and advice should be carefully listened to and heeded by leaders in national policy processes.

"Working with fishing communities and agencies to develop the human capacity needed to stabilise and rebuild coastal and lake fisheries, and then fostering value adding through supply chains, will both reverse the negative trend and add tremendous value to Africa's Blue Economy."

[30] Fisheries can generally be divided into two broad categories which exploit distinct species and ecosystems: industrial scale offshore fisheries, and; small-scale fisheries along the coasts and in estuaries, rivers, and lakes.

[31] Zeller, D., et al. (2016) Still catching attention: Sea Around Us reconstructed global catch data, their spatial expression and public accessibility. Marine Policy 70, 145-152.

[32] Le Manach F., et al. (2015) Tentative reconstruction of Kenya's marine fisheries catch, 1950–2010. Pp. 37–51 In Le Manach F and Pauly D (eds.) Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2). Fisheries Centre, University of British Columbia [ISSN 1198–6727].

[33] Bultel E., et al. (2015) An update of the reconstructed marine fisheries catches of Tanzania with taxonomic breakdown. Pp. 151–161 In Le Manach F and Pauly D (eds.) Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2). Fisheries Centre, University of British Columbia [ISSN 1198–6727].

[34] Doherty B, et al. (2015) Marine fisheries in Mozambique: catches updated to 2010 and taxonomic disaggregation. Pp. 67–81 In Le Manach F and Pauly D (eds.) Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2). Fisheries Centre, University of British Columbia [ISSN 1198–6727].

[35] Le Manach F., et al. (2011) Reconstruction of total marine fisheries catches for Madagascar (1950-2008). pp. 21-37. In: Harper, S. and Zeller, D. (eds.) Fisheries catch reconstructions: Islands, Part II. Fisheries Centre Research Reports 19(4). Fisheries Centre, University of British Columbia [ISSN1198-6727].

[36] Le Manach F, et al. (2015) Artisanal fisheries in the world's second largest tuna fishing ground — Reconstruction of the Seychelles' marine fisheries catch, 1950–2010. Pp. 99–110 2015 In Le Manach F and Pauly D (eds.) Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010. Fisheries Centre Research Reports 23(2). Fisheries Centre, University of British Columbia [ISSN 1198–6727].

[37] Nunoo, F. K. E., et al. (2014) Marine Fisheries Catches in Ghana: Historic Reconstruction for 1950 to 2010 and Current Economic Impacts, 2014. Reviews in Fisheries Science & Aquaculture, 22:4, 274-283, DOI: 10.1080/23308249.2014.962687.

[38] Belhabib, D. and Pauly, D. (2015) Côte d'Ivoire: fisheries catch reconstruction, 1950-2010. pp. 17-36. In: Belhabib, D. and Pauly, D. (eds). Fisheries catch reconstructions: West Africa, Part II. Fisheries Centre Research Reports vol.23(#). Fisheries Centre, University of British Columbia. [ISSN 1198-6727].

1.1 Developing the Fisheries Potential of Africa's Blue Economy

Small-scale fisheries are key to the sustainable development of Africa's Blue Economy. Historically they caught the higher value species favoured for seafood tourism (i.e., reef fish and lobsters), today they supply the small low value pelagic species for local subsistence diets. Throughout the African continent, the range of species being caught, along with the size of individual fish, is being over-fished down to ever smaller fish of ever lower value. This will eventually (or has already)[39] lead to long term declines in landings. In many areas large bodied higher value species have already been locally extirpated, and these local extinctions are spreading and growing into regional and national extinctions.[40,41,42,43] This has several negative consequences, including:

1) **no investment in developing markets and supply chains, due to the uncertainty of future catch results.**
2) **stagnation of innovation, efficiency, and new technology adoption (unsustainable fisheries without effective management will deplete resources at a greater rate).**
3) **young people not entering the industry because they and their communities are aware of the collapse of these resources and their associated livelihoods.**

Preventing the complete collapse of small-scale fisheries, stabilising them, and then working with fishing communities to rebuild and add value to their production must be the highest fisheries policy priority. This is the fishing sector that provides local food security and generates local economic activity, including coastal tourism. Many of the coastal species targeted by the small-scale fisheries (lobster, shrimp, and reef fish, etc.) attract premium prices[44] per kilo in international markets and can be processed and handled relatively easily by the domestic supply chains which need developing. If successful, stabilising and rebuilding their sustainability will bring orders of magnitude of value to Africa's Blue Economy.

In contrast, as the fish being taken by foreign industrial fleets are generally landing into ports outside of African nations, there is relatively little benefit to the local economy other than the relatively small license fee for the right to exploit the resource, which is generally received and administered nationally. This is in stark contrast to the SSF catch, which is landed by domestic African fleets that have nutritional, tourism, employment, and ancillary processing values that could provide strong local economic multipliers.

[39] Pauly, D. et al. (1998) Fishing down marine food webs. Science, 279, 860–863. https://doi. org/10.1126/science.279.5352.860

[40] Ibid

[41] McClanahan, T.R., Hicks, C.C., Darling, E.S. (2008) Malthusian overfishing and efforts to overcome it on Kenyan coral reefs. Ecological Applications 18, 1516-1529.

[42] Kaunda-Arara, B., et al, (2003) Long-term trends in coral reef fish yields and exploitation rates of commercial species from coastal Kenya. Western Indian Ocean J. Mar. Sci. 2, 105-116.

[43] Sadovy, Y. (2005) Trouble on the reef: The imperative for managing vulnerable and valuable fisheries. Fish and Fisheries, 6, 167–185. https://doi.org/10.1111/j.1467-2979.2005.00186

[44] "All the most valuable species groups with significant production – lobsters, gastropods, crabs and shrimps, with an estimated average value by group of USD 8,800 to USD 3,800 per tonne – marked a new catch record in 2016". FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

New Tools for Empowering Community Based Management - Mikoko Pamoja[45]

Fishing communities must be integrally involved in the process of fishery co-management.[46] However, until now scientifically assessing small-scale fish stocks has required expensive long-term government run research projects for each population of fish.[47] Therefore, it has been almost impossible to empower community-based management processes with scientific management advice.[48] An international FAO supported study estimated that in terms of the species being fished, 90 per cent of the world's fisheries could not be assessed with the standard methods.[49] As a consequence, almost nowhere in the world are small-scale fisheries sustainably managed,[50] with catches declining, values falling, and often population collapse of their most valuable species.

A recently developed new technique called Spawning Potential Surveys (SPS) enables simple assessment of fish stocks and develops management advice by comparing the size of adulthood to the size of capture.[51,52] In the five years since its publication, it has become the most applied data-poor fisheries assessment methodology globally.[53] The technique makes possible simple snapshot assessments of marine stocks of all kinds by measuring small numbers (200-1000) of fish. It takes just days to apply, and costs only in the range of $USD100s to $1,000s, rather than the $10,000 to $1,000,000s and years/decades needed for traditional techniques. The SPS methodology estimates the reproductive potential of a stock rather than population size, and its results translate easily into advice about minimum size limits, the size of mesh in nets, hooks or escape gaps in traps, or levels of fishing pressure. The methodology is based on easily understood and widely appreciated concepts, and communication materials have been developed to support its application in collaboration with fishing communities. Its application develops an understanding and perception of overfishing amongst artisanal and subsistence fishing communities, informing and empowering community-based management processes.

The SPS methodology has been trialled in four Pacific Island nations over the last 5-6 years, and has been readily adopted by beachhead communities, fishery agency partners, and policy decision-makers in each country. Successful results are also being seen in South America[54] and Sri Lanka.[55] A well-received introduction to Kenya's coastal fisheries has attracted broader interest from government agencies and NGOs involved in this field.

[45] Mikoko Pamoja is a community-led mangrove conservation and restoration project based in southern Kenya and is self-described as "the world's first blue carbon project."

[46] Sadovy de Mitcheson, Y., et al. (2013) Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion-dollar fishery. Fish and Fisheries, 14, 119–136. https://doi.org/10.1111/j.1467-2979.2011.00455.x

[47] Prince J. D. (2010) Rescaling fisheries assessment and management: a generic approach, access rights, change agents, and toolboxes. Bull. Mar. Sci. 86 (2): 197-219.

[48] Pauly, D. (2013) Does catch reflect abundance? Nature, 494: 303–305.

[49] Prince, J.D. (2003) The barefoot ecologist goes fishing. Fish and Fisheries 4: 359-371. 2003.

[50] Andrew, N.L., et al. (2007) Diagnosis and management of small-scale fisheries in developing countries. Fish. 8,227–240.

[51] Costello, C., et al. (2012) Status and solutions for the world's unassessed fisheries. Science 338, 517–520. 2012

[52] Hordyk, A., et al. (2015) A novel length-based estimation method of spawning potential ratio (SPR), and tests of its performance, for small-scale, data-poor fisheries. ICES J. Mar. Sci. doi:10.1093/icesjms/fsu004

[53] Canales, C.M., et al. (2021) Can a length-based pseudo-cohort analysis (LBPA) using multiple catch length-frequencies provide insight into population status in data-poor situations? Fish. Res. 234. doi:10.1016/j.fishres.2020.105810.

[54] Prince. J (2021) Personal Communication

[55] Prince, J., Creech, S., Madduppa, H., Hordyk, A. (2020) Length based assessment of spawning potential ratio in data-poor fisheries for blue swimming crab (Portunus spp.) in Sri Lanka and Indonesia: Implications for sustainable management. Regional Studies in Marine Science, 36, DOI:/10.1016/j.rsma.2020.10130956 Prince, J.D., et al. (2015) Length based SPR assessments of eleven Indo-Pacific coral reef fish populations in Palau. Fish. Res. 171: 42-58.

"A recently developed new technique called Spawning Potential Surveys (SPS) enables simple assessment of fish stocks and develops management advice by comparing the size of adulthood to the size of capture."

1.3 Ideas for Change

The global challenge of sustaining small-scale fisheries has many parallels with the issue of managing rural health in developing countries.[17, 56] For example, China successfully addressed their rural health problem in the 20th Century with their 'barefoot doctor' program. The generic solutions to the majority of local health issues were taught to trained technicians recruited from, and returned to, their local communities. This chapter suggests that a similar strategy is possible for managing small-scale fisheries;[57] by training and deploying 'barefoot ecologists' armed with a generic 'tool kit'. With the development of the SPS methodology we now have a practical range of tools necessary to equip these 'barefoot ecologists' to help protect and stabilise small-scale fisheries. Recruiting, training, and deploying Pan-African 'barefoot ecologists' to rebuild small-scale fisheries is an ambitious idea to be supported by a co-ordinated effort by government, academics and NGOs.

1.4 South-South Partnerships

Strategies aiming to prevent the collapse and rebuild Africa's small-scale fisheries should be the primary focus of developing a Blue Economy. We now have the tools to address this problem, and their application in Africa could empower and enable African fisheries agencies and fishing communities to assume agency over the problem. With these tools the Pacific Island nations are already successfully building a shared understanding of overfishing and are starting to sustainably manage their own resources, with governments supporting them by reforming policy frameworks. This creates an opportunity for a significant new South-South partnership between Pacific and Indian Ocean Island states and coastal communities under a one health approach.

The Blue Economy can also be enhanced by investing in the human capital of Africa's fishing communities, its fisheries agencies, and through partnering with research institutes and universities. This investment does not depend upon the good will and co-operation of international governments and fishing fleets, or large investments in advanced technologies. Instead, it is capitalising one of Africa's greatest natural resources, its vast human potential.

To support these commitments to sustainable small-scale fisheries development, it is crucial to develop the understanding and knowledge base about small-scale fisheries. Several global initiatives are underway to improve and expand existing empirical information and to quantify the importance of the marine and inland small- scale fisheries sector, including an update of the World Bank (2012) study 'Hidden harvest: the global contribution of capture fisheries.[58]

"To support these commitments to sustainable small-scale fisheries development, it is crucial to develop the understanding and knowledge base about small-scale fisheries"

[56] Prince, J.D., et al (2015) Length based SPR assessments of eleven Indo-Pacific coral reef fish populations in Palau. Fish. Res. 171: 42-58.

[57] Sainsbury, K. Institute Marine and Antarctic Science, Hobart, Australia personal communication.

[58] Other important opportunities to expand the evidence base include the global conference on Tenure and User Rights in Fisheries 2018: Achieving Sustainable Development Goals by 2030 (September 2018) and the third Global Congress on Small-Scale Fisheries, organised through the Too Big To Ignore research partnership (October 2018) FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

1.5 Promoting the protection of natural wetlands/mangrove forests/lagoons.

Greater effort is also urgently needed to enhance the protection of Africa's valuable natural wetlands/mangrove forests/lagoons. While several organisations are actively championing this agenda (such as RAMSAR, WWF, etc.), many governments do not effectively enforce or regulate designated protected marine areas. It is critical that more attention is given to these coastal wetlands. They are potentially very productive sources of food, nutrition, and income. A focus should thus also be put on exploring viable modalities for empowering local communities to both exploit and serve as guardians of these areas. Much of the collapse of Ghana's fisheries is reportedly linked to destruction and neglect of mini-lagoons and estuaries. Existing wetland areas across the African continent need serious protection and destroyed areas need significant restoration.

Kenya provides a good example of what is possible. In addition to the Kenyan government managing nine marine protected areas, the nation now also has 14 community run marine parks.[59] Under the rubric of the Western Indian Ocean Marine Science Association (WIOMSA), some 30 communities along the Western Indian Ocean rim are implementing an innovative conservation model and transforming livelihoods in a unique way.[60] Across the West Indian Ocean zone from Rodrigues Island in Mauritius to Lamu Island in Kenya, coastal communities are pioneering new conservation models to enhance species conservation, improve public awareness, enhance community participation, and promote policy changes. Ocean spaces are being adapted and turned into community managed marine parks. The parks have a simple controlled system that declares these special zones as available for 'off-take' for a limited period.[61] This approach has successfully boosted community livelihoods, and at the same time as it has helped to spawn fish and enriched marine conservation at the national and regional level. Community approaches have now been adopted in Tanzania, Mozambique, Madagascar and Seychelles.

In Mozambique, areas around the coastal city of Beira that had embraced Nature-Based Solutions (NBS) in the form of planting mangroves suffered less damage in the aftermath of Tropical Cyclone Idai[62] than areas that failed to embrace this concept, which forms a critical climate adaptation and mitigation defence shield.[63] A similar project was undertaken in nearby Quelimane[64] with local Mayor Manuel de Araújo reporting in the Cyclone's aftermath that "Ultimately, it's our mangroves that saved us. They are our first line of defence. The day we don't have mangroves, I don't think our city will survive".[65]

"Across the West Indian Ocean zone from Rodrigues Island in Mauritius to Lamu Island in Kenya, coastal communities are pioneering new conservation models to enhance species conservation, improve public awareness, enhance community participation, and promote policy changes. Ocean spaces are being adapted and turned into community managed marine parks. The parks have a simple controlled system that declares these special zones as available for 'off-take' for a limited period."

[59] The 2018 Community Managed Marine Areas (CMMA)report, Indian Ocean Observatory Ocean Literacy Hub available at: http://www.theioo.com [accessed 24 June 2021]

[60] Editorial: The 2018 Community Managed Marine Areas (CMMA)report, Indian Ocean Observatory Ocean Literacy Hub available at http://www.theioo.com [accessed 24 June 2021]

[61] Ibid

[62] Personal communication, Prof A.M.Hoguane, Professor of Physical Oceanography at the School of Marine and Coastal Sciences, Eduardo Mondlane University

[63] Charrua, Alberto B. et al. (2021) Impacts of the Tropical Cyclone Idai in Mozambique: A Multi-Temporal Landsat Satellite Imagery Analysis Remote Sens. 13, no. 2: 201. 2021 available at https://doi.org/10.3390/rs13020201 [accessed 24th June, 2021]

[64] Available at https://2012-2017.usaid.gov/news-information/frontlines/climate-change-2015/mozambique-cities-adapt-climate-change-one-tree-and [accessed 24 June, 2021]

[65] https://nextcity.org/daily/entry/the-day-we-dont-have-mangroves-our-city-wont-survive-quelimane

2.Tackling Illegal, Unreported and Unregulated (IUU) Fishing

Combating the plunder of Africa's ocean resources[67] is essential to achieving several SDGs. In addition to Goal 14 'Life below water', these also include Goal 1 'No poverty'; Goal 2 'Zero hunger'; and Goal 8 'Decent work and economic growth'. While its primary call is for a much greater focus on small-scale coastal fisheries, The Commission also acknowledges that more must be done to counter large-scale illegal fishing, mainly of pelagic resources. This continues to have a significant negative economic and ecological impact on countries whose fishing rights are not being honoured.
The deadline year set in 2015 to achieve the SDG 14 target of ending IUU fishing was 2020. In response to this ambition, efforts have intensified at the international policy coordination level. On 5 June 2016, the Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) entered into force. A year later, the first operational version of the Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record), a phased and collaborative global initiative to make available certified vessel data from State authorities was launched in 2017. The FAO Voluntary Guidelines on Catch Documentation Schemes for wild-captured fish for commercial purposes was also approved in July 2017.[68]

Africa's ability to harness its ocean resources for the benefit of all is predicated on these resources being transparently administered. Lack of adequate information and data management remains a major problem. At the national level, new research and policy recommendations should be made available to political leaders to inspire them to push for the implementation of bold new international policies that will more effectively tackle the continuing large-scale plunder of Africa's Blue Economy resources.

The Indian Ocean Tuna Commission (IOTC), which succeeded the Indo-Pacific Tuna Development and Management Programme, and the International Commission for the Conservation of Atlantic Tunas (ICCAT), are two of the five global regional fisheries management organisations (RFMOs) established under UNCLOS to implement the conservation and management of straddling fish stocks and highly migratory fish stocks. IOTC is headquartered in the Seychelles and ICCAT is in Spain. Both are inter-governmental multilateral treaty organisations.

IOTC brings together 31 states. Unlike other RFMOs where large-scale industrial operations dominate fisheries, the IOTC region fisheries have artisanal fisheries as the dominant aspect.[69] Similar initiatives with robust approaches bringing together governments, civil society, private sector, and even academia, complement the RFMOs and are found in the oceans around Africa that help in safeguarding the regional Blue Economy. These include the Nairobi Convention; Abidjan Convention; Benguela Convention, Barcelona Convention, and the Jeddah Convention.

"The sea has not so much been used as misused; it has too often been plundered for quick gain and treated as a dumping ground for land generated waste. The big difference now is that it must be used with sustainability always in mind."[66]

[66] Michel, James Alix (2016) Rethinking the Oceans: Towards the Blue Economy USA Paragon House.

[67] Grain, Fish, Money; Financing Africa's Green and Blue Revolutions Africa Progress Report 2014. Africa Progress Panel, P.O. Box 157 1211 Geneva 20 Switzerland. pp. 177. ISBN 978-2-9700821-4-9.

[68] FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO. 2018.

2.1 Information Deficits

Basic information often remains out of the public domain. Such information includes the status of fish stocks and marine ecosystems, conditions attached to fishing authorisations, the contracts of fishing access agreements signed between fishing nations and coastal states, or the quantity of fish taken from the ocean. But without such information, the quality and credibility of decision-making can be undermined, while the prospect of effective oversight and accountability diminishes. A more systematic, cooperative regional and international approach to combating plunder of the oceans is needed. In 2014, the APP stressed that while impressive new solutions had been promoted in recent years, they had not yet been systematic enough. The then existing patchwork of voluntary rules and fragmented institutions was termed by the APP to be a "coordinated catastrophe".[70] The APP in 2014 urged further improvements in governance, accountability, and transparency in the fisheries and maritime sector. In 2019 the EU launched its 'CATCH' software to facilitate digital sharing in real-time of fish product consignment information entering the region; replacing the existing easily forged paper-based system. It is anticipated that use of the system will be commonplace, and it is hoped that it will make a tangible and quantifiable difference to document fraud. The Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record) was launched in April 2017, less than a year after the entry into force of the PSMA. This information system has been widely supported by FAO members and observers and is expected to close the information gap on vessels carrying out fishing and fishing-related activities. In addition to recording identification information (such as registration, vessel characteristics and ownership), it also includes information relevant to the fight against IUU fishing, such as previous vessel names, owners, operators, as well as authorisations to fish, transship or supply, and history of compliance.

It is widely accepted that the Global Record will play an important role in support of the PSMA and other international instruments (such as the UN Fish Stocks Agreement). Such support includes providing reliable up-to-date information about the identity and characteristics of vessels and their activities, which is useful for counterchecking the information provided by the masters of vessels when requesting entry into port or upon arrival in port. The information is also useful in risk analysis on which to base inspection decisions. This global tool will not only be useful to port and coastal nations, but also to flag states, which can check on the history of a vessel (names, flags, owners and operators) when deciding on registering vessels under their flag. It will also provide valuable information to market states on the legal (or not) origin of the fishery products that enter national and international markets, particularly through linkages with catch documentation schemes through the Unique Vessel Identifier.[71] In early 2020 there were 62 FAO Members participating in the Global Record recording details on 10,902 vessels; approximately half of the global fleet with an eligible International Maritime Organisation number.[72]

[69] Sinan, Hussein and Bailey Megan (2020) "Understanding Barriers in Indian Ocean Tuna Commission Allocation Negotiations" Sustainability, August.

[70] Grain, Fish, Money; Financing Africa's Green and Blue Revolutions Africa Progress Report 2014. Africa Progress Panel, P.O. Box 157 1211 Geneva 20 Switzerland. pp. 177. ISBN 978-2-9700821-4-9.

[71] FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

[72] FAO. 2020. The State of World Fisheries and Aquaculture 2020 – Sustainability in action. Rome. Licence: CC BY-NC-SA 3.0 IGO.

2.2 Transparency

Another notable initiative born out of the recommendations made by the APP's 2014 report has been the global Fisheries Transparency Initiative (FiTI), spearheaded by APP member Professor Peter Eigen. It now forms part of a system of new approaches to global governance in various realms that allow for informed public debate on key issues—between government, the private sector, and civil society. The essential innovation of this approach is its emphasis on governments' adhering to a comprehensive transparency standard for fisheries management, called the 'FiTI Standard'. This is the only global standard that establishes a detailed list of the different types of information about their 'fishing sector' that all governments should make available to the public online. "A trustworthy regime [for transparency] should be built around the following pillars: clear and well-defined public commitments; regular progress reporting against those commitments; independent and transparent audits to verify progress; and follow-up actions in response to lack of progress."[73] Indeed, countries that join the FiTI agree to clear reporting procedures, subject to verification by a National Multi-Stakeholder Group comprised of government, business, and civil society representatives that approve all FiTI Reports. These yearly reports establish the government's level of compliance with the FiTI Standard and its commitments towards progress. The preparation and approval of the reports and the implementation of the commitments made require the participation of the different interested parties, hence empowering a wide range of stakeholders to improve transparency in the sector. African countries have played a lead role in moving the agenda forward, and the global secretariat was transferred to Seychelles in early 2019. During the first half of 2021, Seychelles and Mauritania published their first FiTI Reports, an achievement that was welcomed with enthusiasm across the world. Notably, Mr. Manuel Barange, Director of the Fisheries Division at FAO, expressed that transparency lies at the heart of the sector's long-term sustainability from its multiple angles—environmental, social, and economic. The FiTI country report, he said, corroborates how different stakeholders can benefit from the generated information. The Third Commission can play a small supportive and catalytic role in moves to keep up this momentum, particularly in the Indian Ocean and Africa and Asian coastal states that neighbour Australia.

2.3 International Coordination and Cooperation

The FAO underscores the importance of effective partnership between the developed and developing worlds towards the achievement of SDG target 14.4, "particularly in policy coordination, financial and human resource mobilisation and deployment of advanced technologies". It also emphasises that the reported continuous increase in the per centage of stocks fished at biologically unsustainable levels does not mean that the world's marine fisheries have not made any progress towards achieving SDG target 14.4. The reason? There has been a global divergence of a worsening overcapacity and stock status in developing countries, in contrast to management and stock status improvements in developed countries.[74,75] Such a divergence is fueled by economic interdependencies through international trade and fisheries access agreements, as well as limited management and governance capacities in developing countries.[76]

Several areas of supportive engagement can already be highlighted. This includes bolstering national and international multi-stakeholder initiatives to combat the plunder of Africa's oceans. All African coastal states should be supported in efforts to put in place more effective port measures, and improve regional and international coordination and cooperation.
All coastal nations should work more collectively to help keep illegally caught fish out of the national and international marketplace by denying port entry or services to vessels suspected of illegal fishing. There has been notable progress in moving the agenda forward of the FAO sponsored voluntary PSMA to tackle IUU since the launch of the APP in 2014. The PSMA provides an international framework to allow coastal states to exercise greater control on vessels coming in and landing their catch, and for improving coordination and cooperation between coastal states in that regard. However, critical to success is a nation-state's capacity for surveillance, to interdict, and deter illegal activity in its own Exclusive Economic Zone (EEZ). As well, better governance of marine fisheries and enforcement of regulations could be greatly enhanced by embracing more transparency.

> **"All African coastal states should be supported in efforts to put in place more effective port measures, and improve regional and international coordination and cooperation."**

[73] Solène Guggisberg, Aline Jaeckel, Tim Stephens, (2021) Transparency in fisheries governance: Achievements to date and challenges ahead, Marine Policy, 104639, ISSN 0308-597X, https://doi.org/10.1016/j.marpol.2021.104639.

[74] FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

[75] Ye, Y. & Gutierrez, N.L. (2017). Ending fishery overexploitation by expanding from local successes to globalized solutions. Nature Ecology & Evolution, 1: 0179. doi:10.1038/s41559-017-0179.

[76] FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

2.4 Foreign Fishing Interests in African Waters

Most of the world's productive marine ecosystems are proximate to Africa; as a result, the continent's contribution to the world's fish-related food supply is immense. It is equivalent to some half dozen million metric tonnes annually, generating billions in GDP for the continent.[77,78] Although the practices that have evolved over the decades including transshipping and aggregation of catches[79,80] have resulted in significant missed opportunities for on-shore development of ancillary industry, it has also led to underreporting and illegal conduct.

Until recent decades, fishing fleets from Europe and Japan, with a later entrance of South Korea, dominated African waters among non-African fishers. In mirroring the rise of its economy and ties with Africa, China has more recently become a significant player in Africa's fishing sector. It is almost three decades since WorldWatch Institute asked, "Who Will Feed China?". Since then, the scale of China's interest—and prospects for further elevated interest—is increasing the level and nature of competition for Africa's fish. This is leading to equivalent questioning around the sustainability of such elevated levels of foreign interest within the various Exclusive Economic Zones (EEZ) of the countries of Africa.

Led by China and foreign demand in Asia, Europe and North America, more than 50 processing plants produce fishmeal—a lucrative protein-rich power made by pulverising and cooking fish—on the coasts of Mauritania, Senegal, Guinea Bissau and The Gambia.[81] The volume of fish being consumed is enormous—the BBC reports that one plant in The Gambia alone consumes more than 7,500 MT fish annually.[82] Sierra Leone may be next to install such a mill, which in The Gambia has infamously also polluted sea waters, further interrupting fishing supplies.

Ominously, intensifying political tensions between Australia and China could add to the frequency of such headlines by both exaggerating fears alongside Chinese interests in African fisheries.[83] In parallel, the UK's exit from the European Union has also exaggerated European fishing access fears. The result could, moreover, heighten the level of illegal fishing in African waters (West African waters in particular), with Chinese fisheries interests again accused of being at the forefront of such activities.[84] Indeed, from Sierra Leone, The Gambia in the west to Kenya and Tanzania in Africa's east, China is perceived as pushing the boundaries of the trade-off between sustainable modernisation and earlier subsistence economic livelihoods. Perhaps nowhere more emotively than in the fishing sector in general[85] with The Gambia offered as a prime example.

Yet, perceptions vary. Just as Australia, Canada, Norway and Scotland have, for decades, gained economically from the export of seafood, African countries equivalently aspire to lucratively reap from the ocean. In 2019 Nigeria sought Asian foreign investment of some USD1.5-2.5bn for a new fishing port, processing facilities, warehousing zones, and ship maintenance yards.[86] As if Africa is home to the world's last fish, every such announcement brings parallel headlines around fears that China is going to clear out the world's oceans—right at a time when climate change may achieve the same in any case. In late 2020, Foreign Policy went as far as to run a story under the headline "China's Monster Fishing Fleet".[87]

Speaking at the China-CELAC (Community of Latin American and Caribbean States) Forum for Agricultural Minister in March 2021, the Director General of the United Nations FAO, Chinese national Qu Dongyu, may have captured the tipping point, which applies as much to sustainable fishing as any agricultural sector:

"Building green and inclusive agri-food systems is one of the most powerful ways to recover from the current crisis by better production, better nutrition, a better environment and a better life. Now we have to act. We need to transform our agri-food systems to provide food security and better nutrition for all, be economically sustainable, inclusive, and have a positive effect on the climate and the environment."[88]

The COVID-19 pandemic may have galvanised political will to address China's underlying (and much bigger and more challenging) structural food security concerns. China has promised to partner with Africa in elevating food cultivation productivity, and in so doing elevate rural incomes and reduce hunger. It so far appears less concerned for oceanic sustainability and for the livelihoods of subsistence fishing communities and those relying on them in Africa.[89]

[77] de Graaf, G., & Garibaldi, L. (2014). The value of African fisheries. FAO Fisheries and Aquaculture Circular.

[78] Li M-L, Ota Y, Underwood PJ, et al. Tracking industrial fishing activities in African waters from space. Fish Fish. 2021;22:851–864. https://doi.org/10.1111/faf.12555

[79] C. Ewell, S. Cullis-Suzuki, M. Ediger, J. Hocevar, D. Miller, J. Jacquet, (2017) Potential ecological and social benefits of a moratorium on transshipment on the high seas. Mar. Policy 81, 293–300.

[80] Tickler, D., Meeuwig, J. J., Palomares, M.-L.,Pauly, D., & Zeller, D. (2018). Far from home: Distance patterns of global fishing fleets. Science Advances, 4(8), eaar3279. https://doi.org/10.1126/sciadv.aar3279

[81] Samba, O., & Jatta, E. (2021). THE NATIONAL INTEREST OF CHINA IN THEIR ECONOMIC COOPERATION WITH THE GAMBIA. Indonesian Journal of International Relations, 5(1), 80-101. https://doi.org/10.32787/ijir.v5i1.184

[82] https://www.bbc.com/future/article/20210323-the-factories-turning-west-africas-fish-into-powder

[83] https://www.theguardian.com/environment/2021/may/17/sierra-leone-sells-rainforest-for-chinese-fishmeal-plant

[84] https://www.business-humanrights.org/en/latest-news/china-three-companies-sanctioned-for-illegal-fishing-in-west-africa-greenpeace reports/#:~:text=The%20Chinese%20Ministry%20of%20Agriculture,IUU)%20fishing%20in%20West%20Africa.&text=Three%20companies%20lost%20their%20certificates,owners%20and%20captains%20were%20blacklisted.

[85] https://chinaafricaproject.com/podcasts/how-chinese-business-practices-are-disrupting-the-kenyan-fishing-industry/

[86] https://www.seafoodsource.com/premium/global-bulletin/mega-fishing-project-in-nigeria-seeking-chinese-investment?private=true

[87] https://foreignpolicy.com/2020/11/30/china-beijing-fishing-africa-north-korea-south-china-sea/

[88] http://www.fao.org/director-general/speeches/detail/en/c/1377353/

[89] Alami, Abdallah, (2020) "Changing Tides: The Impact of Chinese Investment In Gambia's Fishing Industry". Master's Theses. 1291. https://repository.usfca.edu/thes/1291

2.5 Legal and Law Enforcement Concerns

Contract secrecy, the lack of regulation, potential transhipping loopholes, and lack of sufficient capacity to enforce laws against IUU and various stages of the fisheries crime 'value chain' allow organised illegal fishing and related crimes to flourish across borders. The gravity of the situation requires traceability throughout the entire supply chain, from the fishing net to the plate, and transparency around economic flows and owners of fishing vessels and fishing companies. Beneficial ownership of all fishing vessels should be disclosed.

Even if African countries were to implement the appropriate policies in isolation, it is obvious that the sustainability and final success of these efforts critically depend on the strengthened collaboration of global stakeholders. This is particularly important if Africa is to make progress on SDG 14—to conserve and sustainably use the oceans, seas, and marine resources—as well as the other SDGs as cited above.

The Third Commission is recommending an increase in investment in legal education, tools, and platforms to enhance the necessary human and institutional legal capacity in Africa, including marine and maritime law, and criminal law. The focus here must be on enabling African nations to negotiate for better terms across the value chain in the Blue Economy, as well as significantly strengthening their capacity to improve their regulatory and legal systems, enforce their laws, and successfully prosecute all perpetrators of fisheries crime caught and arrested in their national waters. There is also an urgent need to strengthen capacity on Blue Economy related contract negotiations.

In that context, regional and international organisations, universities and think tanks with the required skills and expertise could be grouped into a 'Blue Economy legal resources and capacity enhancing network', with a secretariat housed within a respected, independent, globally focused policy, research, and advocacy institute. Such an institute would provide comprehensive advisory services that provide an overall picture of the problem and enable each nation to formulate very clear and transparent Blue Economy policies within a regional and international framework.

Within such a network, there is urgent need for a dynamic interactive repository and mapping of the ongoing and planned operations, as well as the funding available for member states within the various UN, regional, and subregional intergovernmental organisations, funds, and programmes currently active in this area. This will improve coordination and knowledge sharing. Innovations, such as blockchain, have a potential role in supply chain certification, revenue collection, data monitoring, resource control, forensic investigation facilitation (etc.) in ocean resources management. These innovations should be explored and applied via research funding and specific training for sectoral experts and policymakers.

"Even if African countries were to implement the appropriate policies in isolation, it is obvious that the sustainability and final success of these efforts critically depend on the strengthened collaboration of global stakeholders. This is particularly important if Africa is to make progress on SDG 14—to conserve and sustainably use the oceans, seas, and marine resources—as well as the other SDGs as cited above."

3. Fulfilling the Promise of Aquaculture in Africa

The Africa Integrated Marine Strategy (AIMS) 2050[90] championed by the African Union brings together multiple and overarching continental plans to enable Africa to attain maritime viability, fulfil Blue Economy goals, and attain prosperity in line with the AU Agenda 2063. However, it is not advisable to increase the yield from capture fisheries in the time needed to supply the food and nutritional demands of the demographic growth trends on the African continent. Indeed, capture fisheries, particularly near-shore small-scale fisheries, in the main, require a decrease in fishing pressure, and must not be relied upon to increase fish protein consumption. The demographic transition already underway calls for a massive increase in scale in productivity and fish production in aquaculture. With farmed species expected to contribute to an increasing share of global fish food consumption, reaching about 60 per cent of the total in 2030, major opportunities and challenges exist for increasing fish production in a sustainable manner across Africa to meet the continent's food security and nutrition needs. Such an ambitious scale up in investment in aquaculture offers a massive injection to faster employment growth rates and wealth creation across the Blue Economy value chain in the region, especially for young Africans, both male and female.

> **"Aquaculture is also easier for humans to control and manage. Fish farmers have significantly greater control over their harvest than those in the capture fisheries sector."**

[90] AIM Strategy 2050, African Union, 2012.

Aquaculture is also easier for humans to control and manage. Fish farmers have significantly greater control over their harvest than those in the capture fisheries sector. Additionally, the benefits of vertical and horizontal integration in aquaculture production and supply chains adds considerable opportunity and flexibility to how and where fish are grown and value-added.[91] Much of the global increase in aquaculture and fish consumption has been shaped by urbanisation. Considering its current rapid rate of urbanisation, Africa can learn from the rapid growth in aquacultural experiences of other urban regions and plan to better adapt its own aquaculture capacity to urban growth more proactively and effectively.[92]

The Third Commission argues that similar trends underway in Africa could be better maximised to spur greater growth in fish consumption on the continent. In that regard it is convinced that available opportunities for faster and scaled-up aquaculture growth the region must be seized with haste.

Aquaculture is one of the fastest growing global food sectors. According to the FAO, there has been a significant rise in aquaculture in Africa since the start of the new millennium.[93] UN research found that between 2004 and 2014, there was a seven-fold increase in production, with an average growth rate of 21 per cent.[94] The majority of production was from inland aquaculture of species of African catfishes and tilapia. Just seven countries accounted for 93 per cent of the total production. Between 2000 and 2017, nine African countries were among the top 14 countries globally with an annual aquaculture production growth rate of between 20-40 per cent (Fig 5).[95] Despite this growth, Kenya requires a predicted 34 per cent annual aquaculture growth between 2017-2030 to satisfy demand by domestic fish markets, and to increase the current fish consumption patterns.[96]

FAO estimates that aquaculture production will continue to expand on all continents, albeit with variations in the range of species and products across countries and regions. The most significant increases are projected to occur in Africa (61 per cent) and Latin America (49 per cent). In Africa, this huge expansion is projected "partly on the basis of the additional culturing capacity put in place in recent years, but also because of rising local demand from higher economic growth and local policies promoting aquaculture".[97]

While the trend is positive as far progress towards meeting the needs of food and nutritional security across Africa are concerned, considerably more attention is still needed in biosecurity and aquaculture. Most fishery stocks are expected to remain maximally sustainably fished or overfished over the coming ten years or more. In that context, the push for a major increase in aquaculture, which the Third Commission joins others in supporting, has the potential to address the aquatic food demand and supply gap, as well as contribute to progress towards the achievement of 2030 Agenda.[98] However, at the same time, greater attention needs to be placed on how sustainably this is achieved. The rapid growth of aquaculture in recent years across the globe has also raised several questions related to its potential negative impact on the climate, environment, and human health.[99] Perhaps Africa's relatively late entry into the sector will allow for widespread adoption of world-leading practices (using a 'one health' approach) as the industry grows.

To achieve this outcome, the Third Commission calls for three interventions:

1) Doubling of the current productivity of existing artisanal farms. Rapid and achievable modifications in current production and post-harvest methods are available. These are primarily in the areas of improved fish nutrition, biosecurity, genetic management, oxygenation, temperature, and water quality control, and the implementation of ice-based cold chains. Any large improvement in productivity needs to be done in a step-wise fashion, balancing operator experience/capability, financial capacities, and sustainable capacities of the local environment. This will require financial, technical, input, and marketing support.
2) Foster an additional 10 Mt of new artisanal fish farm produce per annum. Key to the success of this pan-African initiative will be the development of a comprehensive and data-driven site map for location of potential new and sustainable farms. A balance of large and small fish farms will be needed to mitigate potential problems with resource destruction, congestion, conflict, lack of collaboration, and poor regulation and policies, otherwise they will likely be exposed to major financial losses and negatively impact consumer sentiment. A phased development approach leaves room to adapt along the way for local nuances with less financial and environmental risks.
3) Reinforce the enabling environments for large scale aquaculture, and expansion of successful seaweed, algae, and other 'unfed' mariculture operations to produce food, aquafeed, and fish for domestic consumption and use. Such reinforcement can begin with improving the natural productivity of water bodies (potentially 'extensive-plus', and/or mild-semi-intensive aquaculture). In the initial phases this will lead to advanced local knowledge that can enable successful evolution into intensive fish farming. Large and expensive intensive aquaculture and mariculture production systems must achieve 'best practice' management and environmental and safety/biosecurity standards.

The first two interventions will enable Africa to achieve consumption of 20kg of fish per person per year. This is still below the world average, but more than twice the current consumption. These interventions must be underpinned by a thoroughgoing knowledge sharing and capacity building program that includes an emphasis on strict biosecurity practices. Harnessing small-scale African entrepreneurship is a powerful force, and with minimal government oversight that simply aims to ensure that the continuity of local environment and the biological integrity of aquatic systems are protected, entrepreneurs can 'pave the way' for local people to 'get on with it'.

[91] FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

[92] Ibid

[93] Ibid

[94] FAO 2017 Regional Review on Status and Trends in Aquaculture Development in Sub-Saharan Africa – 2015 FAO fisheries and aquaculture circular, ISSN 2070-6065.

[95] The Federal Republic of Nigeria, the Republic of Uganda, the Republic of Ghana, the Republic of Kenya, the Republic of Zambia, the Republic of Madagascar, and the Republic of South Africa: Obiero et al., 2019. Policy Brief: High aquaculture growth needed to improve food security and nutrition.

[96] Obiero et al., (2019). Policy Brief: High aquaculture growth needed to improve food security and nutrition.

[97] FAO. (2018). The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.

[98] Hambrey, John. (2017). "THE 2030 AGENDA AND THE SUSTAINABLE DEVELOPMENT GOALS: THE CHALLENGE FOR AQUACULTURE DEVELOPMENT AND MANAGEMENT." FAO Fisheries and Aquaculture Circular: I,IV,VII,1-62.

[99] Stentiford, G.D., Bateman, I.J., Hinchliffe, S.J. et al. (2020) Sustainable aquaculture through the One Health lens. Nat Food 1, 468–474. https://doi.org/10.1038/s43016-020-0127-5

3.1 Feed and nutrition development

Aquaculture development throughout SSA countries is currently constrained by a lack of good quality feed and the high purchase cost.[100] While discussions on aquaculture diets have focused on fishmeal and fish oil resources, the sustainability of aquaculture sector growth also remains closely linked to supplies of terrestrial animal and plant proteins, oils, and carbohydrates.[101] Significant research is now directed into novel aquaculture feedstuffs, including microbial, seaweed, and insect sources, but it is likely to be some years before these become widely available and affordable. Therefore, it is necessary to determine and farm locally available ingredients and manufacture aquaculture diets in Africa, near the main feed-markets to reduce the carbon footprint associated with long-distance transportation. This includes growing herbivorous and omnivorous fish species that can be fed foliage of locally grown aquatic and terrestrial plants, either as a formulated or supplemental unprocessed diet. It is also important to undertake scientific trials to analyse and improve diets for new aquaculture species and to look towards developing industries collaboratively. For example, sweet potato and taro leaves, which have a suitable protein content, can be used to supplement tilapia diets while also providing the tubers as carbohydrate sources for direct human consumption. Most aquafeeds throughout East Africa are produced locally near artisanal farms using either single ingredients (e.g., brans) that are fed as dietary supplements, or used in a mix of cooked or raw ingredients incorporated into a dry or moist pellet.[102] Conversely, large aquaculture operations in Africa purchase 'complete diets' to provide consistency in pellet nutritional composition and fish production output. The development of affordable complete diets tailored for each culture species and milled nearby artisanal farms is required to improve fish production and supply security.

Developing marine and freshwater aquaculture using herbivorous species provides increased food security and an opportunity for developing fish diets from locally sourced and grown ingredients (aquatic plants and algae) with minimal aquafeed processing. This also reduces the carbon footprint associated with production. One potential marine species is the 'rabbitfish', aka the 'Shoemaker spinefoot', *Siganus sutor*. This schooling species belongs to an economically important group of herbivorous fish and can be found in high abundance and have potential to be incorporated into sustainable aquaculture feeds. *Siganus sutor* currently accounts for ~180 tonnes (11 per cent) of the artisanal fishery landings[103] in Kenya. However, it is currently being overfished and there is no management plan in place,[104] making it an important species to consider for aquaculture. In freshwater aquaculture, cyprinid species are ideal for herbivorous fish culture, while catfish and tilapia, as omnivores, are already established as some of Africa's most important culture species.

With climate change continuing to impact the marine and freshwater environments into the future, it is important investigate other suitable and robust herbivorous finfish species, and to examine their growth rates using feed manufactured from local aquatic and terrestrial feed ingredients. Notably, Africa has several large feed manufacturers. Skretting has developed feeds for Whiteleg shrimp, African catfish, and Tilapia, and has been working to combat the use of antibiotics and for sustainable feed production. Manufactured aquafeed should be stored in dry, cold, pest-free environment (e.g., refrigerator). However, this is not possible for many remote locations that lack reliable electricity supplies and refrigeration. In addition, the high summer humidity in many countries is likely to lead to rapid degradation of manufactured feeds. Therefore, it is important that fish feeds are made locally by aquaculturists as required, using locally-sourced fresh ingredients. This requires skill and expertise to manage feed production and in growing and sourcing ingredients for pellet manufacturing. Furthermore, improved fish nutrition reduces disease impacts and increases fish culture resilience, also improving nutritional value for the consumer.

"With climate change continuing to impact the marine and freshwater environments into the future, it is important investigate other suitable and robust herbivorous finfish species, and to examine their growth rates using feed manufactured from local aquatic and terrestrial feed ingredients."

[100] Obiero, K. O., Waidbacher, H., Nyawanda, B. O., Munguti J. M., Manyala, J. O. and B. Kaunda-Arara (2019). Predicting uptake of aquaculture technologies among smallholder fish farmers in Kenya. Aquaculture International (2019) 27:1689–1707. https://doi.org/10.1007/s10499-019-00423-0

[101] Troell et al. (2014) Does aquaculture add resilience to the global food system? PNAS | September 16, | vol. 111 | no. 37 | 13257–13263 www.pnas.org/cgi/doi/10.1073/pnas.1404067111

[102] Obiero, K. O., Waidbacher, H., Nyawanda, B. O., Munguti J. M., Manyala, J. O. and B. Kaunda-Arara (2019). Predicting uptake of aquaculture technologies among smallholder fish farmers in Kenya. Aquaculture International (2019) 27:1689–1707. https://doi.org/10.1007/s10499-019-00423-0

[103] https://www.kmfri.co.ke/images/pdf/Fact_Sheet_Stock_Assessment_of_Siganus_sutor_2016.pdf

[104] N. Wambiji, E. Kimani, C. Aura, G. Okemwa, R. Anam, D. Kosieny, J. Emuria, S. Langat, V. Orenge, P. Ndung'u, E. Owido,S. Ndegwa, J. Manyala, C. Munga, B. Fulanda, G. Waweru (2016). Fact Sheet: Stock Assessment of Rabbitfish (Siganus sutor) along the Kenya coast. Kenya Marine and Fisheries Research Institute. <https://www.kmfri.co.ke/images/pdf/Fact_Sheet_Stock_Assessment_of_Siganus_sutor_2016.pdf > accessed 12/8/2019.

3.2 Women and equity in aquaculture organisations

Like many primary industries, aquaculture is well-suited to employ women on equal terms, provided appropriate facilities and equipment are available. The 2030 Agenda calls for gender equality and the empowerment of all women and girls (SDG 5). Ms Angela Lentisco and Mr Robert Lee in a comprehensive review for FAO have demonstrated the extent of women's participation in fisheries and the importance of their contributions to fish supply.[105] FAO[106] conducted a gender-sensitive value chain analysis in Burkina Faso, Côte d'Ivoire, Ghana, and Tunisia. It portrayed significant gender inequities having negative impacts on the performance of women and their livelihoods. For instance, in Tunisia in 2016, women clam collectors who typically spend six to eight hours per day in the seawater were earning four times less than intermediaries, and only 70 per cent of the legal minimum salary in the agriculture sector. Looking at the whole value chain, these women were earning only about 12 per cent of the final sale price. Strategies identified to address these issues include strengthening of technical, organisational, and business management capacities of participating women, product differentiation and fostering of networking, investment in infrastructure, and access to financial services and new markets (including lucrative international and institutional opportunities, such as public procurement for school feeding programmes, hospitals, and campuses). The interventions identified in Tunisia led to significant results. Women were endowed with stronger bargaining power; advocacy at the policy level triggered more transparent marketing transactions; and a fair-trade agreement was established among an association of women clam collectors, a clam depuration and export establishment, and an international importer. Thanks to the fair-trade agreement, in November 2017 women collectors were receiving 47 per cent the sale price, from which they pay 8 per cent of the sale price to the transporter intermediary.

A handbook produced by FAO and the International Collective in Support of Fishworkers (ICSF)[107] highlights experiences, concepts, and guidance for gender-equitable small-scale fisheries governance and development. Participation in fisher organisations offers women an important pathway for engaging in management. Global case studies[108] on fisher organisations revealed that women participate as members and leaders in fisher organisations, but much less than men. Ongoing FAO analyses focus on how women's participation and leadership in fisher organisations have an empowering effect on women, and contribute to balancing the gender power relationships. Findings to date[109] indicate that the barriers to women's participation and leadership in fisher organisations include the lack of information on women's contributions due to the absence of gender disaggregation in many employment statistics and lack of integration of women's expert knowledge into fisheries management.

3.3 Biosecurity Provides Food Security

Biosecurity policy and procedures need to be at the forefront of all aquaculture sector development in Africa, addressing each stage of the production cycle for each species. Without aquaculture biosecurity, businesses become unsustainable and fail with dire consequences. The aquaculture sector is vulnerable to exotic, endemic, and emerging disease epizootics such as epizootic ulcerative syndrome (EUS) which is a disease affecting both wild and farmed fish in freshwater and estuarine environments.[110] Constraints in dealing with aquaculture diseases include limitations in diagnostic techniques, and the existence of cryptic pathogens and benign organisms that may become pathogenic when introduced to new hosts and new environments. Too often, significant time elapses from the first observation of mortality in the field to the identification and reporting of the causative agent and the application of appropriate control and risk management measures. A paradigm shift is needed in dealing with aquaculture biosecurity risks. However, biosecurity measures have their limitations. This includes a limited capacity in open aquaculture systems (oceans, lagoons, lakes, and rivers) relative to the high effectiveness in controlled systems.

"Thanks to the fair-trade agreement, in November 2017 women collectors were receiving 47 per cent the sale price, from which they pay 8 per cent of the sale price to the transporter intermediary."

[105] Lentisco, Angela & Lee, Robert. (2015). A Review of Women's access to Fish in Small Scale Fisheries. ISBN 978-92-5-108857-9 FAO Fisheries and Aquaculture Circular No. 1098 FIRO/C1098.

[106] Thirty-third Session, Rome, 9-13 July (2018) Progress By Fao And Partners Concerning The Implementation Of The Ssf Guidelines Since The Thirty-Second Session Of Cofi In 2016 http://www.fao.org/3/MW692EN/mw692en.pdf

[107] N. Biswas, (2017), Towards gender-equitable small-scale fisheries governance and development, International Collective in Support of Fishworkers ISBN 978-92-5-109796-0.

[108] In Barbados, Belize, Costa Rica, Indonesia, and the United Republic of Tanzania (Siar and Kalikoski, 2016).

[109] Alonso-Población, E.; Siar, S.V., (2018), WOMEN'S PARTICIPATION AND LEADERSHIP IN FISHERFOLK ORGANIZATIONS AND COLLECTIVE ACTION IN FISHERIES, ISSN 2070-6065.

[110] Kamilya D., John K. (2020) Chapter 15 Epizootic ulcerative syndrome (Aphanomyces invadans) pp 291-301 in Woo P., Leong, J.A., Buchmann K. Eds. (2020) Climate Change and Infectious Fish Diseases CABI.

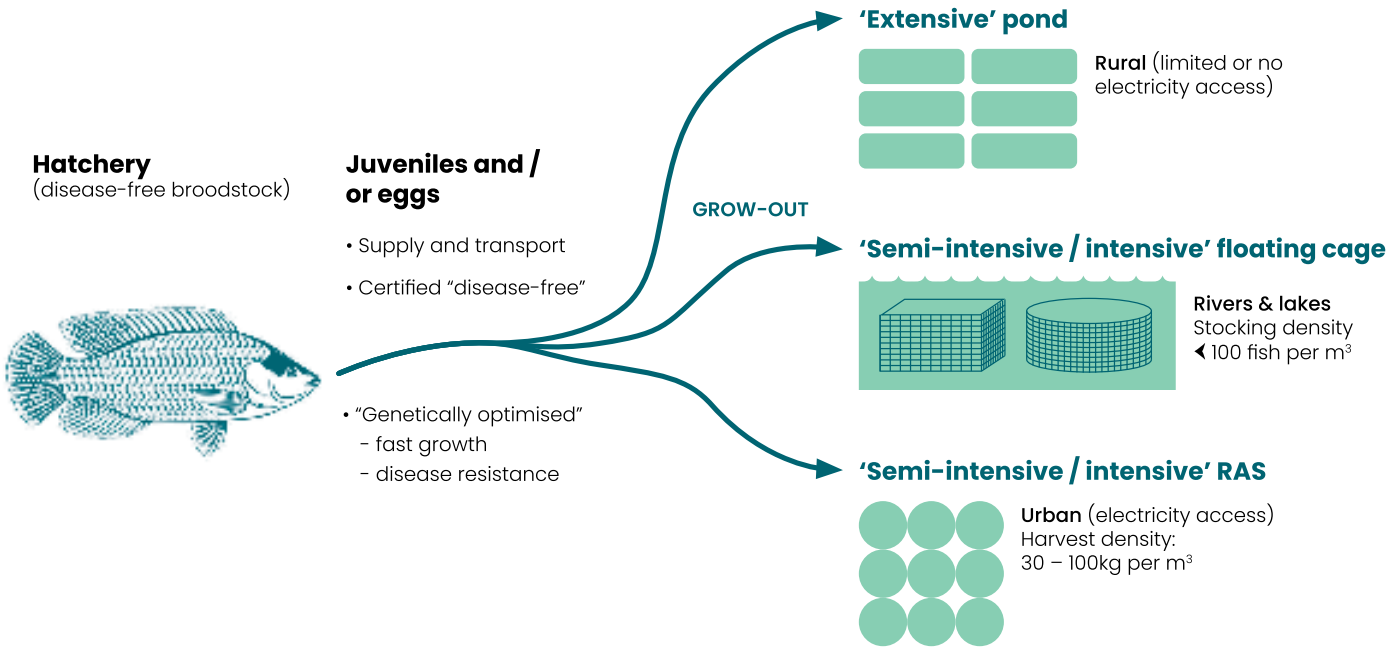
It is imperative to address issues such as access to marine bio-genetic resources. Given the prevailing pandemic-recovery global biodiversity framework concerns such as fair and equitable benefit sharing (plus access to genetic resources as enshrined in the Convention on Biological Diversity[111] and the Nagoya Protocol) can help the African continent to meet some of their conservation and biological development costs.

Addressing biosecurity requires many resources, strong political will, and concerted international action and cooperation. National strategic planning for aquatic animal health and biosecurity is vital; without it, a country can only react in a piecemeal fashion to new developments in international trade and serious transboundary aquatic animal diseases, and its aquaculture and fisheries sectors will remain vulnerable to new and emerging diseases.

An integrated monitoring and surveillance programme within a one health platform,[112] which includes study of antimicrobial usage and antimicrobial genes in different sectors (human, agriculture, veterinary, aquaculture), can improve understanding of the drivers leading to selection and spread of antimicrobial resistance in the aquatic environment. Safer trade practices should be promoted. Special attention to the needs and empowerment of small-scale producers should be accorded priority, as they often lack the means to undertake the measures needed in any biosecurity system.

Biosecure hatcheries and reliable provision of certified 'disease free' and 'genetically optimised' fingerlings to farms designed specifically for grow-out, will provide security in quality fish supply and form the foundation for disease management (Figure 1). Having a harvestable protein source in the form of living fish suits communities without access to refrigeration. For tilapia and carp species, diets can be supplemented with foliage from plants grown by local communities. Wherever possible, it will be important to plan culture systems that are as biosecure as possible to reduce ecological impacts from fish escapees. Indeed, community awareness around the harmful ecological effects of fish escapees of genetically optimised fish will continue to be an important aspect of aquaculture training programs, in addition to site selection (regulated zoning, permits etc.) and production method suitability assessments..

Figure 1. Schematic diagram of *Oreochromis niloticus* supply for grow-out in African communities with biosecure hatchery supply. Note, this process is beginning to take shape at KMFRI in Mombasa, Kenya. Further development work is required around the areas of genetics, disease management and biosecurity, hatchery, grow-out, and post-harvest processes



[111] Article 10. Nagoya Protocol.

[112] Stentiford, G.D., Bateman, I.J., Hinchliffe, S.J. et al. (2020) Sustainable aquaculture through the One Health lens. Nat Food 1, 468–474 (2020). https://doi.org/10.1038/s43016-020-0127-5

Figure 2. Kenyan aquaculturists netting juvenile tilapia in a tidally filled saltwater earthen pond. This experimental farm near Mombasa was built and is maintained by the women of the community, with support from KMFRI.

3.4 Improving Culture Systems to Maximise Production

Modern technologies are missing from artisanal aquaculture in Africa. Simple additions and modifications, such as aeration and shading, will increase yields and improve production efficiency. To achieve increased production from current and future artisanal aquaculture farms in Africa, the addition of energy efficient 'stand-alone' technologies powered by renewable energies are required. While cost-effective, many of these technologies are still relatively expensive, and much support and capacity building initiatives will be necessary to create a 'critical mass' of adoption and sustained investment. In the first instance, site selection is of paramount importance. In Kenya, earthen pond systems have been built on tidal creeks amongst fringing mangrove communities for tilapia grow- out, using salt tolerant *O. niloticus* fingerlings developed and supplied by the Kenya Marine and Fisheries Institute in Mombasa (Fig's 2 and 3). Tilapia are grown in low density (3-4 fish per m^2) by the women of the community in the ponds, with final grow-out in floating cages located in the tidal river.

As climate change effects continue to impact and shape current and future aquaculture practices in Africa and other parts of the planet,[113] maintaining control of water temperature will be critical to allow efficient and predictable fish production. Therefore, low intensity, simple aquaculture buffers a lot of these issues. Maintaining water temperatures, as air and water temperatures rise due to global warming will be challenging, and the key may lie in the adaptability and/or resilience of individual species. In this case, specific selection of breeding varieties will need to be researched and tested.

[113] Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. (2018). Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Figure 3. Kenyan aquaculturists exhibiting healthy juvenile tilapia stock grown in saltwater. Experimental farm near Mombasa was built and is maintained by the community with support and fingerling provision by KMFRI. Saltwater production assists to minimise fish losses from fungal infections and skin infections associated with freshwater production, reducing the need for chemicals and treatment.

"As climate change effects continue to impact and shape current and future aquaculture practices in Africa and other parts of the planet, maintaining control of water temperature will be critical to allow efficient and predictable fish production. Therefore, low intensity, simple aquaculture buffers a lot of these issues."

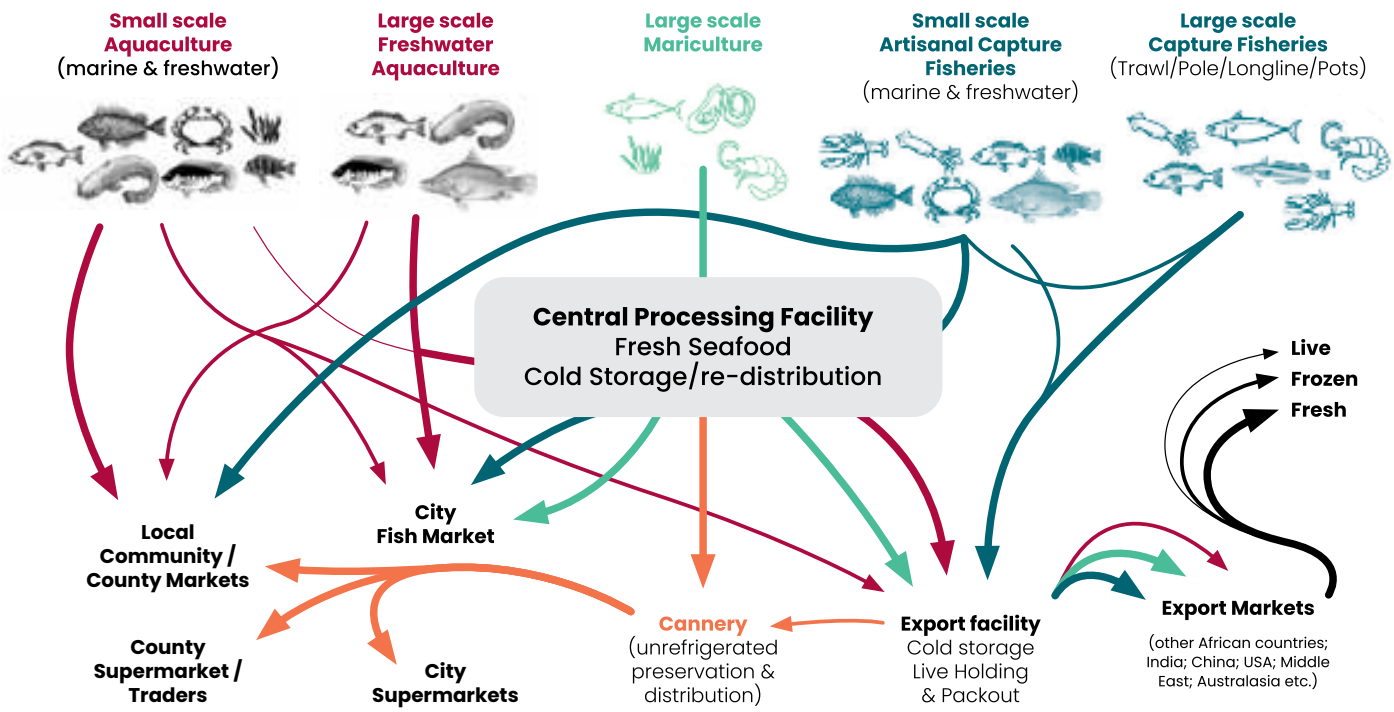
3.4.1 Building a Robust Cold Chain and Seafood Safety System for Africa

Building a cold chain on a country-by-country basis to accommodate all sectors of Africa's aquaculture and capture fisheries industries must be of the highest priority for Africa's Blue Economy. A robust cold chain will not only provide a reliable protein supply for African people, but it will also encourage international investment into developing seafood industries and provide a reliable supply of quality seafood and ornamental fish for export. In turn, it offers employment and training opportunities for millions of African people.

Currently, cold chains across Africa are largely non-existent or do not operate efficiently, and large quantities of food are perishing post-harvest. Recent estimates of perished food are between 25-30 per cent for animal products and 40-50 per cent for plant products.[114] It is essential that seafood from capture and aquaculture fisheries is maintained within the cold chain from the moment of harvest to that of consumption. A 'Zero Seafood Waste' campaign/approach will be needed to 'set the standard' in cold chain best practices throughout Africa. This will also provide an example for other food industry sectors to follow. Infrastructure and training for all cold chain operators must be carefully planned and implemented to accommodate the needs of the various seafood industry sectors and markets relevant to each country. Figure 4 indicates infrastructure and distribution pathways required for creating a cold chain that meets the needs of each African country; further explanation is provided hereafter relative to each facility, aquaculture, and capture fishery sector.

Canneries will provide a great option for seafood preservation and distribution throughout Africa, by allowing seafood storage and trade safely outside the cold chain (Fig. 4). Canneries will be critical for contributing towards 'Zero Seafood Waste' in Africa. Lower grade seafoods suppliers can be made into valuable and safe products, with additions of oils, marinades, and flavours during the canning process. High grade and high value products, such as abalone, may also be canned for safe distribution into African restaurants and export into Asian markets, while tinned mussels and oysters may provide alternative sustainable products for domestic and export markets. South African canned abalone for export to China is one such mariculture success story.[115]

Figure 4. Proposed seafood cold chains, processing, and preservation facilities, markets and distribution pathways required for each African country. Arrow width indicates the approximate volume of product movement through each distribution pathway.



[114] Dramé D., Njie, D., Meignien, X. and D. Coulomb (2016). Developing the cold chain in the agrifood sector in sub-Saharan Africa: Agroindustry FAO Policy Brief 2. Pp4. http://www.fao.org/3/a-i3950e.pdf

[115] Bolton J., (2017) Aquaculture in sub-Saharan Africa: small successes, bigger prospects? The Conversation. https://theconversation.com/aquaculture-in-sub-saharan-africa-small-successes-bigger-prospects-78861

3.4.2 Ten Million Additional Tonnes from Artisanal Aquaculturists (Marine and Freshwater)

The Third Commission identified the need for 10 million tonnes p.a. of additional artisanal aquaculture production to maintain current per capita consumption rates as the African population continues to grow. Cold chains will be necessary for seafood storage, transport, and sale; from harvest to consumption. Therefore, remote communities require access to reliable electricity to power the ice making machines and produce ice, plus access to refrigeration and freezing facilities wherever possible. This includes access to clean water to produce the ice, ice-making machines, commercial ice boxes, and salt to create ice-slurries for marine species. Importantly, these tools enable small-scale farmers to sell their seafood outside their local communities and extend the shelf life of seafood retained for local communities. This becomes even more important as climate change leads to increasingly warmer climates and the frequency of very hot days and nights. Extending the storage life (for both local consumption and for transport to distant markets) is critical for maintaining and improving the livelihoods of fishers and food security, in general. However, access to refrigeration is limited by cost, electricity availability, and access constraints. Current research[116] into utilising plasma activated water (PAW) cooling mechanisms may be a significant contributor to addressing this problem for inland and coastal fisheries.

The majority of seafood produced by rural small-scale aquaculture will continue to be retained for sale in the local community where it has been produced, or for use by the fish farmers themselves. For example, in Kenya, artisanal aquaculture farmers typically retain seafood product for sale within their communities or for family consumption.[117] However, as urbanisation continues and demand for seafood and protein increases, aquaculture expansion will be urgently needed along with development of modern fish markets and processing facilities. High value live ornamental fish, mud crab, lobster, and fresh products such as macroalgae and fish fillets may be sold directly to or via the 'Export Facility' (Fig. 4). Collectively, these facilities open-up options and opportunities for small-scale farmers to gain access and maintain supply into niche export markets that would otherwise be inaccessible, and to form cooperatives to enable increased efficiency through operation as a collective. While climate change, manifesting as increasing temperatures, will threaten the whole value chain of the fresh fish industry, mechanisms such as efficient and cheap cooling/refrigeration can be applied to extend the lifespan of safe storage from origin to market.

"The majority of seafood produced by rural small-scale aquaculture will continue to be retained for sale in the local community where it has been produced, or for use by the fish farmers themselves. For example, in Kenya, artisanal aquaculture farmers typically retain seafood product for sale within their communities or for family consumption."

[116] An Australia Africa Universities Network (AAUN) research proposal development led by Murdoch University (2020-2021).

[117] Obiero, Kevin & Cai, Junning & Abila, Richard & Ajayi, Oluwafemi. (2019). Kenya: High aquaculture growth needed to improve food security and nutrition.

Small-scale aquaculture success stories

Mud Crab Ecotourism in Kenya: A Successful Community-Driven Model

Three decades of mud crab (*Scylla serrata*) aquaculture development in Kenya has seen the evolution of successful community-driven model for poly-silviculture (mangroves, mud-crab farming and eco-tourism). The Dabaso-Mida Creek mangrove forests at Watamu[118] (Figure 5) is a long-term success story arising from a once over-exploited tidal mangrove forest previously used for charcoal production. It was re-envisioned by the local Mida Creek Conservation Community (MCCC). The MCCC interventions have, over time, resulted in the creation of a thriving nursery for marine fishes and invertebrates; specifically, juvenile mud crabs.[119] Initially, local mud crab growers struggled to make a profit selling crabs into tourist hotels, homes, and to distributors.[120] Creative thinking on the part of the community led towards the stepwise development of a rustic upmarket eco-restaurant, 'The Crab Shack', attractively nestled among the mangrove forest overlooking the marine inlet.

The MCCC initiative, supported by the Kenya Marine and Fisheries Research Institute (KMFRI) and other funding bodies, quickly became an eco-tourism success story. The Crab Shack[121] serves mud crab samosas and fish sausages as signature dishes along with other locally sourced seafood and produce. Importantly, by attracting tourism dollars, the eco-restaurant run by the MCCC has been able to achieve a good return for locally sourced mud crab. This in-turn enabled the upgrading and development of a sustainable small-scale mud crab aquaculture industry (with capacity for expansion), further developing eco-tourism and education programs. The enterprise also supported ongoing mangrove plant propagation and revegetation work undertaken by the women of the community. Additionally, the many positive impacts through new employment and training opportunities are flowing back into the local community, which developed the successful silviculture model through innovation, collaboration, research, hard work, and perseverance.

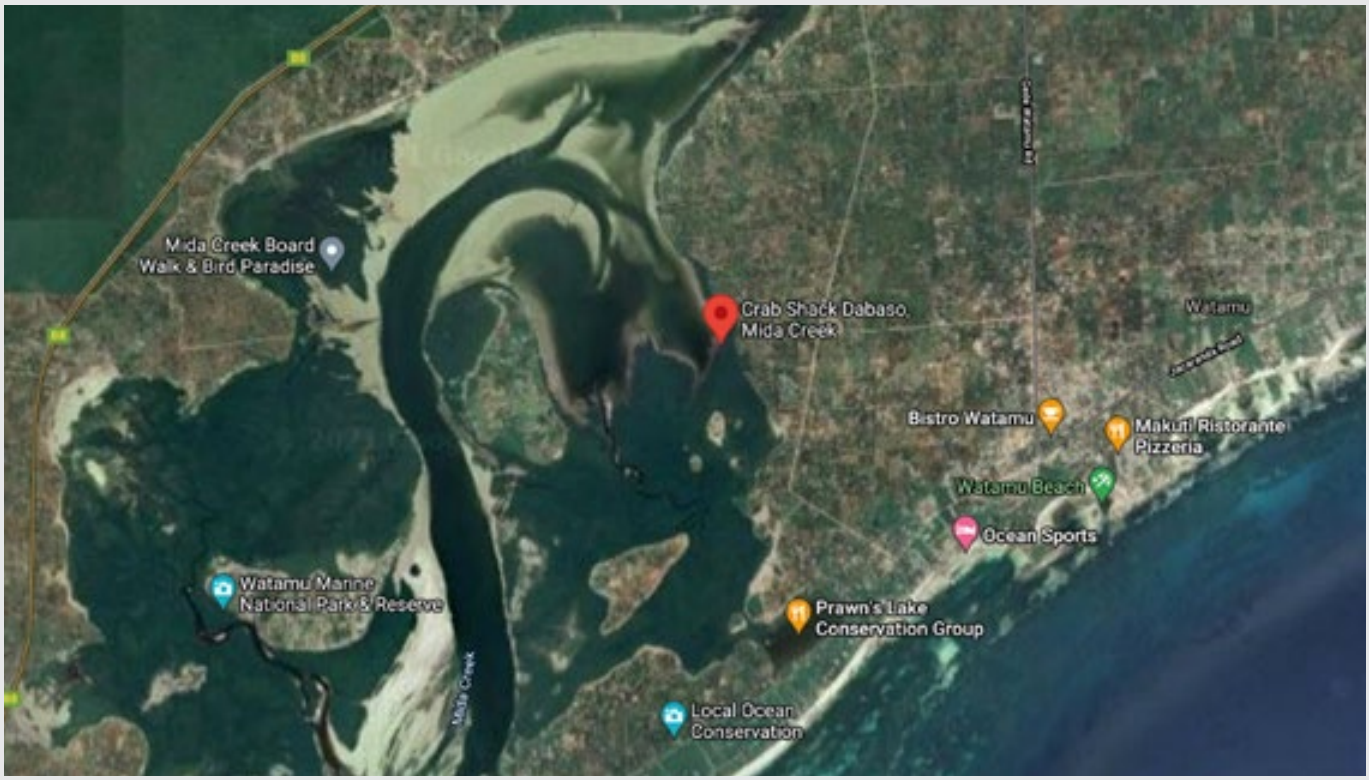


Figure 5. Location of the Crab Shack restaurant amongst Mida Creek's mangrove forest near Watamu, Kenya. Source: Google Maps (10/1/2020)

[118] Mwaluma, J., Mirera H. O. D., Wairimu, M. E., Wainana, M. and A. Kimathi (2018). Mud crab farming policy brief- 2: Improving livelihoods through mud crab farming in coastal Kenya; research innovations for food security and livelihoods. KMFRI Mariculture publication No. 002/2018

[119] MMA (2020). 'The Crab Shack, Mida Creek, Watamu'. Watamu Marine Association website: http://www.watamu.biz/watamu-business.php?cid=86 (accessed 01/10/2020).

[120] Mwaluma, J., Mirera H. O. D., Wairimu, M. E., Wainana, M. and A. Kimathi (2018). Mud crab farming policy brief- 2: Improving livelihoods through mud crab farming in coastal Kenya; research innovations for food security and livelihoods. KMFRI Mariculture publication No. 002/2018

[121] MMA (2020). 'The Crab Shack, Mida Creek, Watamu'. Watamu Marine Association website: http://www.watamu.biz/watamu-business.php?cid=86 (accessed 01/10/2020).

Mud crab aquaculture in Mida Creek and throughout Kenya is growing; stemming from an extensive research program with KMFRI, who determined the best production methods using wild seed stock.[122] As with most crustacean aquaculture, cannibalism limits mud crab communal grow-out and survival rates, and often restricts commercial hatchery successes. However, in Kenya, crab cannibalism is avoided by individually housing 350-gram crabs in floating plastic cages throughout the subtidal mangrove forest while being grown out on locally sourced fish offal, bycatch, and gastropods. To avoid wild mud crab stock declines there remains an urgency to complete the first marine hatchery at Shimoni to supply the growing mud crab industry in Kenyan coastal communities.[123] These culture methods result in fast growth rates and excellent profit margins, particularly when incorporated into cuisine for The Crab Shack restaurant.

Figure 6. The Crab Shack restaurant with locally trained staff

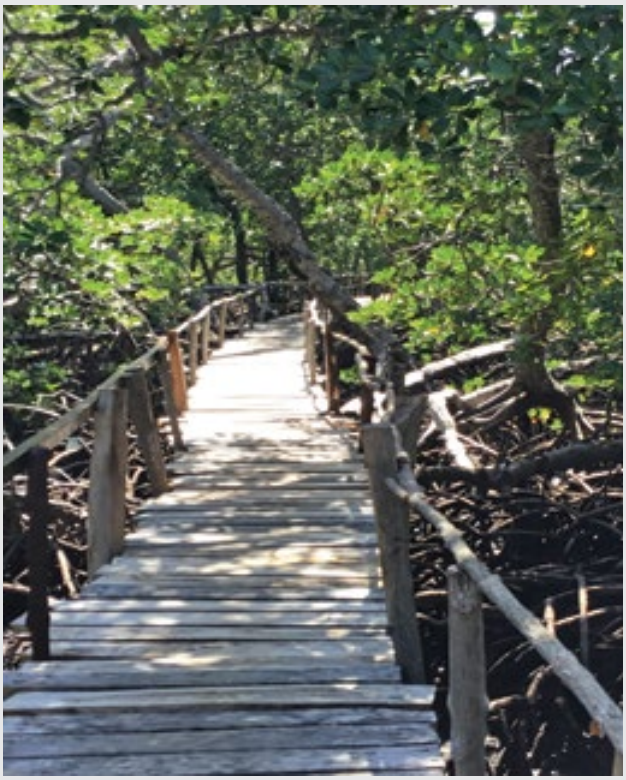


Figure 7. Walkway to the Crab Shack and grow out cages at low tide

[122] Mwaluma, J., Mirera H. O. D., Wairimu, M. E., Wainana, M. and A. Kimathi (2018). Mud crab farming policy brief- 2: Improving livelihoods through mud crab farming in coastal Kenya; research innovations for food security and livelihoods. KMFRI Mariculture publication No. 002/2018.

[123] Mwaluma, J., Mirera H. O. D., Wairimu, M. E., Wainana, M. and A. Kimathi (2018). Mud crab farming policy brief- 2: Improving livelihoods through mud crab farming in coastal Kenya; research innovations for food security and livelihoods. KMFRI Mariculture publication No. 002/2018.

3.5 Large scale freshwater aquaculture

Large scale freshwater aquaculture includes any aquaculture farm producing >20 tonnes of fish, invertebrates, or macroalgae, annually. One of the prominent issues in large scale freshwater aquaculture in Africa is that fish are being produced for export without provision to domestic markets. Thus, there is a desperate need to find the balance between large scale fish production for export and for domestic market supply, particularly in countries with high levels of poverty and poor nutrition. However, fish production for export also benefits local communities and economies by providing wages and income that would not otherwise be available. Anecdotal evidence suggests that each person employed to grow fish for export in Zimbabwe, may support between 20 and 80 other people financially. And beneficially, fish frames and offal by-products from processing are sold cheaply into local communities, providing a source of nutrition.

The Third Commission recommends an urgent research focus on determining the best approaches for large scale freshwater aquaculture production to provide high volumes of fish for both domestic (affordable product) and export (high value product) markets. Community and cultural sustainability in addition to economic and environmental sustainability must be retained at the forefront when planning large scale freshwater aquaculture for Africa.

This will be even more important as demand increases for diminishing freshwater resources under population growth and climate change scenarios. Indoor recirculating aquaculture systems (RAS) are often used as biosecure hatcheries, with grow-out in cage cultures to reduce the production costs. However, with environmental impacts, cultural considerations, farm security and biosecurity issues associated with cage culture, indoor RAS are being increasingly utilised in developed nations for all stages of fish production. They provide potential for biosecure organic fish production, nutrient and water re-use and value-adding by incorporating aquaponic vegetable production.

3.6 Culture Systems and Species

With the necessary expansion of aquaculture in Africa, it is important to identify current aquaculture farm locations and identify new areas suitable for aquatic farming, based on infrastructure, proximity to services and marine or freshwater, and access to markets. It is a priority to identify and build on strengths that already exist across the aquaculture sectors in Africa. Safe seafood production may be increased rapidly with improvements to current practices and post-harvest processes, upgrades to infrastructure, and support for currently invested farmers.

In addition to large scale traditional aquaculture activities, there remain significant numbers of smallholder terrestrial farmers who also farm fish (often catfish to supplement their own protein intake). This smallholder sectoral integrated farming practices can be further encouraged. Integrated Multitrophic Aquaculture (IMTA) is considered important to maximise profits and minimise environmental damage. IMTA systems typically reuse fish waste to grow benthic animals such as echinoderms and molluscs beneath and surrounding fish cages, while nutrients released also support the growth of marine algae. The same principle applies in freshwater aquaponics where the vegetable crop produces financial income equal to that of the fish produced without the need for extra water and minimal nutrients. These integrated production systems are ideal for locations with deficient soils and low or variable rainfall.

"In addition to large scale traditional aquaculture activities, there remain significant numbers of smallholder terrestrial farmers who also farm fish (often catfish to supplement their own protein intake). This smallholder sectoral integrated farming practices can be further encouraged. Integrated Multitrophic Aquaculture (IMTA) is considered important to maximise profits and minimise environmental damage."

TROPO FARMS Case Study (2000-2020)

Tropo Farms Ltd, a two-decade old large-scale commercial tilapia farming enterprise in Ghana, provides an example of critical incentives, enablers, and bottlenecks to the successful growth of large-scale aquaculture, and associated policy environments on the continent.

Origins and Immediate Challenges

Tropo Farms Ltd. was registered in the late nineties as a profitable opportunity to replace imported frozen tilapia from Taiwan by growing it in its indigenous territory. After sourcing available and unencumbered land, construction of the farm began in mid 2000. In the first year, production was inadequate due to slow growing local strains of Nile tilapia (Oreochromis niloticus). However, after a year, with the permission of the Ghana fisheries commission, Tropo received a permit to import faster growing strains of the same species from Thailand. This enabled fast growth, good survival rates, and higher stocking densities. Two decades ago there were no skilled aquaculture personnel in Ghana, requiring the young company founders, a young husband and wife, to train the initial team of 17 employees.

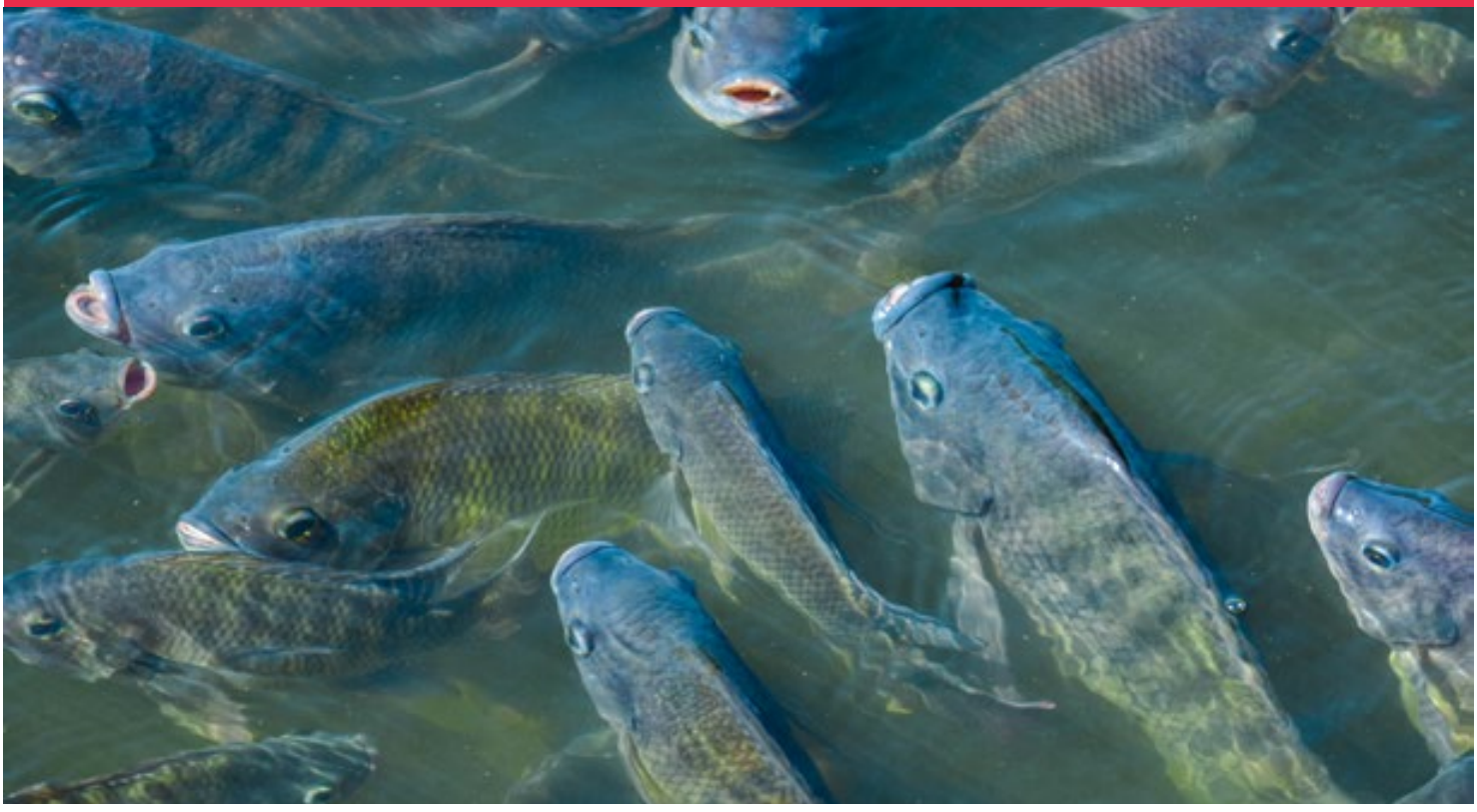
> **"After sourcing available and unencumbered land, construction of the farm began in mid 2000."**

Expansion and Growth

By early 2020 with a 35 per cent share of the local Ghana market, Tropo was the largest fish farm in West Africa, and one of the top three on the African continent. Its success story is inspiring to other potential aquaculture market entrants. In 2003 it was decided to expand due to increased market demand. A location at Mpakadan near Akosombo on the Volta Lake was identified in 2004 and cages were used. One condition of the Ghana Environmental Protection Agency permit was to use slower growing native strains of tilapia, not the imported faster growing strains. A small growth trial using 6 small cages and fingerlings produced from native brooders sourced from the northern parts of the lake. Premium imported feed and low stocking density resulted in adequate growth to make a profit. By expanding this model in 2011 production increased to 5,000 Mt, employing over 400 staff. Further expansion with a second pond hatchery site at Anyaase (30 km from Akosombo on the shore of the Volta Lake) with an open water cage site in the middle of the lake 10 km offshore enabled production in the range of 9,600 tonnes in 2018 and a team of 700 men and women. The long-term plan is to grow sales to above 30 Mt p.a. by 2026.

Market Growth and Threats

The aquaculture industry in Ghana is predicted to grow as a result of the high demand for farmed fish products from rapid human population growth, decline of capture fisheries, and reduced costs of farmed fish compared to other protein sources. To ensure sustainability of the local aquaculture sector requires policies to enable greater local industry cooperation and methods to increase productivity and cost effectiveness. Such policies including inclusion of naturally selected faster growing and more disease tolerant strains of Nile tilapia can assist local producers to outcompete low-cost frozen imports from Brazil and China.



"The Third Commission recommends urgent prioritisation of small-scale coastal, estuarine, river, and lake fisheries, with a renewed focus on environmentally sustainable growth and biosecurity that underpin both local food security, jobs, and exports, and that incorporate the growing threat of climate change impacts."

CONCLUSIONS AND RECOMMENDATIONS

The Third Commission aims to catalytically contribute to a rapid acceleration of the current positive momentum in the global Blue Economy, particularly in the Indian Ocean region, linking the many African and Asian coastal states that neighbour Australia. Following expert consultation on the priorities of Africa's Blue Economy in London in June 2018 and consensus of the need to take a 'people centred approach', we have focused on the human security nexus between the environmental, food production, nutrition, equity promoting, and livelihoods aspects of the sector.

Within this context, The Third Commission recommends a rapid growth of sustainable aquaculture across Africa to address the regional aquatic food demand and supply gap, as well as contribute to progress towards the achievement of the 2030 Agenda.[124] The Third Commission recommends urgent prioritisation of small-scale coastal, estuarine, river, and lake fisheries, with a renewed focus on environmentally sustainable growth and biosecurity that underpin both local food security, jobs, and exports, and that incorporate the growing threat of climate change impacts. Adoption of world-leading practices (using a one health approach) can enable doubling of the current productivity of existing artisanal farms through improved use of digital tools and mapping, nutrition, biosecurity, genetics, pond management, and cold chains. These include fostering of enabling scaled investments in intensive aquaculture and expansion of seaweed, algae, and other mariculture operations to produce aquafeed and for domestic consumption.

Finally, The Third Commissions recommends scale-up of comprehensive activities to tackle illegal, unreported, and unregulated (IUU) fishing and fish crime through promoting greater transparency, innovations in monitoring and enforcement, and applied technology. More must be done to counter large-scale illegal fishing of pelagic resources, which undermines livelihoods and environmental protection. By investing in legal education, tools, and platforms to enhance human and institutional legal capacity in Africa, nations will be more able to negotiate better terms and significantly strengthen their capacity to enforce their laws and successfully prosecute all perpetrators.

A greater cooperation between regional and international governments, organisations, and universities with the required skills and expertise could provide comprehensive advisory services and interactive repository and mapping data to improve coordination and knowledge sharing for fishery resources and contract accounting and management. As James Alix Michel eloquently stated in his UN address on the theme of the Blue Economy, "to be successful the concept must embrace environmental as well as economic interests."[125] With a people-centred approach, the nexus between many seemingly disparate elements and actors can come together to advance the sector's immense contribution to improving human security in a sustainable manner.

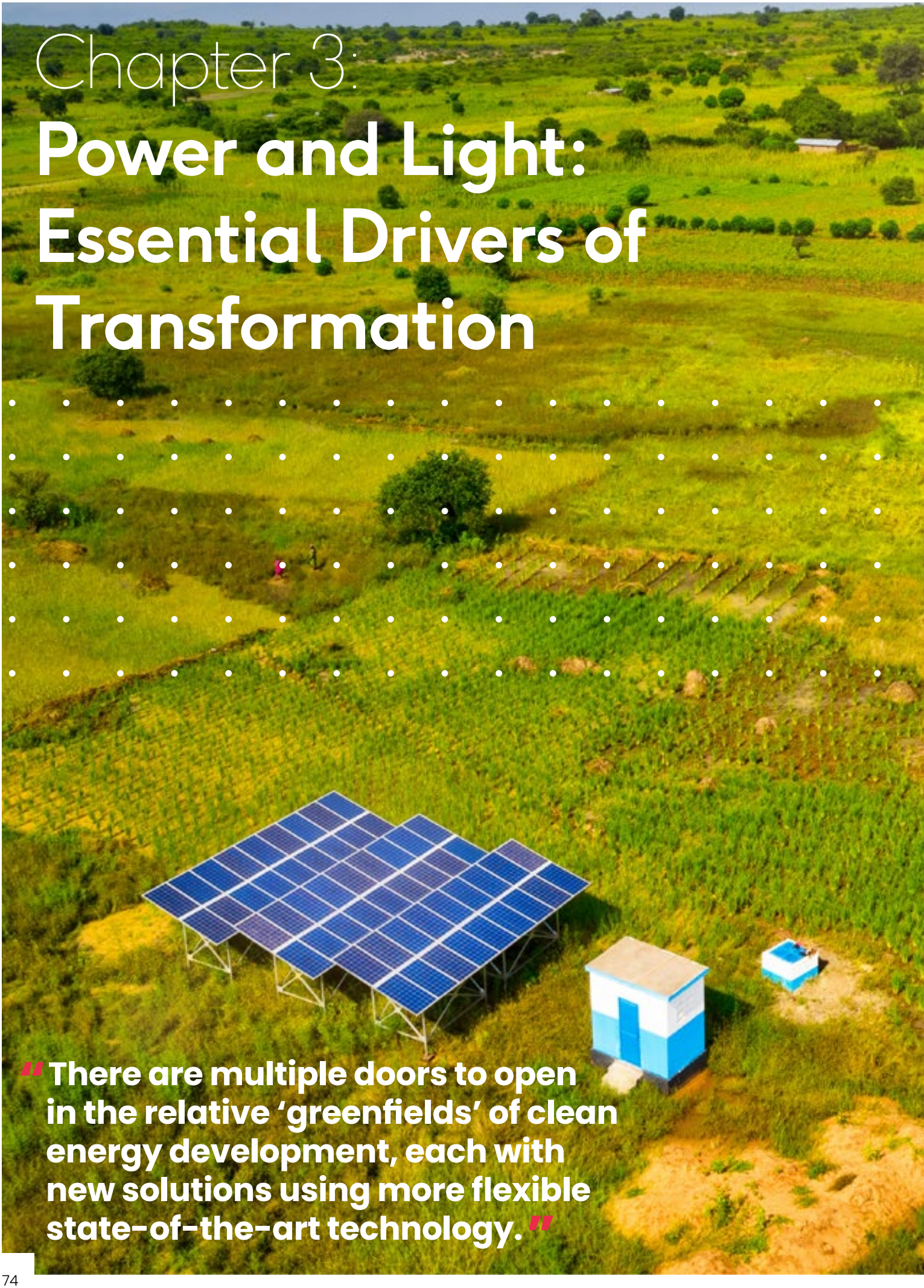
"To be successful the concept must embrace environmental as well as economic interests. With a people-centred approach, the nexus between many seemingly disparate elements and actors can come together to advance the sector's immense contribution to improving human security in a sustainable manner."

[124] Hambrey, John. (2017) "THE 2030 AGENDA AND THE SUSTAINABLE DEVELOPMENT GOALS: THE CHALLENGE FOR AQUACULTURE DEVELOPMENT AND MANAGEMENT." FAO Fisheries and Aquaculture Circular: I,IV,VII,1-62.

[125] Michel, James Alix (2016) Rethinking the Oceans: Towards the Blue Economy USA Paragon House.

Chapter 3:

Power and Light: Essential Drivers of Transformation



"There are multiple doors to open in the relative 'greenfields' of clean energy development, each with new solutions using more flexible state-of-the-art technology."

INTRODUCTION

Imagine an Edison and Tesla building their systems for an African village today. Would you follow the path dependency of a traditional centralised system, or be open to exploring the many alternatives? It is not mandatory to follow the same development path (which can also become a rut) or have one successful model.[1] There are multiple doors to open in the relative 'greenfields' of clean energy development, each with new solutions using more flexible state-of-the-art technology. In urban Africa 78 per cent of the population have access to electricity, while in rural Africa the number plummets to 31 per cent.[2] This urban-rural dichotomy is the reason that 591 million Africans are still without electricity.[3] While 110 million urban Africans without electricity needs to be addressed with expansion of current infrastructure, the larger challenge remains how electricity will be delivered across vast distances to sparsely populated rural communities.

One hundred years ago the same dilemma was faced in the now advanced economic countries (rural electrification in the US, Canada, and Australia was continuing mid-century). The 20th Century solution was built on centralised baseload power stations often located in the coal producing regions of a country, with arrays of high-tension power lines criss-crossing the landscape. The 21st Century solution looks vastly different. Fortunately for Africa, what is currently an impediment (the lack of electrical infrastructure and generation capacity), may very well turn out to be a blessing. This is because the staggering technological advances in harnessing the terajoules of solar and wind energy are now cheaper to deploy than any fossil fuel alternative in African rural and remote regions. In other words, the electricity is already 'delivered' to every community; it just needs to be captured, stored, and shared. The economic and policy decisions required to deliver such technology are less encumbered by historical legacies of '20th Century solutions' to energy supplies. Equally exciting is the new opportunities from the low-power Direct Current (DC) revolution in lighting and electrical appliances and mechanisation that are ideally suited to be coupled with renewable energy generation.

[1] McHenry, M.P. and Doepel, D. (2015) The 'low power' revolution: Rural off-grid consumer technologies and portable micropower systems in non-industrialised regions. Renewable Energy, 78 . pp. 679-684.

[2] World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program.

[3] This represents 63% of the global total - World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program. Population data from the UN World Population Prospects (UNWP).

The year 2020 marked a significant monitoring milestone in the quest to achieve the 2030 Sustainable Development Goals (SDGs).[4] At the same time, it provided a critical point at which to take stock of progress since the 2015 Paris Climate Agreement. Both agendas are at the core of the narrative and policy recommendations of the Africa Progress Reports (APP) and policy papers released between 2015 and 2017.[5] However, the COVID-19 pandemic is upending two decades worth of sustained socioeconomic achievements and dimming the continent's future growth prospects. It is too early to properly assess the damage caused by COVID-19, although it has already incurred massive human, economic, and social costs. IMF's recently released growth forecasts (***World Economic Outlook, 2021***) have revealed that due to the devastating impact of COVID-19, it will take years for many developing countries, including in Africa, to return to pre-COVID-19 levels. This will significantly delay the continent's development and progress towards the SDGs. In addition, the pandemic has significantly reduced Africa's fiscal ability, requiring a reprioritisation of other considerations. Yet, one major opportunity is prioritising energy access and transition as part of the post-COVID recovery (as called for by the UNU-INRA in its upcoming paper on ***Africa's Green Transition Pathway***). Within the post-COVID-19 recovery, Africa's clean energy transition agenda is gaining greater currency among African policymakers and partners.

In 2015, in ***Power, People, Planet: Seizing Africa's Energy and Climate Opportunities,***[6] the APP emphasised the links between energy, climate, and development in Africa. It outlined the risks of staying with a business-as-usual approach to the climate and energy challenge. Africa's advantageous position to leapfrog to low carbon modern energy systems was stressed (in the same manner as its mobile telephony revolution of the past two decades). The report recommendations called on Africans and their international partners to take the steps necessary to enable Africa to play a leadership role in the global transition to a low carbon energy system.

Two years later in its policy paper ***"Lights, Power, Action***[7]***"*** the APP strongly advocated for the implementation of the African Development Bank's ***New Deal on Energy for Africa***[8] and related initiatives to scale-up electrification rapidly. It emphasised the urgent need for more significant investment in developing new energy systems, comprehensive power-sector reforms, and "special measures to support off-grid solar, other renewables and mini-grids" across the entire continent. Of relevance to this report was the recommendation that countries need long-term strategies for building the capacity of knowledge institutions to provide the managerial, policy, and technical workforce to enable them to play a stronger role in financing, planning, digitising, and implementing the energy transition.

[4] GA Resolution 70/1 - Transforming our world: the 2030 Agenda for Sustainable Development.

[5] Africa Progress Panel Geneva 2015, *"Global Goals, African Realities"*, *"Power, People, Planet"* and *"Lights, Power, Action"*.

[6] Africa Progress Report June 2015.

[7] APP March 2017.

[8] African Development Bank (2015) New Deal on Energy for Africa https://www.afdb.org/fileadmin/uploads/afdb/.../Brochure_New_Deal_2_red.pdf

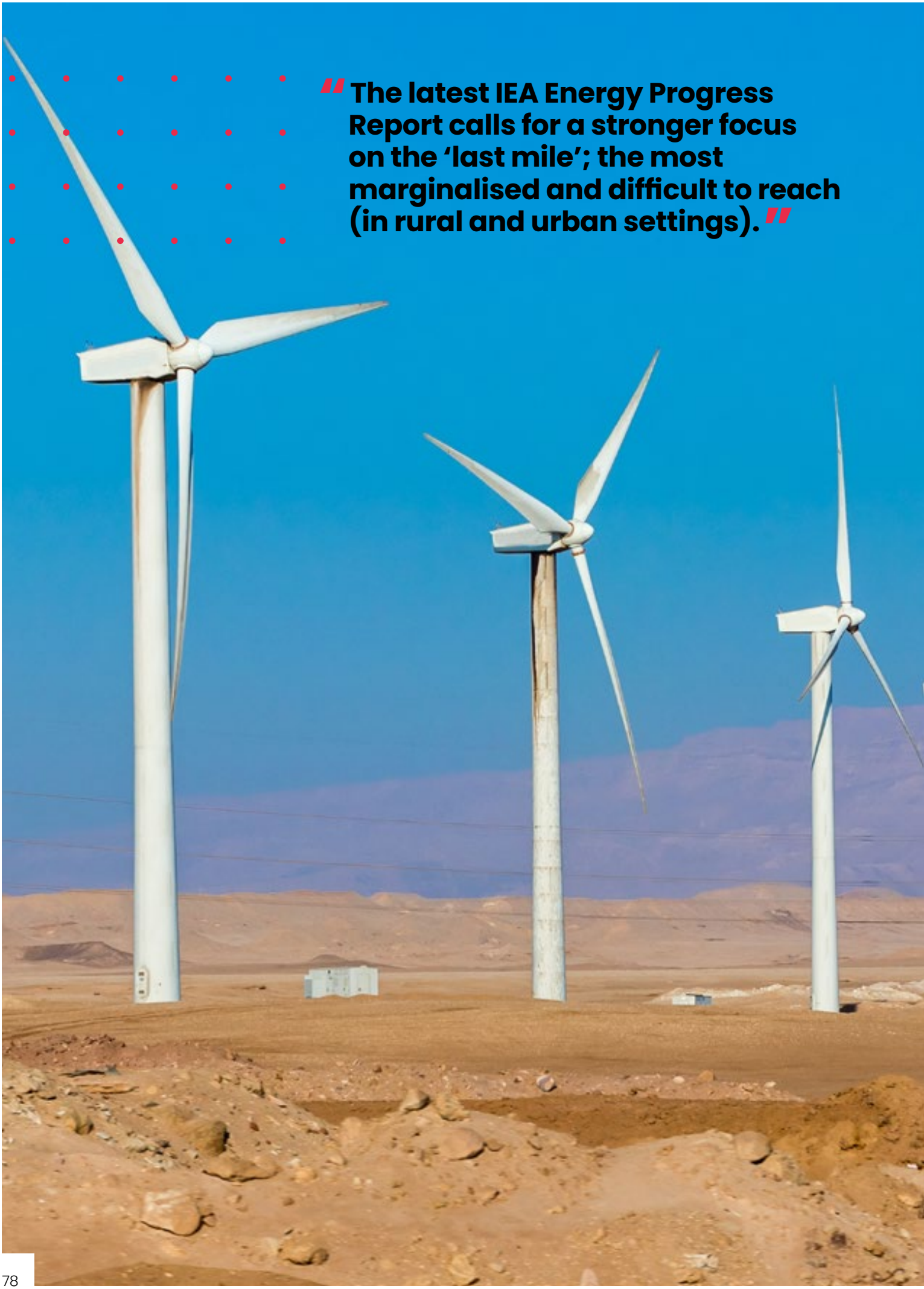
The Third Commission finds that the 'power and light' agenda for action set out by the APP and the African Development Bank's New Deal on Energy for Africa remains highly relevant today. It is not alone in this view. The recent findings of a consortium of influential international institutions share similar perspectives.[9] According to the analysis cogently presented in *Tracking SDG7: The Energy Progress Report 2019,* the world is currently not on track to meet SDG 7.[10] Progress to date also falls short on all four of the SDG 7 targets, encompassing universal access to electricity, clean fuels, and technologies for cooking; a doubling of the rate of improvement of energy efficiency, as well as a significant rise in the renewables share of the overall global energy mix. Much of the drag on global progress towards the targets is a result of the slow pace in Africa. The threat of climate change impacts will exacerbate this.

In that context, this chapter investigates the status of the sustainable energy access acceleration process, challenges, and opportunities in Africa to recommend areas of engagement that are within the comparative advantage of several respected African and Australian network of partners in this field. In particular, it identifies capacity building research and policy interventions as well as knowledge-based advocacy that can contribute to moving the bar forward in the selected areas that encompass the overall core themes of The Third Commission's work. In light of Western Australia's experience as a global leader in fringe-of-grid and off-grid power, a strong emphasis is placed on innovative approaches to scaling up energy access via decentralised systems. The need to implement renewable and non-fossil fuel-intensive energy generation, including to meet the baseload power, productivity enhancement, and rapid inclusive growth needs of key employment generating and productive sectors in Africa is a significant driver of these innovative approaches.

"Technological advances in harnessing the terajoules of solar and wind energy are now cheaper to deploy than any fossil fuel alternative in African rural and remote regions."

[9] Tracking SDG7: The Energy Progress Report (2019) The Energy Progress Report is a joint report of the Custodian Agencies – the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO).

[10] SGD 7 calls for ensuring "access to affordable, reliable, sustainable and modern energy for all" by 2030.



"The latest IEA Energy Progress Report calls for a stronger focus on the 'last mile'; the most marginalised and difficult to reach (in rural and urban settings)."

1. Global Goals, African Realities

The International Energy Agency (IEA) stated that SDG 7 is achievable by 2030 if Africa is at the heart of the process.[11] A key driving force is that electricity from the sun and wind are now cheaper than the fossil alternatives, and that the price difference will only increase in the years to come. This growing price divergence implies that it will become increasingly attractive to close coal power plants in the period up to 2030 and beyond. Gas will become and remain an integral part of Africa's energy transition story. Africa's realities show that the continent needs more than just renewable-only options to meet the SDG 7 and its development needs to close its massive energy gap (see above). Rapidly falling prices for batteries will increase the possibility and profitability of electricity storage. The global policy response since 2015 has been notable and positive, though there is still a long way to go, as the rate of growth in energy access competes with often more powerful demographic trends.[12] The Energy Progress Report 2019[13] notes that Africa south of the Sahara remains the region with the most extensive access deficit with 573 million people (1 in 2 of the population) lacking access to modern energy. Furthermore, the region is home to the twenty countries in the world with the lowest rates of electrification, with stark differences in access between urban and rural areas. A gender dimension of access is also highlighted with male-headed households in some regions having better access than female-headed households. There has also been an uneven spread in progress. Four countries (Ethiopia, Kenya, Nigeria, and Tanzania) account for more than half of all the progress achieved in SSA since 2011, despite accounting for just under a third of the population. If the pace of change remains the same, around 600 million Africans will be without access to modern energy by 2030.[14] Some projects initiated in 1999/2000 in regions in South Africa[15] promised much in terms of launching the rural non-grid electrification programme, but these have subsequently not been followed up. Greater knowledge is required to avoid repeating the same mistakes in future programme designs.

The latest IEA Energy Progress Report calls for a stronger focus on the 'last mile'; the most marginalised and difficult to reach (in rural and urban settings). The promotion of geographic and technological diversity of distributed generation and storage for household and individual energy services (including portable devices), could enable cost-effective alternatives to electricity network augmentation in remote locations. Affordability and reliability will be key. It is also important to understand that Africa needs more than just lighting. Power generation for productive use will be critical in shifting behaviours and promoting a wider uptake of clean energy options. These options should be adapted to specificities and needs. A more significant investment in the rollout of decentralised off-grid and distributed solutions is identified as essential to accelerating the energy transition through boosting access to affordable and renewable energy systems. This call was also made in the recommendations of the 2018 UN High Level Political Forum,[16] which urged governments and other stakeholders to "leave no one behind" and push to close the access gap through harnessing the potential of decentralised renewable energy solutions. There remains much to do to respond to this call effectively. Indeed, many stakeholders have a range of individual and collective roles to play. This chapter explores options and modalities related to this.

[11] IEA, *Energy Access Outlook* (2017) www.iea.org/energyaccess

[12] Tracking SDG7: The Energy Progress Report 2019.

[13] Tracking SDG7: The Energy Progress Report © 2019 International Bank for Reconstruction and Development / The World Bank.

[14] Tracking SDG7: The Energy Progress Report 2019.

[15] http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-2004/04ERC-Solar_electrification-Eastern-Cape-baseline.pdf

[16] The HLPF is the principal United Nations platform on sustainable development, and it has a central role in the follow-up and review of the 2030 Agenda for Sustainable Development the Sustainable Development Goals (SDGs) at the global level. General Assembly resolution 70/299 provides further guidance on the follow-up and review of the 2030 Agenda and the SDGs.

"Africa is now emerging as the new digital frontier and supporting the continent's digitalisation agenda could potentially be another entry point for international partnerships."

2. Data Deficits

According to the IEA and the International Renewable Energy Agency (IRENA), despite the surge in global electrification between 2015 and 2017, there is a need for substantially greater acceleration in global renewable energy consumption to meet the SDG 7 targets.[17] The agencies note continued difficulties in tracking off-grid electrification data. Such opacity is due to the sectorial growth being uncoordinated, small-scale, and private sector led.

A holistic approach to the challenge calls for the creation of coherent national policy frameworks. African states need to build more supportive and cohesive national policy frameworks for electrification strategies. In that context, the APP proposed actions to encourage more public-private partnerships and the implementation of a context appropriate mix in each African country that included conventional utility grid, mini-grid, off grid and renewable generation options, that are "backed by effective transmission and distribution to customers as well as revenue collection."[18] To make the right choices, policymakers need to be informed by quality analysis based on robust data. Lack of accurate data for much of Africa, however, makes it difficult to measure, monitor, and respond to the challenge on a grander scale.

Responding to this challenge, the African Continental Free Trade Agreement (AfCFTA) is a landmark agreement launched earlier this year and will have major implications for the continent's energy space. With the acceleration in regional integration, the continent will likely see an increase in cross-border power supply and trade, greater integration of regional power pools and markets, and more regional clean energy initiatives. These include the AfDB's "Desert-to-Power" project that aims to turn the Sahel desert into a clean energy superpower. However, the acceleration of clean energy access on the African continent hinges upon the development of adequate digital infrastructure and skilled workforce to effectively deploy and use digital technology in support of clean energy solutions. Africa is now emerging as the new digital frontier and supporting the continent's digitalisation agenda could potentially be another entry point for international partnerships.

[17] Tracking SDG7: The Energy Progress Report 2019.

[18] *"Lights, Power, Action"*, APP March 2017.

Across the globe, conventional electricity networks require significant investments to accommodate growth in peak demand spikes from new energy-intensive industries and consumer devices. The cost-effective delivery of electricity is increasingly challenging.[19] Without parallel advancements in energy policy and pricing alongside technological advancements, it is difficult to incentivise cost-effective and sustainable investments. Without such investment, there cannot be the growing diversity of new demand and new lower carbon-intensive generation technologies. The UNU-INRA's Discussion Paper on Africa's Stranded Assets, published in 2019 revealed that Africa's energy transition may not be swift. In particular, the continent needs support to properly plan and sequence the stranding of their carbon-based assets and identify the transitional carbon-based resources to achieve its energy supply and climate goals. In this regard, given Australia's own dilemma of stranding its oil, gas, and coal assets, this could possibly be an important area of cooperation between the two continents. This is because technical advancements in energy network, generation, and storage will mean little if African policymakers do not also distribute the costs and benefits of energy investments within electricity markets effectively and fairly.

Due to policy failures, many benefits, and costs of electricity infrastructure investment (including, but not limited to, environmental externalities) remain outside market transactions. They are increasingly leading to suboptimal electricity network outcomes that prevent new significant energy developments and local manufacturing industries. Without fiscal mechanisms enabling electricity utilities and other electricity market participants to transact, there are limited means to distribute the costs and benefits from large new investments and consumer behavioural changes in conventional energy markets. Traditional public electricity networks commonly pass costs onto taxpayers rather than electricity consumers directly. Such pass-throughs are due to legacy cross-subsidies and policies that can stifle new and timely investments in the energy network, new generation capacity, and prevent new large customers that can unlock a cascade of additional new investments.[20] The COVID-induced tight fiscal space forces us to think of new and innovative ways to finance renewable energy (RE) initiatives. The OECD in its 2019 report has revealed that Africa has only received a small fraction of global RE financing. One way for Africa to remedy the situation is for countries to partner with Australia, which could help the continent in mobilising greater international financing for Africa's RE projects. Another way is to encourage Australia's businesses to invest in Africa's RE market and scale up existing initiatives.

Innovative solutions also exist at the local level. Co-ordinated investment infrastructure strategies (such as off-take agreements for water, energy, commodities, transport, etc.) can foster commercially sound opportunities for larger-scale energy and other infrastructure investments through agglomeration as a cost-reduction from shared infrastructure.[21] An example discussed by McHenry and Persley[22] explored conventional energy infrastructure investment in mining/manufacturing sectors can be 'oversized' to enable local off-take (for any local demand—a tomato processing plant, a cold-chain facility, or even a community). Off-take agreements for excess electricity available from a larger mining/manufacturing activity may be sold to local third parties to reduce the cost of energy to all with access—achieved on a commercial basis. Benefits from coordinated energy offtake investment strategies that enable larger 'nameplate' capacity ratings include lower marginal energy costs and reductions in unnecessary investment duplication. Such savings from co-operative off-take agreements can potentially further catalyse/accelerate additional public and private energy infrastructure investments at the local level.

Data and information paucity is one area where The Third Commission urges the African, Australian, and wider international research community to address. Governments also have an important enabling role to play. In ***Lights, Power, Action***, the APP cited the opportunities offered now by geo-referencing software such as geographic information systems to produce maps of connection options across a national territory and construct models of most effective ways of providing electricity and other forms of energy inputs for manufacturing. Studies conducted in Ethiopia and Nigeria found that mini-grids and stand-alone systems would be the most economical solution in areas with low population density.[23]

[19] McHenry, M. P. (2013). "Technical and governance considerations for advanced metering infrastructure/smart meters: technology, security, uncertainty, costs, benefits, and risks." Energy Policy 59: 834-842.

[20] McHenry, M,P., Johnson, J., and Hightower, M (2016) Why do electricity policy and competitive markets fail to use advanced P.V. systems to improve distribution power quality? Journal of Solar Energy, DOI 10.1155/2016/5187317.

[21] McHenry, M.P. and Persley, G.J. (2015) Bread and stones: Co-investing in mining and agriculture in Africa. The Crawford Fund/Murdoch University.

[22] McHenry, M.P. and Persley, G.J. (2015) Op cit.

Geospatial modelling across the region suggests that the least-cost solution for three-quarters of the last mile connections needed in Africa will be through the deployment of decentralised off-grid systems and mini-grids systems based on solar photovoltaics.[24] However, historical projects in South Africa between 1999 and 2007 were welcomed initially with enthusiasm, but were later beset by problems regarding ownership, maintenance, and the limited amount of power produced. Valuable lessons need to be learned from the failure of the broad rollout of the programme in this instance.[25] There is a need to draw lessons for improved planning and roll-out of future RE initiatives, and hybrid low-carbon options that improve energy system diversity that considers local resources and specific needs.

The diversity across the African continent requires consideration of geographical specificities across and within countries and regions to advise appropriate energy options and solutions. For example, the potential of geothermal power in East Africa holds tremendous promise as a reliable and affordable power option, especially as it can provide large-scale baseload generation. For rural areas, biofuel (generated crop residues and animal manure) is likely to offer a sensible power option, while the urban poor could benefit from being connected to affordable electricity given its proximity to the electricity network. In many African countries, hydropower is the dominant form of clean energy generation owing to the scale and affordability of the generated power. Affordability and reliability are the key factors that will determine the success of Africa's RE and clean energy transition agenda. What is needed are a suitable diversity of cleaner energy systems that are the most cost-effective and practical solutions to meet local development needs.

Investment in new research on the extent of existing off-grid rollout along the 'last mile', as well as the remaining challenges and opportunities, could make significant contributions to advancing the agenda. With access to more and better-quality digital data, policymakers and investors would be able to target their interventions with increased efficacy to cater for both centralised energy-intensive industries, and rural population centres with variable energy demand profiles. Here, The Third Commission supports proposals for enhanced use of geospatial planning and satellite imagery that can allow policymakers to design more effective national electrification roadmaps. Such digital roadmaps should cater to both large industrial consumers and population centres and the most marginalised in rural and remote regions. Based on that comprehensive picture, African nations need a smart, diverse mix of energy systems. Such systems could include portable/personal devices, stand-alone home systems, mini-grids, traditional networks, various scales for storage, in addition to local energy production and value-addition. Those future-focused systems can and should be advanced today to meet the needs of tomorrow. Research institutions recognise and support this notion.[26] These future-focused systems could benefit massively from the deployment of adequate digital tools and technology for expediency and efficiency.

Furthermore, there is also a need to improve the dissemination of success stories through an effective knowledge exchange platform to inspire further development at the baseload power industrial-scale as well as in the dispersed smaller off-grid power and clean cooking energy sectors. Such a platform can be part of outlining best practices and tracking progress in meeting the agenda. Collaborations with governments and existing industry bodies, including the Alliance for Rural Electrification (ARE), GOGLA (off-grid solar energy industry association), Clean Cooking Alliance, as well as not-for-profit organisations active in this sector such as the Burn Design Lab (BDL) and the International Lifeline Fund (ILF), can help facilitate this knowledge exchange.

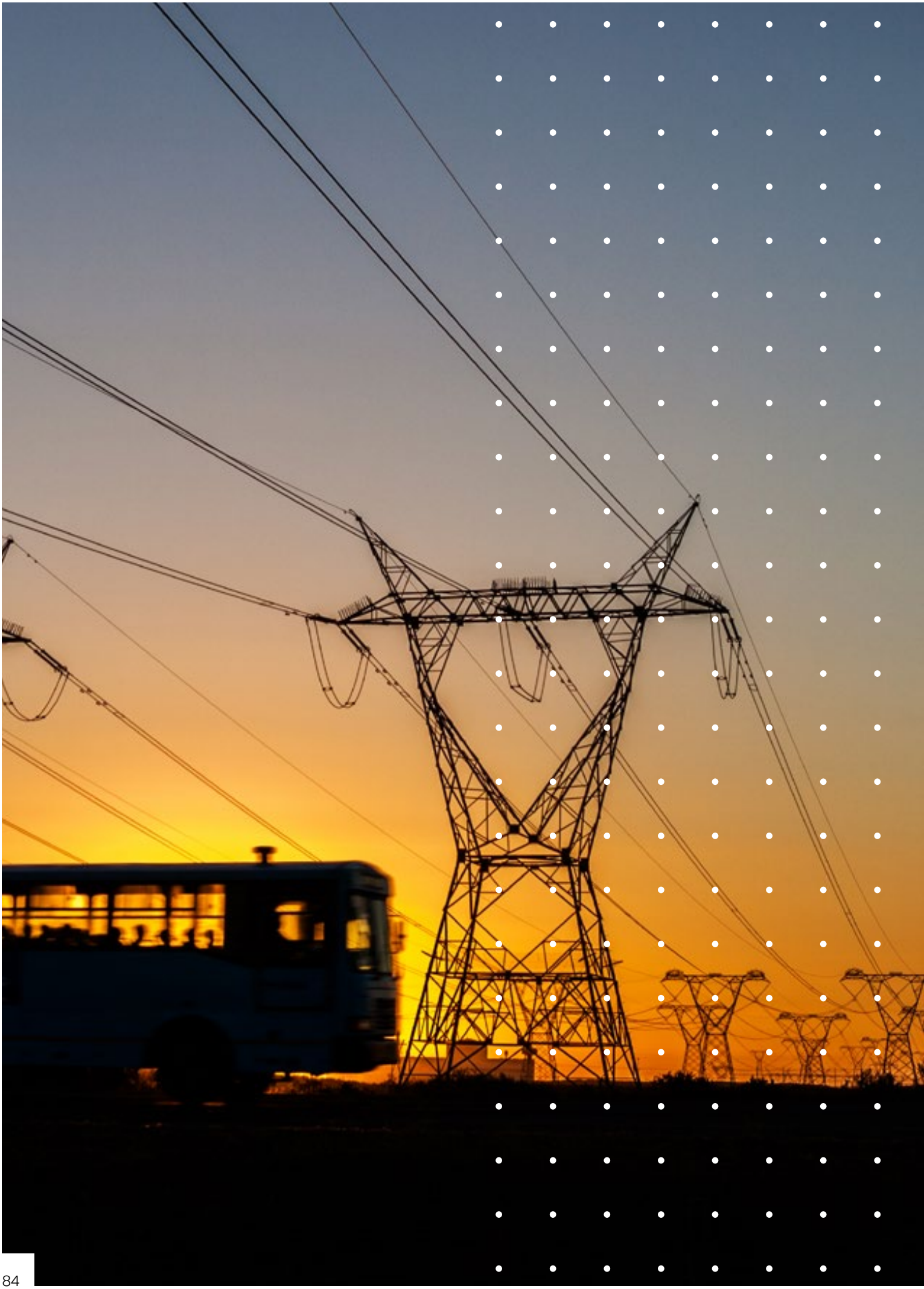
Electricity provision is not the only source of energy in the spotlight. For example, for off-grid rural regions with low availability of electricity, wood, and other cooking fuels, the production of biogas from anaerobically digested agricultural and human wastes provides a low-cost solution. The ability of biodigesters to utilise multiple high-nutrient liquids and solid waste streams to produce useful biogas also solves many issues around waste accumulation and energy accessibility. This integrated approach is an example that concurrently enables safer processing of farm and household wastes by producing a useful gaseous fuel that reduces net carbon emissions when used, and creates a source of organic fertiliser appropriate for food crops.

[23] Nerini, Francesco et al. (2015), "A cost comparison of technology approaches for improving access to electricity services", *Energy*, Available online 2015, published in Energy 95 (2016) pp255-265, Elsevier, Amsterdam cited in APP 2017.

[24] IEA, *Energy Access Outlook* (2017) www.iea.org/energyaccess

[25] Energy Research Centre, UCT: Solar electrification by the concession approach in the rural Eastern Cape: http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-2004/04ERC-Solar_electrification-Eastern-Cape-baseline.pdf

[26] Szewczuk, S (2009) : Hybrid Mini-Grid Systems – Distributed Generation Systems for Communities Based on Renewable Energy Resources https://researchspace.csir.co.za/dspace/bitstream/handle/10204/3845/Szewczuk_2009.pdf?sequence=1



3. Carbon and Climate – Partnerships for Climate Proofing Investments

Any approach to the electrification of Africa must incorporate all attempts to minimise the dependence on fossil fuels and to promote, encourage, and enable low emission energy generation pathways. Africa still requires massive new baseload power sources to drive inclusive development and rapid increases in productivity over the next five to ten years. Geothermal, natural gas, and hybrid power sources could provide viable alternatives in this regard. These technology options need to be as clean as possible for many reasons (health, security, environment, etc.) However, RE sources so far deployed on the continent are not yet sufficient to meet the continent's huge needs. International partnerships are needed to ensure the required transition to increased low/zero emission baseload power generation as the region grows and transitions to the universal deployment of modern energy systems. Traditionally, Western economies have based their own power generation on the cheapest and most readily available resource, which was usually coal or oil. The industrial revolution and rapid technological advances of the 19 and 20th centuries were founded on this model. Indeed, many countries such as Australia and South Africa persist with it due to the availability of cheap coal. However, the externalities of such power generation models are usually not factored into the economic equation. Therefore, such modelling does not factor in air, water, and soil pollution into the costs of such generation. Since fossil fuel combustion is now recognised as a major polluter and contributor to climate change, research into alternative energy sources has been prioritised. Gas is increasingly seen as a less polluting, flexible and affordable, baseload energy option that can be used to expand energy access throughout Africa and complement the renewable energy solutions. The use of coal is largely limited to the Southern Africa region. The phasing out of carbon-intensive energy systems should be a balanced process that considers emissions intensity, pollution generally, and Africa's pressing energy and development needs.

Practical and impactful partnerships may help steer Africa towards a clean energy pathway. Cooperation should be prioritised that aims to increase energy efficiency, diversify energy resources, develop energy production generation, transmission, and distribution infrastructure to build forward and backward linkages through the economic value chains. This includes the skill development of human capital required for the energy transition.

Given Australia's experience in producing energy from gas, it could help Africa develop its gas infrastructure to exploit its vast gas resources. By the same token, given Australia's own experience of reliance on fossil fuels for energy, both African nations and Australia can collaborate to share knowledge and best practices on how best to divest away from carbon-intensive energy and plan for the inevitable stranding of carbon-based assets. Similarly, given Australian businesses' involvement in Africa's extractive industry (oil & gas and mining sectors), Australia can promote the use of clean and efficient technologies and power systems in the continent's extractive industry to reduce the sector's carbon footprint and negative impacts on the environment. Australia could also help tackle Africa's gas flaring issue, which is a detrimental and wasteful practice in oil producing economies (Nigeria, Angola) and perhaps advise on how best to capture the generated gas in the flaring process for productive use of the resource (for example, to generate electricity for surrounding villages and towns).

"The phasing out of carbon-intensive energy systems should be a balanced process that considers emissions intensity, pollution generally, and Africa's pressing energy and development needs."

The most highly developed countries are now finding that, economically and politically, the change to RE is increasingly attractive. Australia, by some measure, is embracing the move to cleaner energy, but in other cases, the availability of coal and gas has been a barrier to a rapid transition. Partnerships and mutual information and technological exchanges can facilitate progress on both continents. New technologies and approaches can, in most cases, be easily transferred to countries and economies in Africa. The leapfrogging of traditional generation legacies and transitions enables the rapid implementation of cleaner and carbon-free energy infrastructure.

Successful implementation and acceptance in African countries, especially in a rural context, can jumpstart local industry and development. By transferring this technology back to Australia, everyone wins.

Climate proofing the investment into energy also implies that the model is resilient to future climate. Robust models can be developed by factoring in both carbon emission reduction to reduce the impacts, but more importantly the future likely scenario changes. Mitigation is facilitated by the phasing out of fossil fuel use in power generation, household cooking and heating, and transport. These are systematic and possibly, programmatic issues that will require massive investment and attitudinal change. By factoring in the inevitable changes, (reduced emissions may improve that), future infrastructural investment should be designed and built to withstand the prospect of increased temperatures, heatwaves, and changing rainfall patterns. The appropriate applications and solutions will vary from region to region, but every investment opportunity must include climate resilience considerations. Best practice techniques and applications can be garnered and applied from numerous sources worldwide.

The knock-on benefits associated leveraging leapfrogging RE technologies are many. Such benefits range from opportunities for small investors, improved health, cleaner air and water, employment opportunities in the manufacturing and maintenance of equipment and infrastructure, and the avoidance of massive infrastructural costs into traditional but inefficient and archaic technology. The Third Commission seeks to illuminate the opportunity of African and Australian institutions collaborating to explore practical examples for Africa to harness the benefits in a way that promotes the creation of new value chains in the energy industry, and job opportunities for youth.

"Successful implementation and acceptance in African countries, especially in a rural context, can jumpstart local industry and development. By transferring this technology back to Australia, everyone wins."

4. Promoting Inclusion

Achieving SDG 7 will have a critical effect on efforts to improve the lives of millions of the most marginalised. These include women and youth, but also most poor populations and those at the forefront of climate change (farmers, pastoralists, fishing communities, etc). Due to their potential application as independent, decentralised, and small-scale solutions, renewable technologies promote more inclusive socio-economic development than traditional fossil fuel-based options. Any serious attempt to overcome marginalisation in energy access must include these technologies as core elements of the transition to new modern energy systems across Africa. Africa's essential advanced RE technologies include modern biomass solutions for cooking and solar installations that play a critical role in providing electricity access for remote off-grid locations and grid-connected applications. Hydroelectricity and wind power also have significant roles to play.[27]

Traditional biomass consumption makes up half of Africa's total energy today, resulting in serious health risks due to smoke inhalation and social disparities, with women and children often responsible for wood collection and cooking. Switching to cleaner cooking systems will have a positive impact on health (particularly of women and children who are the ones most affected by cooking smoke), address gender imbalances, and reduce environmental impacts. IRENA has estimated that a switch to use of modern cooking solutions could result in the population relying on traditional cookstoves declining by more than 60 per cent between 2015 and 2030. Already there have been many and varied successful attempts to introduce cleaner-burning stoves throughout Africa,[28] but there are also records of unsuccessful initiatives.[29] What lessons can be drawn from the failure of some of these initiatives? The health effects of Africa's transition to modern energy systems are significant. The health benefits resulting from indoor air quality improvements because of such a shift would represent global cost savings of between USD 20 billion—USD 30 billion annually by 2030.[30]

[27] IRENA (2015), Africa 2030: Roadmap for a Renewable Energy Future.

[28] https://www.goldstandard.org/projects/cleaner-cook-stoves-rwanda

[29] https://www.washingtonpost.com/opinions/these-cheap-clean-stoves-were-supposed-to-save-millions-of-lives-what-happened/2015/10/29/c0b98f38-77fa-11e5-a958-d889faf561dc_story.html

[30] IRENA (2015), Africa 2030: Roadmap for a Renewable Energy Future.

Given the many stakeholders and factors involved, this transformation cannot be achieved by a top-down approach. A people-centred approach is critical to its success.
The African Renewable Energy Initiative (AREI) is founded on a demand-driven approach with African led mapping and assessment involving multiple stakeholders.[31] However, from the perspective of some civil society organisations, there is a need for a more participatory approach to drive the clean energy transition in Africa. The formulation of energy policies is claimed to be still mainly top-down with little inclusion of the views of civil society, especially women and youth. In that regard, more attention needs to be paid to the aspects of civil society generally, which is becoming more assertive in raising its voice in this area.

"The formulation of energy policies is claimed to be still mainly top-down with little inclusion of the views of civil society, especially women and youth."

In 2018 a coalition of 60 African and international civil society organisations wrote to the President of the AfDB calling for the Bank to dramatically increase its financing for mini and off-grid energy solutions and clean cooking.[32] Attention was drawn to the fact that most of the funding is still targeting large-scale grid infrastructure and that support for clean cooking remains very low. The letter also urged the AfDB to:

1) Dramatically increase resources for distributed renewable energy and clean cooking to reflect their importance in achieving development outcomes;
2) Mandate meaningful civil society participation, which is critical to enhancing outcomes, including in-country strategy development processes;
3) Ensure energy access resources for distributed renewable energy flow to countries with lower levels of energy access and more impoverished communities within states that have relatively higher levels of access;
4) Use all the financial tools at its disposal to support scaled-up finance for energy access through distributed renewables, including guarantees and other risk mitigation instruments; and
5) Build the capacity of local and regional financial institutions to finance energy access solutions.

[31] Africa Renewable Energy Initiative (AREI) (2015), *A framework for transforming Africa towards a renewable energy powered future with access for all*, AREI, http://www.arei.org/wp-content/uploads/2016/04/AREI-Framework_ENG-1.pdf

[32] letter to AfDB decision-makers November 2018

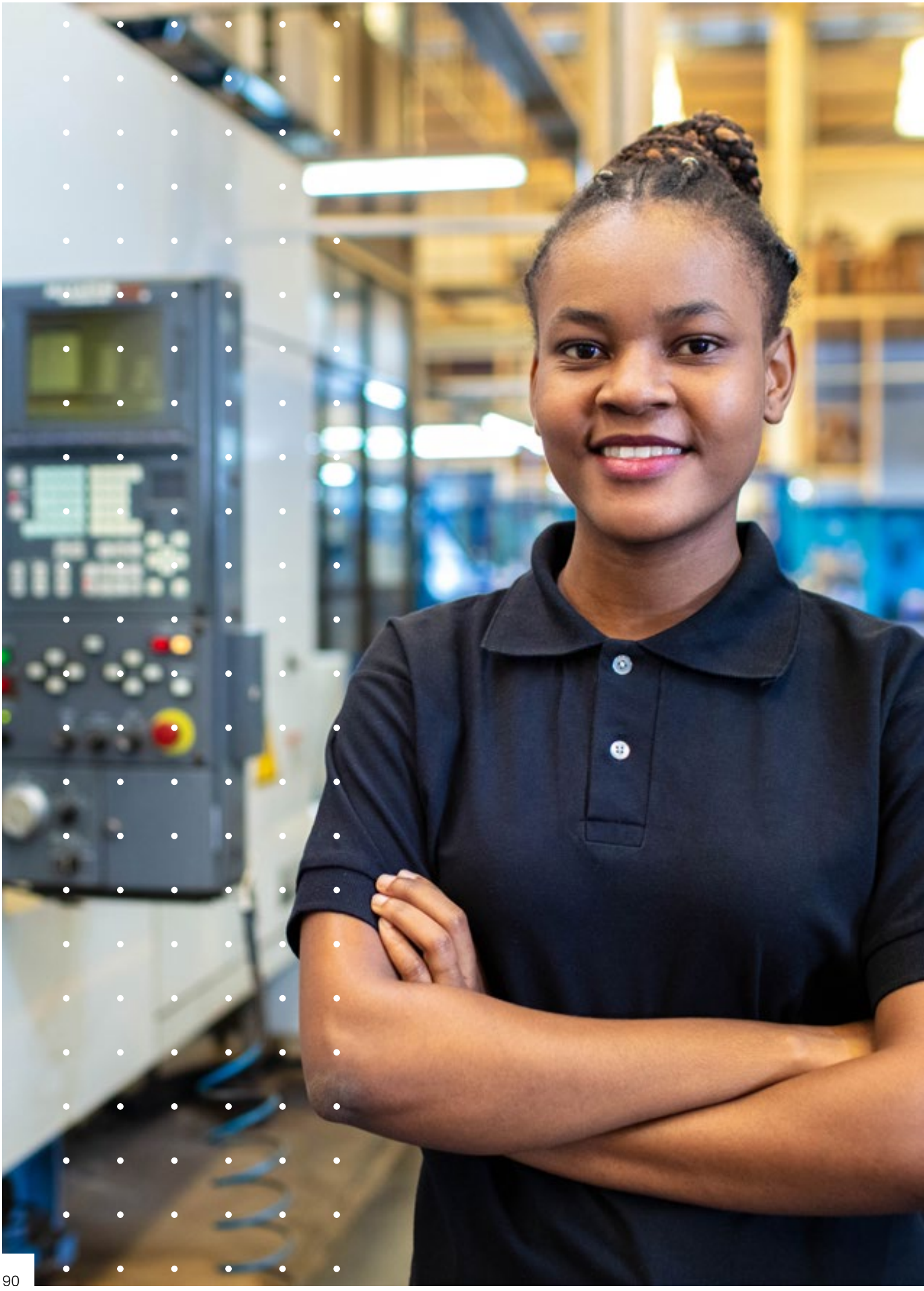
Further research is needed to understand better the perceptions and needs of end-users, as well as their interest and ability to engage with change implementation. Capacity enhancement support to these stakeholders to enable them to play a more significant role, could also usefully contribute to shifting the dynamics of energy policymaking and implementation by allowing these processes to be more inclusive. Schools can become strategic platforms for engaging with the community to promote new technologies. An example is Sunny Money, who run school campaigns for solar lights as a foundational step for establishing markets for solar lighting.

Additionally, improved collection and dissemination of sex-disaggregated data on electricity access could be useful in painting a clearer picture of the gender aspects of improving electricity access for all. Power Africa's Beyond the Grid initiative *2019 Ghana Case Study—Advancing Gender Equality in Africa's Off-Grid Sector* is an excellent example of the type of study that is needed.[33]

The APR 2017 illuminated progress from portable solar solutions to home systems and to mini-grids is anything but linear. For the RE options to be impactful, they need to provide constant, adequate, reliable, and affordable power supply to bring about attitudinal changes because of improved lives and livelihoods. Cheap and low-quality technologies simply erode the trust of users. It is time for Africa to explore RE solutions for sustained productive use, which could bring it a step closer to the clean energy revolution.

"Additionally, improved collection and dissemination of sex-disaggregated data on electricity access could be useful in painting a clearer picture of the gender aspects of improving electricity access for all."

[33] Power Africa BTG Case Study (PDF - 727K)



5. Employment and Entrepreneurship in Decentralised RE and Mechanisation Investments

Increasing the installation of off-grid energy can also have a positive impact on job creation. The Powering Jobs Census[34] undertaken by the Power for All initiative found that the decentralised RE sector was growing fast, creating twice as many informal jobs as the formal sector. Therefore, the industry presents a significant opportunity for stepping up the pace of annual job creation on the continent. This would not only accelerate the pace of transition to more use of decentralised systems across the continent but also provide the jobs for many people that are entering the job market in Africa every year. However, the potential opportunity of the decentralised RE sector to create vast numbers of jobs for women and youth is still mostly untapped. Women currently make up less than a quarter of the official workforce but are often involved in more informal work arrangements making them less visible to formal data collection, financial institutions, and public policymakers. Their increased participation, especially in sales and distribution, can bring many benefits.[35] To ensure the sustainability and broader acceptance of these initiatives and behavioural change, there is need to bring about meaningful change in the livelihoods of the people. Not just in terms of income generation, but also in terms of building the human capital and the value chains (local manufacturing of clean solutions) for the clean energy sector and beyond.

Energy access for agricultural mechanisation is another strategic focus for collaborations between Africa and Western Australia. Agricultural mechanisation has been recognised as an essential part of Africa's development agenda, not only by transforming its agriculture value chains, but also through creating jobs and helping curb migration to urban centres.[36] Agricultural mechanisation can exist in many variations; water pumping, transport, powered hand tools, post-harvest machinery, ICT devices, etc., and the associated energy services and support that enable them. Agricultural mechanisation enables large increases in productivity by replacing human and animal labour components and outmoded technologies. Human and animal labour is fundamentally 'bioenergy' at its most basic, and this energy can be measured in terms of useful output akin to mechanical equipment. For example, the basal metabolic rate of a human adult is generally under 100 Watts. It is the minimum amount of energy required to be alive. Any additional activity requires more energy. The maximum amount of energy that a human can produce physically at any one time is called their 'peak Watts'. Riding a conventional bicycle at around 20 km/hr (a medium level activity) will use on average around 100 Watts of energy in addition to the basal metabolic rate. Whereas jogging or riding up a steep hill can require around 300 or more Watts above the minimum, depending on the fitness and strength of the individual. At the extreme, the peak Watts a trained professional sprinter can sustain is generally between 1,000 and 2,000 Watts for only a few seconds.[37] Assisting or substituting human and animal energy output with alternatives has many obvious benefits, but also less obvious ones.

"Women currently make up less than a quarter of the official workforce but are often involved in more informal work arrangements making them less visible to formal data collection, financial institutions and public policymakers."

[34] Power for All. Powering Jobs Census https://www.powerforall.org/resources/research-summaries/research-summary-jobs-decentralized-renewables-and-energy-transition

[35] Power for All. Powering Jobs Census.

[36] The Malabo Montpellier Panel (2018), *Mechanized Transforming Africas Agriculture Value Chains*, https://www.mamopanel.org/media/uploads/files/MaMo2018_Mechanized_Transforming_Africas_Agriculture_Value_Chains.pdf

[37] McHenry MP, Doepel D, de Boer K & Zhou E (2015) Co-production of high-protein feed and bio-oil for poultry protein productivity and fuel switching in Mozambique: avoiding transesterification and food insecurity. In: Agriculture management for climate change. Eds. McHenry MP, Kulshreshtha SN & Lac S. Nova Science Publishers. ISBN 978-1-63483-026-3.

By viewing agricultural mechanisation in terms of pure energy enables direct comparisons between the utility of various production systems and technologies. This includes the substitution of some human and animal labour with power from other options, but also an understanding of the equivalence of energy embodied in crops and food/feed compared to other forms of energy. For example, capturing sunlight over a one square meter area using a photovoltaic panel produces around the same amount of energy as one farm labourer hoeing or operating a manual hand pump. Such output represents much more energy from that land than can be grown using plants for feeding workers and animals. Furthermore, 'back-breaking' work at high peak Watts can result in physical injury. However, power tools and power-assist devices can both prevent damage (if used safely) and enable longer working hours or higher rates of output, while reducing the need for conventional food/feed inputs in the system. The questions of what level of mechanisation and what technologies to adopt is a salient one. The answers will depend on the evolution of technology and knowledge, and the relative costs compared to their benefits and value within the system in question. A broad overview of agricultural mechanisation specific to African regions, including policy and best practice recommendations, is provided in the report by the Malabo Montpellier Panel.[35] They include examples of successful adoption in African countries of new irrigation technologies, efficient post-harvest processing, renewable-based crop storage and preservation, motorised transport, and two-wheel tractor innovations. Furthermore, The Third Commission believes there are a plethora of opportunities to adapt and/or electrify many conventionally fuel-powered or other expensive machinery. Examples of such transformation include small hand-powered tools from the global hardware sector, and also advancing the evolution of two-wheel tractors themselves and their associated components, implements, and applications. Local production of such equipment is likely to promote the uptake of such technologies while creating employment opportunities. But beyond mechanisation, the partnership should consider the possibility of promoting the agroprocessing value chain, which could meaningfully change the sector and the lives of the people living in rural areas.

[35] Power for All. Powering Jobs Census.

Considering the growing technical requirements of occupations surrounding energy services and mechanisation within agriculture, significant investment will need to be made in capacity building to train a new generation of energy sector workers. Training in the sector should focus on deployment, installation, and maintenance of off-grid systems, and their applications in the rural sector. Local innovation to determine agricultural power tools and implements that enable productivity and profitability improvements using appropriate and affordable technologies and service support networks are crucial to sustaining ongoing investment. The establishment of mentorship programmes, training, R&D, matching entrepreneurs, technology companies, and researchers in Africa with Australian and global counterparts could be an effective means of capacity building in the sector for appropriate mechanisation that is economically and socially attractive. There are countless examples of proven, simple, and cost-effective technologies and useful knowledge and/or advice that are suitable for rapid adaptation and adoption into new agricultural systems globally. The growing choice of global collaborations available to African nations has never been more diverse or exciting in terms of exploring new ideas, technologies, systems, markets, cultures, and investments.

"To ensure the sustainability and broader acceptance of these initiatives and behavioural change, there is need to bring about meaningful change in the livelihoods of the people."

6. Productive Use of Energy (PUE)

Given the ability of off-grid RE applications to reach millions currently without energy services, there has been growing interest in Productive Use of Energy (PUE), and of renewable energy (Productive Use of Renewable Energy, or PURE).[38] Several researchers and institutes have offered definitions of the concept. The Global Environment Facility (GEF) and UN FAO define a PUE as "one that involves the application of energy derived mainly from renewable resources to create goods and/ or services either directly or indirectly for the production of income or value." Other definitions highlight that PUE is "agricultural, commercial and industrial activities involving electricity services as a direct input to the production of goods or provision of services."[39] Similarly, PURE has been defined as "agricultural, commercial and industrial activities, powered by renewable energy sources, which generate income."[40] Many definitions distinguish between 'productive' as opposed to 'consumptive use' of energy, and the delineation is not always simple. It is argued that many uses that are viewed as consumptive such as lighting and access to information (TV and the Internet) contribute to economic development. Whilst many practitioners acknowledge that there is a link between the uses that are often deemed consumptive and economic development, they point out that the linkages are less obvious and difficult, if not impossible, to quantify.[41] The varying definitions of PUE lead to different judgements by development practitioners on what to prioritise, implement and measure when carrying out PUE promotion projects.[42]

[38] EnDev (2021) – Productive Use of Energy: Moving to Scalable Business Cases. Available at: https://endev.info/wp-content/uploads/2021/03/EnDev_Learning_Innovation_PUE.pdf [accessed from the web 13 August, 2021]

[39] GIZ and EUEI PDF, Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners:

[40] David Lecoque (ARE), Marcus Wiemann (ARE), (2015). European Union Energy Initiative Partnership Dialogue Facility.

[41] Ibid at 1

[42] Ibid at 3

6.1 Productive Uses of Energy in Rural Areas

Much attention has been paid to PUE and rural development. Aside from raising rural incomes, modern energy services increase other informal aspects of rural incomes by reducing the amount of time spent on activities in rural areas.[43] Based on market experience, 'productive use' businesses in rural areas often fall into one of the following categories:[44]

- **primary industries (e.g., agriculture, fishing, forestry and mining)**
- **light manufacturing (e.g., carpentry, welding and icemaking)**
- **commercial and retail enterprises (e.g., phone charging, eateries, grocers and hair salons).**

Interventions to improve PUE in a rural community must consider existing local and imported production, and the business interests of local entrepreneurs. What are the resources entrepreneurs need to succeed in their local markets, as well as what investments would be financially sound considering expected cashflows? This entails a thorough consideration of the local entrepreneurs' businesses, including the amount and quality of their products and services, the time spent on production and services, to revenues and costs (including energy costs), supply chain strategy, local access to markets, and market prices.[45] In this regard, participation of the local community in PUE programmes and projects is crucial with targeted consultation to understand the local needs, preferences, and increase the social acceptability of such interventions.[46]

Several barriers remain to the widespread private investment in conventional or RE services for productive use in rural areas. Well known barriers of limited capital and access to credit, particularly for rural women is widespread in PUE entrepreneurship. Solutions include PUE developers establishing their own financing schemes (concessionary loans or grants to bridge the finance gap), direct financing to the enterprises/end-users or through local financial institutions, or distribution companies/suppliers of appliances, including 'pay as you go' (PAYG) arrangements. Therefore, facilitating new technology uptake through provision of credit and appliance distribution is critical in increasing PUE demand in rural areas.[47] Recent research conducted by the Minigrid Innovation Lab found that the average income per customer increased steadily to 18 per cent above baseline levels within one year after the introduction of provision of appliances. This indicates that making appliances available addresses the challenges of increasing electricity demand and increasing supply in tandem while delivering productivity gains.[48] This strategy is 'tried and true' and is reminiscent of a Sears catalogue in 1917 in the United States where customers were exhorted to "Use Your Electricity For More Than Light."[49] Sustainable revenue models in rural communities is a key challenge for the microgrid sector,[50] and if PUE accounts for the majority of demand for electricity in a location it can underpin investment in microgrids.[51]

Skills and local business development are a critical component of PUE projects, and training operators to install, operate, and maintain the energy technologies reliably is key. Project developers, NGOs, and local associations can play an important role in this regard. Cooperation and the sharing of 'best practices' is an important part of training and capacity building, and should ideally occur on multiple levels (social, political and industrial). Examples include the Africa-EU Energy Partnership (AEEP) and the Africa-EU Renewable Energy Commission (which are supported by the European Commission and the African Union Commission). At the industry level, well established associations such as Alliance for Rural Electrification (ARE) have an important role in sharing knowledge, experience and 'best practices.'[52]

Several successful productive use energy projects have been implemented in Africa that evidence the importance of a holistic approach that combines financing schemes, market approaches, capacity building and participation of the local community. For example, Energising Development (EnDev), a multi-donor programme managed by GIZ and the Dutch agency Netherlands Enterprise Agency (RVO), initiated a programme whose key objective is to provide modern energy services for productive uses in agriculture and small-scale manufacturing in Ghana. The programme has four components: grid electricity for irrigation; solar pumps for irrigation; improved cookstoves, and; monitoring of electrified light industrial zones. The programme enables access to energy through subsidies for grid connection or finance for purchasing decentralised RE systems. The programme also pursued a market-based incentive scheme that supports 300 small-scale agriprocessors to access institutional cook stoves. Furthermore, EnDev connected with local business associations and government authorities to establish communications channels, provide business development services, as well as technical support and training to farmers utilising grid electricity and solar systems.[53]

[43] Kapadia, K (2004). Productive Uses of Renewable Energy – A Review of Four Bank-GEF Projects.

[44] Booth, S, Li, X, Baring-Gould, I, Kollanyi, D, Bharadwaji, A, Weston, P. (2018) Productive Use of Energy in African Micro-Grids: Technical and Business Considerations. USAID – NREL. United States.

[45] Ibid

[46] David Lecoque (ARE), Marcus Wiemann (ARE), (2015). The productive Use of Renewable Energy in Africa.

[47] Powering Productivity

[48] See Minigrid Innovation Lab, (2019) available at https://energy4impact.org/publications

[49] Luiz Fernando Teles Marretto *Electric Lighting History* available at https://www.academia.edu/27343072/Electric_Lighting_History

[50] Productive Use of Energy in African Micro-Grids: Technical and Business Considerations.

[51] Ibid

[52] See for example, Marcus Wiemann, Ling Ng, David Lecoque (2014) Best Practices for Clean Energy Access in Africa. Alliance for Rural Electrification. European Union Energy Initiative Partnership Dialogue Facility.

[53] See https://endev.info/wp-content/uploads/2021/05/EnDev_Closing_brochure_Ghana.pdf

6.2 Productive Use of Energy among the Urban Poor

The great majority of people without access to modern energy services in Africa are in rural areas, and so has the focus of PUE literature and interventions thus far. However, despite geographic proximity to improved electricity network and other energy supplies, the urban poor also lack energy services,[54] and urban and peri-urban energy poverty has been under-researched.[55] According to UN Habitat, as of 2018 at least 370 million people were living in slum or informal settlements across SSA.[56] Informal settlements within rapid urbanisation and population growth is outpacing the construction of adequate housing and provision of basic services, including electricity.[57] In general, electricity access in slums and informal settlements tend to be good in comparison to national averages. For example, selected slums in Ghana exhibited a high access of 88 per cent, relative to the national average of 66 per cent.[58] Similarly, in one informal settlement in Mozambique, it was revealed that electricity access was reasonably good with 70 per cent connected to the grid. However, many connections in informal settlements are illegally connected to the grid, including almost half of the Ghanaian example above.[59] Likewise, Kenya's largest informal settlement in Kibera houses a majority of people with either illegally connected or tapped electricity from a single point.[60] The majority of people living in informal settlements are economic migrants that play a significant role in the urban economy.[61] Despite their importance—as they are viewed as 'squatters' with no legal rights to their homes—there are very few targeted policies to increase access to modern and clean energy services. Most enterprises operating in informal settlements are energy-dependent, and use several sources of energy, including firewood, charcoal, LPG, electricity, gas oil, oxyacetylene gas, kerosene, petrol, diesel, and candles.[62]

Given the importance of access to energy in the sustainable reduction of poverty, policy formulation and implementation must ensure that energy resources are not only available but accessible, affordable, and acceptable to the user. Proposed interventions to develop PUE enterprises within informal settlements will require collaboration for many actors in relation to policy, accessing finance, modern safer technology selection, reducing illegal connection, and increasing revenues for energy utilities and service providers. In parallel, energy service providers in urban informal settlements should consider that informal settlers often have a high propensity to save, and there is a corresponding potential to cost-effectively deploy safer and modern options to the urban poor. Pay As You Go (PAYG) models for energy service providers deploying solar photovoltaic home systems, microgrid installers/operators, and mobile phone service provision is a viable option to bridge the energy service gaps. Furthermore, informal settlers often placed their savings with formal financial institutions, and it is an option that they may explore the possibility of accessing credit facilities from their own bank.

> **"Informal settlements within rapid urbanisation and population growth is outpacing the construction of adequate housing and provision of basic services, including electricity."**

[54] Vanesa Castán Broto, Lucy Stevens, Diana Salazar. (2015). Energy Access and Urban Poverty poor people's energy briefing 4.

[55] Ibid

[56] UN Habitat https://unstats.un.org/sdgs/report/2019/goal-11/

[57] Ibid

[58] ESMAP (2011) Energy Access and Productive Uses for the Urban Poor.

[59] ESMAP (2011) Energy Access and Productive Uses for the Urban Poor.

[60] S. Karekezi, J. Kimani, O. Onguru (2008) Energy Access among the Urban and Per-Urban Poor in Kenya Global Network on Energy for Sustainable Development (GNESD) "Urban and Peri -Urban Energy Access" Working Group.

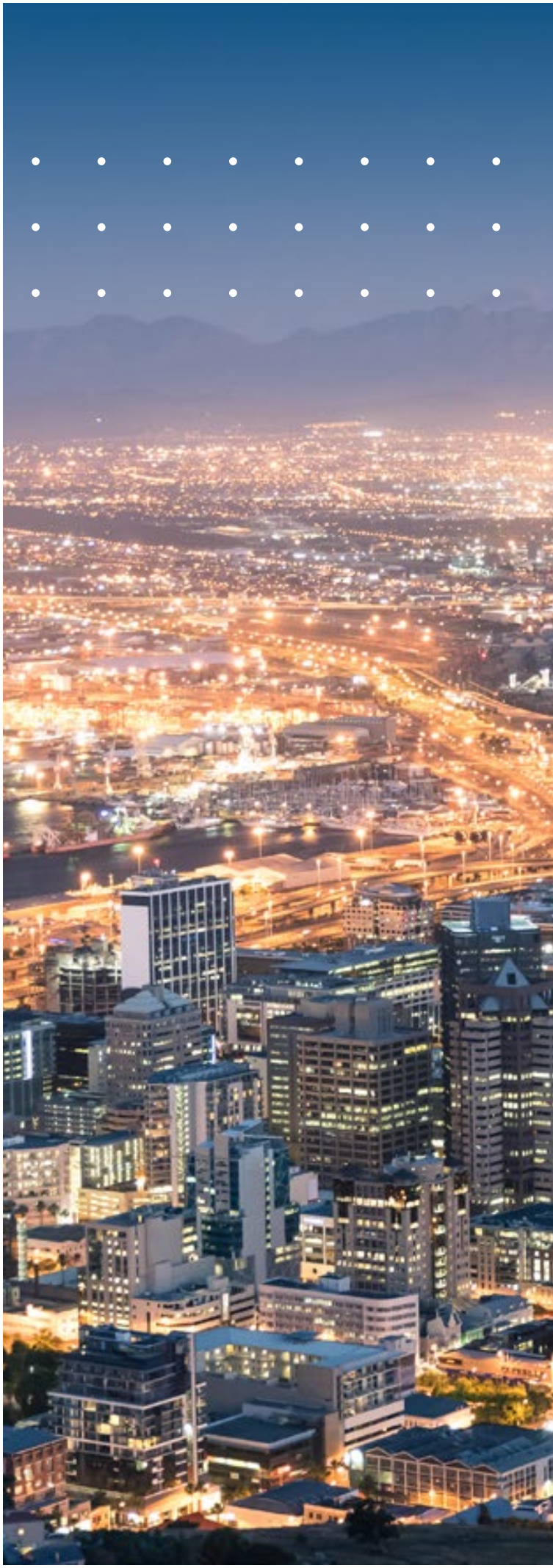
[61] Ibid

[62] ESMAP (2011) Energy Access and Productive Uses for the Urban Poor, Productive Uses of Energy in Enterprises in Slums in Ghana.

6.3 Productive Use of Energy Amongst Commercial and Industrial (C&I) Clients

PURE in connection with large African commercial and industrial businesses has been developing rapidly.[63] BloombergNEF (BNIF) undertook a study to assess the potential and target markets for solar technologies for commercial and industrial (C&I) clients in SSA and found onsite solar production is cheaper than paying electricity tariffs in 7 out of 15 markets that were surveyed.[64] The largest C&I customers for onsight solar production (outside of South Africa), was the manufacturing sector (20 per cent), followed by public buildings (16 per cent), and offices (15 per cent).[65] The majority of the systems had been financed through private funds due to attractive economics alone, and without assistance of the financial sector services or regulatory support.[66] C&I solar developers expressed that regulatory change should concentrate on better enforcement of existing duty and tax exemptions on solar modules, as import taxes and fees can reportedly add approximately 50 per cent to the retail cost of solar systems (even when assembled locally), due to high customs, VAT, and local taxes.[67] For greater encouragement of C&I businesses to adopt the benefits of PURE investments, increased awareness, availability of data, and improved policy implementation will be required.

At present the C&I solar market in SSA is largely driven by competitive economics and unreliable grid connections rather than support mechanisms. Smooth integration of PURE systems can balance network energy demand, improve network reliability and power quality.[68,69] Smart metering and two-way information sharing of energy flows and prices in real time enables collection of significant data enabling additional technical investment and policy innovation.[70,71] With new data from smart metering investments, African governments could judiciously utilise net-metering programmes and tariff structures to allow exporting of excess energy produced, in addition to market mechanisms that value and invest in improved network reliability and power control.



[63] ResponsAbility and BloombergNEF (2019), "Solar for Businesses in Sub-Saharan Africa" *24 January 2019.*

[64] Ibid

[65] Ibid

[66] Ibid

[67] Tralac, (2020) Road to Nigeria's Economic Recovery, 2020.

[68] Frost & Sullivan (2018). "Digitization of Energy Transmission & Distribution in Africa - The Future of Smart Energy in Sub-Saharan Countries" 2018.

[69] Ibid

[70] Ibid

[71] Ibid

"With new data from smart metering investments, African governments could judiciously utilise net-metering programmes and tariff structures to allow exporting of excess energy produced, in addition to market mechanisms that value and invest in improved network reliability and power control."

7. Renewable Energy and Large-scale Industrialisation in Africa

The critical role of energy in industrialisation has long been recognised, and the interdependence of energy and industrial development is a chief driver for energy policy and energy infrastructure planning for many countries, both developed and developing.[72] The UN General Assembly recognised the importance of energy to industrialisation and development and meeting several SDGs.[73] The International Energy Agency (IEA) noted that "Historically, the pathway to economic growth has largely been a consequence of a shift away from an agrarian based economy towards industrialisation and a knowledge-based economy. Such structural changes in an economy in turn change its patterns and levels of energy consumption and shift the types of fuels and energy technologies it utilises. Economic and social development thus tends to go hand-in-hand with energy sector transformation."[74] Understanding the linkages between energy consumption, economic growth, and sustainable development is crucial in formulating sound and sustainable energy policies.[75]

There is a strong interest in an inclusive and 'green' transformation of African industrial development. Agenda 2063 of the African Union (AU) demonstrates African governments' determination to achieve structural transformation to increase industrialisation, develop modern and productive agriculture, and increase investment in science, technology, and innovation.[76] The African Development Bank Strategy 2013-2022 also aligns closely with the green growth agenda, with the central objectives of promoting inclusive growth and the transition to green growth.[77] There are a number of reasons why accelerated green growth is considered important for African economies. Despite the heterogeneity of African economies, many African economies face several common challenges that dictate their economic options and contribute towards their drive for green growth. Firstly, agriculture contributes significantly to, and dominates, most African economies, and therefore, domestic producers need to be able to meet the growing demand for a diverse urban food supply. In building Africa's industrial sector, expanding agri-food processing is impracticable without concurrently building more sustainable management of environmental assets (soil, water and biodiversity – see Chapter 1) that are a requisite for agricultural growth.[78] Secondly, a number of African national economies heavily rely on the extractive industries and other commodities,[79] and expansion of the natural resources sector has important green growth linkages. However, many extractive industries directly create and enable downstream pollution detrimental to health, wellbeing, and the environment. Therefore, industrialisation policies will need to cater for the accelerating demand for a greening and modernisation of extractive sector activities and supporting infrastructure.

"Agenda 2063 of the African Union (AU) demonstrates African governments' determination to achieve structural transformation to increase industrialisation, develop modern and productive agriculture, and increase investment in science, technology, and innovation."

[72] Okorie, Maduako & Inambao, F. & Chiguvare, Zivayi & Alfeus, S. (2018). Renewable energy and African industrialization: A participatory integrated approach in assessing concentrated solar power potential in Namibia. International Journal of Mechanical Engineering and Technology. 9. 509-524.

[73] See https://sdgs.un.org/goals

[74] International Energy Agency. WEO2017 Special Report Energy Access Outlook. International Energy Agency, Paris, France, 2017.

[75] Okorie, Maduako & Inambao, F. & Chiguvare, Zivayi & Alfeus, S. (2018). Renewable energy and African industrialization: A participatory integrated approach in assessing concentrated solar power potential in Namibia. International Journal of Mechanical Engineering and Technology. 9. 509-524.

[76] UNECA (2016). Greening Africa's Industrialization. Economic Report.

[77] AfDB Strategy for 2013–2022 - At the Center of Africa's Transformation available at: https://www.afdb.org/sites/default/files/documents/publications/afdb_strategy_for_2013-2022_-_at_the_center_of_africas_transformation.pdf

[78] UNECA (2016). Greening Africa's Industrialization. Economic Report.

[79] Ibid

7.1 Renewable Energy, Baseload Electricity, and Industrialisation

It is often argued that large-scale electricity systems cannot be based upon renewable sources of generation as they are 'intermittent' and cannot provide 'baseload' power.[80] Baseload power refers to the minimum amount of electric power needed to be supplied to the electrical grid at any given time. As the electricity demand varies over time (but never drops to zero), there is a minimum load, which is often termed baseload.[81,82] Therefore, 'baseload' is a characteristic of electricity demand, not supply.[83] Historically, baseload electricity has been supplied from large hydro, geothermal, coal, gas, and nuclear generation.[84] It is misleading that many of the intermittent RE generation technologies cannot supply baseload demand.[85] Further, providing baseload power with a single large generator of any technology type should not be a sought objective, particularly in terms of reliability and redundancy in case of generator failure. The prime objective should be to supply all electricity loads, from baseload to peak loads, in the most reliable and cost-effective manner. No electricity generation technology can always operate, and no single technology can perfectly supply all the changes in load from second to second, as each technology type has limitations. High generator capacity factors at cost effective operational outputs that do not overproduce and waste excess energy enables electricity producers to efficiently supply load demand.[86]

Over time newer technologies, storage, and demand-side approaches have enabled better matching of variable loads with scheduled and intermittent electricity generation sources.[87,88] It is even argued that baseload is not a requirement for a reliable energy system and that a 100 per cent renewable energy system is feasible and can be achieved by shifting from a 'baseload and peaking' supply to a 'variable and dispatch model',[89] with the variable renewables such as solar and wind supplying the majority of demand, and dispatchable renewables flexibly supplying relatively rapid changes.[90] A diverse portfolio of renewable generation and demand-side management is important for a reliable, flexible, and cost-effective electricity network.[91]

Despite the potential for renewable energy as the foundation for industrialisation, many African nations are planning additional coal-fired generation capacity.[92] This provision of additional coal resources is primarily due to perceived low cost and historical legacy of coal-based technology enabling industrialisation. Given that the lifespan of a coal-fired generator is between 30 and 50 years, new coal-based capacity will either 'lock in' African countries emissions of GHG and other related pollution, or risk premature decommissioning given the current global economic, technological, and policy landscape.[93] Furthermore, given the importance of China's 'Belt and Road Initiative' and power infrastructure delivery, greater attention also needs to be given to the non-coal elements of those infrastructure positioning.[94] Globally advances in electricity network design are increasingly focusing on the inclusion of massive amounts of variable decentralised sources from private PV installation leading to the concept of a Virtual Power Plant that increasingly will struggle to incorporate traditionally built and connected coal-fired power generation.[95]

[80] Diesendorf, M. (2007). The Base-Load Fallacy. ANZSEE Solar 2007 Conference, Alice Springs, October.

[81] IRENA (2015). From Baseload to Peak: Renewables Provide a Reliable Solution. IRENA Working Paper 2015.

[82] Ibid

[83] Ibid

[84] Matek, B and Gawell, K. (2015). The Benefits of Baseload Renewables: A Misunderstood Energy Technology. Elsevier Inc.

[85] See Diesendorf, M. (2007). The Base-Load Fallacy. ANZSEE Solar 2007 Conference, Alice Springs, October, Matek, B and Gawell, K. (2015). The Benefits of Baseload Renewables: A Misunderstood Energy Technology. Elsevier Inc.

[86] Ibid

[87] IRENA (2015). From Baseload to Peak: Renewables Provide a Reliable Solution. IRENA Working Paper 2015.

[88] Ibid

[89] There are two different categories of renewable power generators: dispatchable and variable. Dispatchable renewable power generators control their output within a specific range in a similar manner to conventional fossil power plants whilst the output of variable renewable power sources is much less controllable. Dispatchable energy includes geothermal energy, biomass, tidal, reservoir hydropower plants and concentrated solar power plants with thermal storage. Variable renewable energy includes solar photovoltaics and wind.

[90] See WWF. (2016). Beyond Baseload: 100% Renewable Energy in Australia. WWF June 2016.

[91] Energy and Environmental Economics, Inc., (2014). Investigating a Higher Renewables Portfolio Standard in California: Executive Summary. San Francisco. Accessible at https://www.ethree.com/documents/E3_Final_RPS_Report_2014_01_06_ExecutiveSummary.pdf

[92] The Economist (2019). African Countries Plan to Build Dozens of Coal-Fired Power Stations. Accessible at https://www.economist.com/middle-east-and-africa/2019/07/25/african-countries-plan-to-build-dozens-of-coal-fired-power-stations .

[93] Jain, Prem (2017) "Coal Power in Zambia: Time to Rethink," *Southern African Journal of Policy and Development*: Vol. 3 : No. 2 , Article 6. Available at: https://scholarship.law.cornell.edu/sajpd/vol3/iss2/6

[94] Boqiang Lin, François Bega, (2021) China's Belt & Road Initiative coal power cooperation: Transitioning toward low-carbon development, *Energy Policy*, Volume 156,112438, ISSN 0301-4215, https://doi.org/10.1016/j.enpol.2021.112438.

[95] Bhuiyan, E. et al. (2021) Towards next generation virtual power plant: Technology review and frameworks Renewable and Sustainable Energy Reviews Volume 150, October 2021, 111358 https://doi.org/10.1016/j.rser.2021.111358.

An African Agricultural Revolution – A Power Perspective

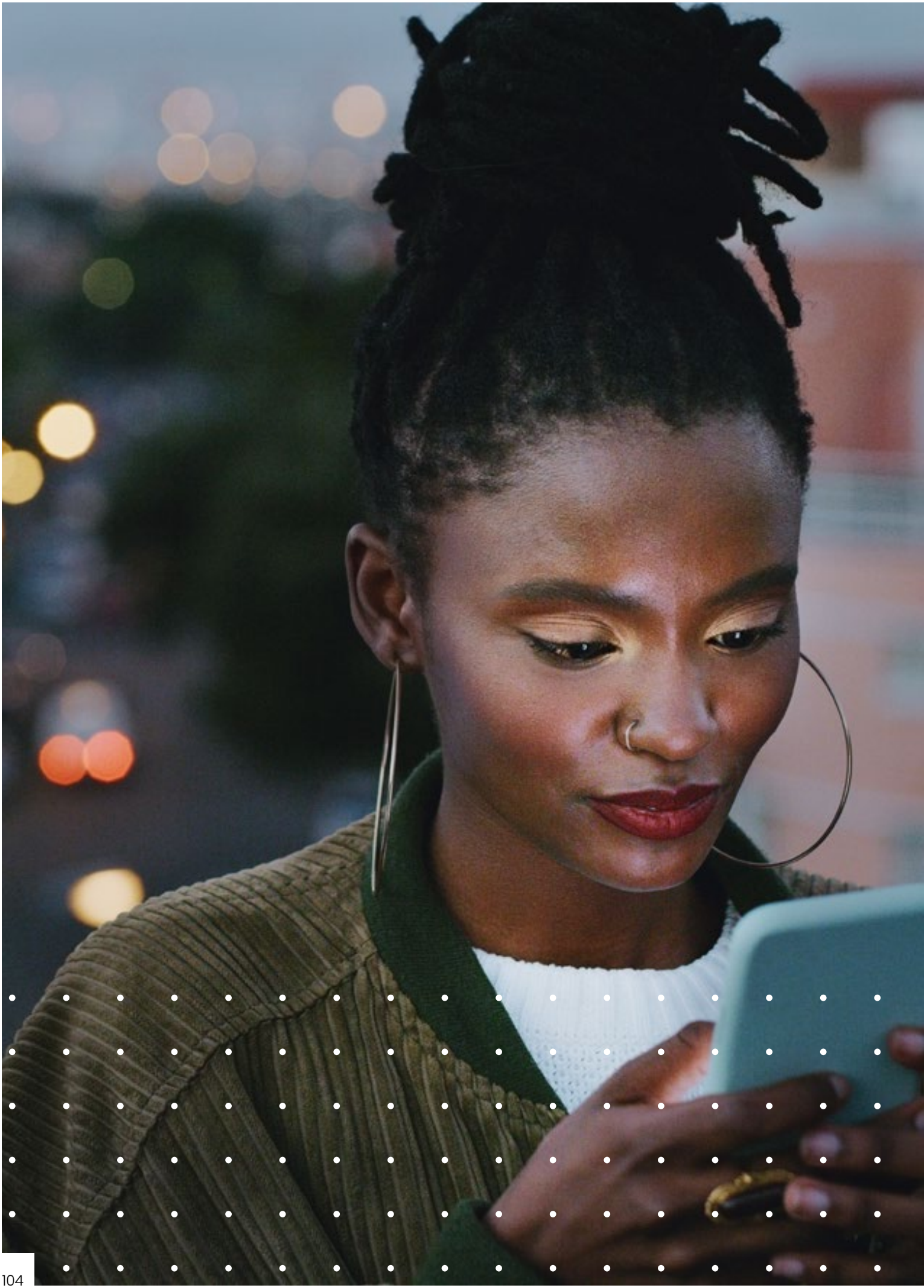
Historically, agriculture in Africa has had a dual nature. Energy provision and use has been a central factor in both. The agricultural economies of most African countries consist of a commercial sector and a smallholder sector, often subsistence. Commercial farms occupy most of the agricultural land in South Africa, Namibia, and Zimbabwe, with increasingly more significant percentages in other countries. Still, millions of smallholder or household farmers occupy the remaining land. Typical constraints to thriving small-scale and emerging commercial agriculture include lack of access to finance, challenges regarding land governance in the communal areas, access to water, the need for effective extension services, and poor infrastructure, such as roads, lack of energy/electricity and access to markets. These challenges need to be rapidly overcome to spur significant increase agricultural productivity and food production.

At the same time, new and existing climate risks must be considered.[96] One of these is the use of conservation agriculture techniques such as minimal or no-till methods, intercropping (mixing crop types in one field) and cover cropping (introducing alternative crops in successive years on the same field). These techniques conserve soil moisture, encourage soil health and may reduce dependence on fertiliser and herbicides. However, until conventional commercial farmers widely implement these techniques, uptake amongst small-scale farmers will remain low. One reason is that specialised equipment is required to adopt the new methods and energy is required to power this equipment. When no-till or minimal till is applied, there is no longer any need for deep ploughing, and instead, special seeding implements that inject seed and fertiliser are used as well as "light touch' soil cultivation for horticulture. The design, manufacture and application of these new implements is both a barrier and an opportunity for the new agricultural revolution in Africa underpinned by a green energy revolution. The obstacle is the lack of availability and the resultant high expense of the equipment, but the opportunity is the possibility of manufacturing this equipment locally. Many African countries, because of their competitive labour market, attract investment for the manufacture and assembly of motor vehicles and similar equipment, and the mushrooming demand for conservation agricultural equipment offers an opportunity for investment and growth of this market. Australia can provide invaluable advice and skills in this effort.

Finally, the uptake and adoption of a more sustainable agricultural system will enable better soil conservation, higher yields, more effective use of water and energy, and thus reduce carbon emissions. These reductions, through global carbon pricing and marketing systems, can offer significant financial rewards to practitioners. Particularly for those who are not yet locked into high-input agricultural systems, and who are flexible enough to change or modify their agrarian techniques to adopt sustainable and low carbon practices.

All these potential developments can only be enabled by affordable energy availability. The known historical mistakes of inappropriate energy, other inputs, and practices that pollute and degrade our air, lands, water, and ecosystems undermine the ability of an agriculturally dominated economy to grow and sustain itself towards economic diversification. The Third Commission urges more active, collaborative, interdisciplinary engagement from such a diversity of sectors (energy, ICT, manufacturing and agriculture), intersections and nexus areas to identify suitable technology and knowledge, capacity building collectively, and policy interventions.

[96] Johnston, P (2019) Farming in South Africa is under threat from climate change. Here's how. *The Conversation*. https://theconversation.com/farming-in-south-africa-is-under-threat-from-climate-change-heres-how-125984



8. Boosting Off-Grid Investment

Accelerated action is needed to support the energy transformation with a focus on shifting towards a more decentralised energy system through new infrastructure investment, deployment of more innovative technologies, the application of new business models, and development of new energy markets.[97] The annual global financing needs to provide electricity for all by 2030 is estimated at US$52 billion per year, which is more than double the level mobilised under current and planned policies. Most of the additional funds, an estimated 95 per cent, will need to be invested in Africa.[98] However, investment in off-grid renewables remains below levels needed to accelerate the energy transformation. To take one example, an independent 2018 study of the New Deal for Energy in Africa, found that while the AfDB's total energy access financing approvals had increased from 11 per cent to 66 per cent between 2014 and 2017, the share of the Bank's finance for off-grid and mini-grid projects had risen at a much smaller rate from 3 per cent to 6.6 per cent of energy approvals during this period.[99] As a result, the AfDB is off track to meet its own new "light up and power" Africa commitments to deliver 75 million off-grid connections by 2025.[100]

The reasons for this include the lack of a genuinely enabling global environment to support the scaled-up rollout of off-grid technologies. Persistent policy, financial and technological challenges remain. These prevent the inclusion of significantly more renewables in the global energy mix. Enhanced international collaboration in sharing good practices in the deployment of new technologies is key to attracting the increased investment necessary to achieve SGD 7. In Lights, Power, Action, the APP noted that the energy transitions would be faster and cheaper if investment climates and policy frameworks were significantly more supportive of the integration of centralised and decentralised energy. IRENA also urges the creation of dedicated policy and regulatory frameworks for the off-grid market to "incentivise the private sector, foster innovative business and financing models and create enabling conditions for deployment."[101]

"The annual global financing needs to provide electricity for all by 2030 is estimated at US$52 billion per year, which is more than double the level mobilised under current and planned policies."

[97] IRENA (2015), Africa 2030: Roadmap for a Renewable Energy Future.
[98] IEA, *Energy Access Outlook* (2017) www.iea.org/energyaccess
[99] Oil Change International, Friends of the Earth U.S. (2018), "*The African Development Bank and Energy Access Finance in Sub-Saharan Africa*".
[100] African Development Bank 2015 New Deal on Energy for Africa.
[101] IRENA (2015), Africa 2030: Roadmap for a Renewable Energy Future.

Retaining a focus on building centralised high voltage electricity systems at an industrial-scale and expense contrasts starkly against the needs of energy-efficient portable devices, vehicles, and electronic goods that underpin a modern rural agricultural economy. The advantages of mobile devices include their built-in storage, enabling a revision of more appropriate electricity system investment models for both regions with and without a conventional historical electricity network. For example, the rapidly advancing hybrid-electric, full electrification, and automation of large and small vehicles have revised assumptions of geographical demand clustering and energy supply projections from the transport sector. The vast majority of these vehicles will either be work-charged (fleet vehicles) or home-charged (privately owned). There will be a rapid revision of what electricity networks are expected to provide cost-effectively and when with particular challenges in non-urban centres to ensure energy supply and convenience. Such a change presents the opportunity to engage the information and communication technology (ICT) and other non-energy sectoral investors as major new private investors in rural energy services and infrastructure.[102] In many jurisdictions globally, electricity supply companies (network operators and retailers) are investing in electric vehicle charging infrastructure as they recognise, they will be a major financial beneficiary of the electrification of transport. Vehicle electrification is in its infancy in Africa but offers a large new source of revenue for electricity companies, enhances their ability to control large new loads, and better manage high penetrations of renewable energy generation. It is also pertinent to the progress and development of this technology that electricity for recharging vehicles is sustainably generated. For example, fossil fuel-powered electricity generation to charge electric cars would be very counterproductive.

The lack of parallel advancements in energy policy and pricing mechanisms alongside the technological advancements are stifling new investment in a diversity of new solutions.[103] Energy storage systems are still expensive by Africa's standards. In addition, maintenance and related costs should be taken into consideration. The growing plethora of advancements in power electronics and electricity storage will only be harnessed if policymakers, electricity utilities, and markets attempt to distribute the costs and benefits of new technology.

Recent advances in distributed ledger technology (of which blockchain is a specific example) show great promise as enabling technology for the collection and distribution of payments in micro-grid environments. Power Ledger in Western Australia is one such example.[104,105] Solutions such as these solve the issues of micro-generation (measured in Watts and not kiloWatts) and allow for a robust tokenonomic model built that could work at a village/community level.

There is a need for advancing partnerships with existing micro-finance institutions to assist families and small businesses with investments in their energy infrastructure. Fostering revolving funds, community savings groups, as well as PAYG schemes for power and lighting, also can help to improve the affordability of energy access. Examples of existing off-grid electricity providers with flexible and PAYG credits schemes include Sun King from Greenlight Planet, M-Kopa Solar, Zola Electric, SolarNow, and Juabar.

Ideally, these new investments in energy infrastructure will be based on a sound commercial footing as a foundation for ongoing demand, maintenance, and re-investment, particularly in rural agricultural regions. Environmental concerns would also be paramount. A range of crosscutting policy instruments is required to catalyse increased energy investment from the private sector. Actions to further boost financing in the off-grid market include the removal of tariffs and barriers to accelerate the introduction of off-grid technologies. In addition, the testing of new models and innovations to unlock domestic private finance, and the possible introduction of performance-based grants as a way of attracting market entrants are also needed.[106] Another possible source of funding is to align Australia's development fund to renewable energy initiatives in Africa. In addition, there is need to promote and incentivise Australian businesses to invest in Africa's energy industry, including in the decentralised and RE sector.

"Recent advances in distributed ledger technology (of which blockchain is a specific example) show great promise as enabling technology for the collection and distribution of payments in micro-grid environments."

[102] McHenry, M.P. and Doepel, D. (2015) The 'low power' revolution: Rural off-grid consumer technologies and portable micropower systems in non-industrialised regions. Renewable Energy, 78 . pp. 679-684.

[103] McHenry, M,P., Johnson, J., and Hightower, M (2016) Why do electricity policy and competitive markets fail to use advanced P.V. systems to improve distribution power quality? Journal of Solar Energy, DOI 10.1155/2016/5187317.

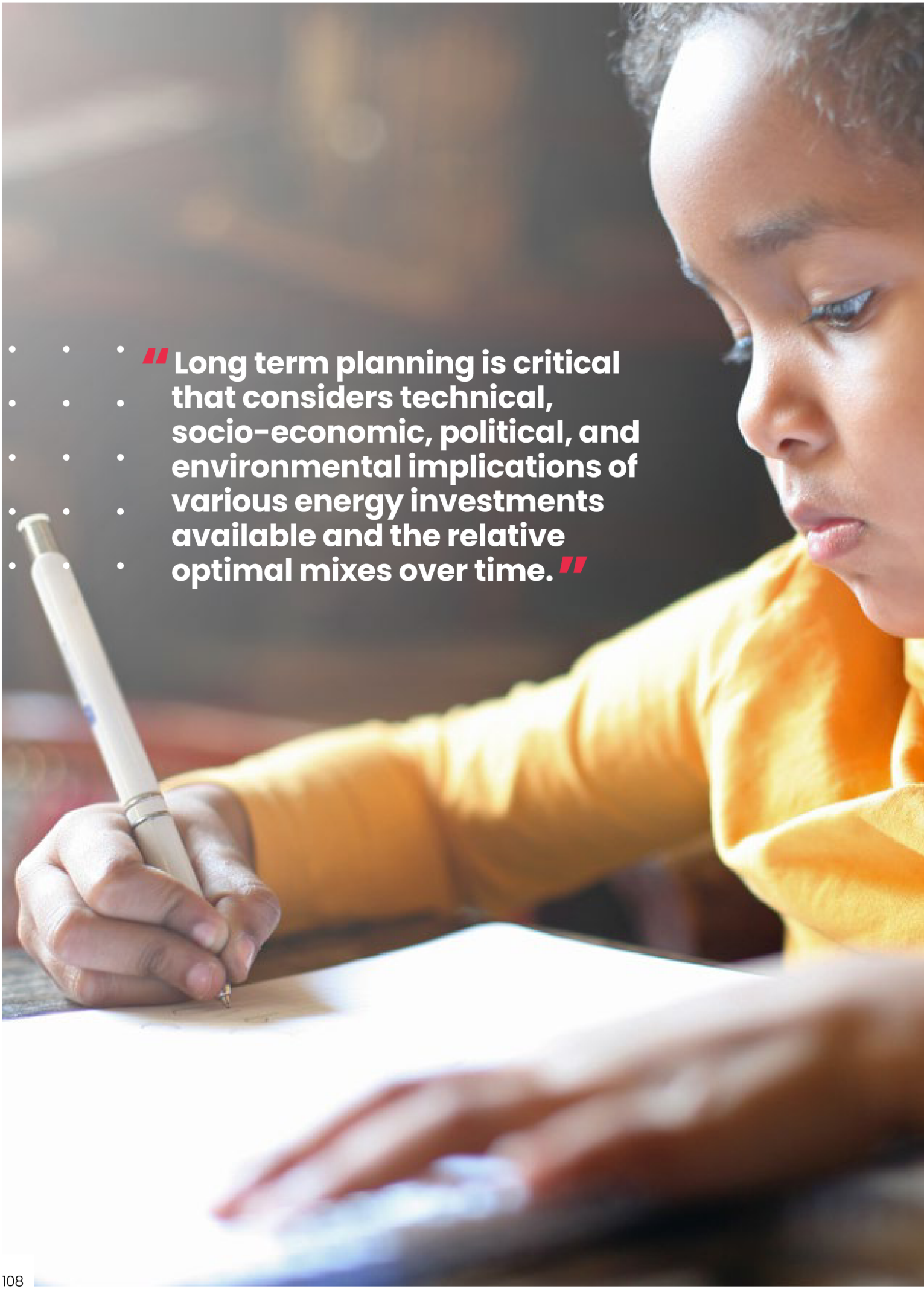
[104] https://westernpower.com.au/energy-solutions/projects-and-trials/white-gum-valley-energy-sharing/

[105] Andoni, et al., (2019) Blockchain technology in the energy sector: A systematic review of challenges and opportunities Renewable and Sustainable Energy Reviews Volume 100, Pages 143-174.

[106] APP 2017

[107] McHenry M.P. (2013) Technical and governance considerations for Advanced Metering Infrastructure/smart meters: technology, security, uncertainty, costs, benefits, and risks. Energy Policy, 59, 834-842.

[108] Bridle, Richard, Lucy Kitson and Peter Wooders. (2014). Fossil-fuel subsidies: a barrier to renewable energy in five Middle East and North African countries. Geneva: International Institute for Sustainable Development, Global Subsidies Initiative.


"Long term planning is critical that considers technical, socio-economic, political, and environmental implications of various energy investments available and the relative optimal mixes over time."

CONCLUSION:
Let there be light (and power)

Without the historical legacy and sunk capital of a centralised high voltage A.C. generation and distribution model, it seems unlikely that this model would be the default choice for establishing electricity services today. Indeed, conventional electricity infrastructure and networks themselves are becoming viewed as a limiting factor in the provision of efficient and cost-effective electricity services.[107] The Third Commission embraces and endorses a 'leapfrogging' strategy for Africa. But as true in Edison's day as in ours, once you have created electricity for light, what else can you do? An African sourced solution for new electricity systems would also embrace decentralised D.C. power equipment. These include D.C. brushless motors (for construction, agricultural, water pumping and sanitation equipment); D.C. televisions (which are currently D.C. devices with rectifiers to convert A.C. to D.C.); D.C. refrigeration; numerous ICT devices, etc. All of this can be achieved with electricity systems under 50 volts, which changes the skillset requirements of installers dramatically.

Such a revolution in devices could also lead to the creation of new manufacturing industries emanating from the Copper Belt and other regions (copper wire is a critical component of all D.C. electrical devices). It would also have the advantage of offsetting copper's phase-out in telecommunications in favour of fibre optics, which has negatively impacted the industry. Beginning with copper ore mining, electrowinning of copper metal, and the creation of motors for electric bicycles, fridges, fans, pumps, etc. Agricultural equipment integrated with micro-grids, powered, and their utilisation measured by blockchain technology. Water pumping and filtration solutions at the home and village level. And, of course, light.

There are several reasons why African countries should prioritise RE as the backbone of electricity for industrialisation. Firstly, a number of policies and long-term planning is required to effect policies that reduce or eliminate the billions of $US that African taxpayers subsidise fossil fuels each year.[108] Secondly, RE has been hindered by outdated policy regimes that favour large electricity generation systems and prevent investment in both centralised and decentralised RE systems. There are numerous policy options including: regulating and charging energy technologies for the pollution and health system costs they produce; tax reductions/exemptions on importation of RE technologies; stimulating local industry through local content policies; encouraging research and development; introduction and enforcement of cost-reflective feed-in-tariffs and policies; opening up the power sector to independent power producers; standardising power purchase agreements; and strengthening land rights. Thirdly, investment in modernising grid infrastructure and mobilising public financing to trigger investment in enabling infrastructure for RE and targeted investments in smart grids. This can partly be achieved by redirecting public finance away from subsidising fossil fuels. Whilst smart grid technologies can be expensive they enable long-term savings, including transmission loss reduction, peak demand reduction, and overall energy efficiency benefits.[109] Smart grid technologies can also lower the costs associated with integrating very large variable RE generation capacities with variabilities in electricity demand.[110] Finally, long term planning is critical that considers technical, socio-economic, political, and environmental implications of various energy investments available and the relative optimal mixes over time.[111,112]

A fundamental tenet in agricultural regions is that the farmers themselves are best placed to own privately and invest in much of this equipment, because each specific implement improves the profitability and productivity. If they do not own equipment themselves, then they contract it from other farmers/locals. They undertake or arrange timely servicing and replacements.[113] Each component in the supply chain needed to create the equipment (from mining, transport, manufacturing, marketing, and final equipment use) proceeds on the assumption of enhancing future business profitability of each separate input. Therefore, profitable businesses, availability of finance, local servicing and support capacity, processing and transport/storage options (in addition to many other inputs) are all key necessary precursors for successful and sustained mechanisation, industrialisation, and development investment. Questions of when, where, how, and why these successful and lasting developments exist; answers must be analysed and shared to enable further adoption, adaptation, and advancement. There are many potential collaborations between African nations and Australia on key input for energy supply chains and logistics, akin to the Australian experience within the extractive and agricultural sectors and their associated servicing businesses upstream and downstream. From an agricultural perspective, affordable energy technologies, services, and implements that allow the production of healthy food and fibre must ideally be safe, clean, and suitable for use in small-scale gardening (with considerations given to suitability of new technologies for women small-scale farmers) and larger farm environments. Capturing as much local content in the development of these sectors must also be based on profitable business models. Accelerating genuine progress for both urban and rural populations can open the doors to achieving the 2030 SDGs,[114] the AU's Agenda 2063, and an infinite number of African development aspirations as detailed in the many African nation based vision statements—Vision 2030 (Kenya), Vision 2020 (Rwanda), Vision 2040 (Uganda), Vision 2030 (Mauritius), Emergence 2030 (Madagascar), Vision 2050 (EAC).

[109] Braziliana, M. Smart and Just Grids: Opportunities for sub-Saharan Africa.

[110] IRENA (2015). From Baseload to Peak: Renewables Provide a Reliable Solution. IRENA Working Paper 2015.

[111] Jain, Prem (2017) "Coal Power in Zambia: Time to Rethink," *Southern African Journal of Policy and Development*: Vol. 3 : No. 2 , Article 6. Available at: https://scholarship.law.cornell.edu/sajpd/vol3/iss2/6

[112] Matek, B and Gawell, K. (2015). The Benefits of Baseload Renewables: A Misunderstood Energy Technology. Elsevier Inc.

[113] FAO (2011) Investment in agricultural mechanisation in Africa. Conclusions and recommendations of a round table meeting of experts. Rome.

[114] GA Resolution 70/1 - Transforming our world: the 2030 Agenda for Sustainable Development.

Chapter 4:
Minerals and Metals in Africa

"Will we invest our natural resource revenue in people, generating jobs and opportunities for millions in the present and future generations? Or will we squander this opportunity, allowing jobless growth and inequality to take root?"

Kofi Annan - Equity in Extractives: Stewarding Africa's Natural Resources for All

INTRODUCTION

The topic of mining in Africa begins with a recitation of the history of stone and metals on the continent. Such a discussion highlights that the knowledge of geology, extraction, smelting, beneficiation and the associated economic development benefits have been well understood for thousands of years before, and independent of, the arrival of Europeans and the so-called modern mining methods. Therefore, the task is not to learn how to derive and preserve benefit from the modern extractives sector but rather remember how the benefit was accrued in the past and what the 21st Century African model could, or more appropriately, should look like. While we use the term 'extractives' inclusively, a special focus has been given to the diversity of mineral extraction on the continent.

It is oft said that the human family didn't "leave the stone age because we ran out of stones."[1] Instead, we left because of the discoveries that the valuable properties of stones (strength, hardness) derived from the atoms and the associated atomic bonds within them and that these can be 'extracted' directly. Africa, of course, as the birthplace of the human family, has an unrivalled archaeological record of innovations in the development of stone tools over hundreds of thousands of years before their atoms were 'extracted'. Indeed, while evolution gave humans neither fangs nor claws, it did give the intelligence to create both from stones. The innovations of blades for scraping meat and stone spear tips for hunting led to the creation of a virtuous circle consisting of creative problem-solving delivering more nutrition leading to increasing cognitive abilities that in turn led to continued problem-solving and innovation.[2]

"While we use the term 'extractives' inclusively, a special focus has been given to the diversity of mineral extraction on the continent."

[1] attributed to Sheikh Ahmed Zaki Yamani.

[2] Williams AC and Hill LJ (2017) Meat and Nicotinamide: A Causal Role in Human Evolution, History, and Demographics International Journal of Tryptophan Research Volume 10: 1–23.

Evidence from the Ologesailie basin in the southern Kenyan Rift Valley around 300,000 years ago shows Stone Age obsidian use and trade with considerable innovation in the creation of multiple types of blades for a variety of applications.[3] Africa has an equally rich archaeological record documenting the evolution from stone into metal tools. This metalsmithing history dates back perhaps over two millennia. Iron smelting and its use, principally for agriculture (and also warfare), can be traced on the continent for thousands of years in both modern-day South Africa,[4] Nigeria[5] and as early as 750CE in Mali.[6] Pre-industrial metal extraction (ore workings, smelting, smithing and trade and use) "developed locally and regionally, creating a very richly varied history of local innovation and cross-cultural borrowing."[7] For example, the ascendancy of various kingdoms (Yoruba) was because of their resource base and skill in transforming iron ore into superior agricultural implements and weapons. Unlike the neighbours to the European North, iron-making in Africa preceded bronze-work. Archaeological evidence of copper and bronze manufacture on the African continent emerged around the year 1000 CE.

Centres of activity in the 'Copper Belt' area, along with a vibrant trade in copper wire ornaments, extended from modern-day Zambia to modern-day Zimbabwe. Copper production was also present in South Africa during the same period.[8] Gold, of course, was also important with the famous Mansa Musa, the King of Mali still regarded as the wealthiest person in history. The King was heavily involved in precious metal extraction and manufacture, trade, and scholarly knowledge, with numerous historical descriptions of his gold caravans, generosity, and the profound effect on the economies of North Africa.

These collective 'metal ages' derive from the physical properties of strength and malleability. These properties confer the ability to transform and shape sophisticated tools, weapons, and items of cultural adornment. There are, of course, other properties of metals (not related to strength, hardness and malleability) that are equally important for the development of modern civilization. These additional properties created a second and third age of metals. The second began with the discovery of electromagnetic

[3] Potts et al. (2018) Environmental dynamics during the onset of the Middle Stone Age in eastern Africa Science 360, 86–90.

[4] Alpern, S. B. (2005) "Did They or Didn't They Invent It? Iron in Sub-Saharan Africa," History in Africa. Cambridge University Press, 32, pp. 41–94. doi: 10.1353/hia.2005.0003.

[5] Darling P. (2016) Iron-Smelting in Nigeria. In: Emeagwali G., Shizha E. (eds) African Indigenous Knowledge and the Sciences. Anti-colonial Educational Perspectives for Transformative Change. SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6300-515-9_17

[6] Nixon, S. (2010) Before Timbuktu: the great trading centre of Tadmakka. Curr.World Archaeol. 39, 40e51.

[7] Shadreck Chirikure (2015) Metals in Past Societies: A Global Perspective on Indigenous African Metallurgy Springer Cham Heidelberg New York Dordrecht London, ISSN 1861-6623 p19.

[8] Hammel A. et al (2000) Pre-colonial mining in southern Africa *The Journal of The South African Institute of Mining and Metallurgy* pp 49-56.

induction (1830s Michael Faraday in Great Britain and Joseph Henry in the United States) and the principal applications for conducting electricity and creating the electric motor. The third 'metal age' relates to the electrochemical properties of metals in the absorption and emittance of photons and electrons and is referred to as the age of 'critical metals' or energy minerals.

Each of these ages, while historically sequential, coalesce together and are indispensable components of the fourth industrial revolution. Without an extractives[9] sector, there is in fact, no modern world. The question, therefore, is not should Africa have an extractives sector but instead, *"Will we invest our natural resource revenue in people, generating jobs and opportunities for millions in the present and future generations? Or will we squander this opportunity, allowing jobless growth and inequality to take root?"*

(Kofi Annan - *Equity in Extractives: Stewarding Africa's Natural Resources for All*)

"Africa has an equally rich archaeological record documenting the evolution from stone into metal tools. This metalsmithing history dates back perhaps over two millennia."

[9] While the Africa Progress Panel uses extractives sector in the more expansive definition and includes oil and gas. The Third Commission in this chapter narrows the focus to only include mining and only peripherally discusses the oil and gas. Gas is covered more thoroughly in the Power and Light Chapter.

1. Equity in Extractives: Yesterday, Today, Tomorrow

In the modern era, Africa's resource-rich economies continue to present a stark contradiction: abundant in resources but a paucity of human capital, wealth creation and job-generating capacity for most of their populations. Furthermore, the economic growth trends of these economies in recent years have dragged down regional averages and this is even more true in a pandemic year with -4.4 per cent growth for resource rich countries in 2020 and 2.1 per cent for 2021 vs -0.9 per cent for non-resource intensive countries in 2020 and 4.3 per cent projected for 2021. This growth is an aggregate of sharp differences in performance between resource-intensive and non-resource intensive countries, with the latter outperforming the former by a factor of two. Ensuring long term robust economic performance in resource-intensive countries, where most Africans live, remains a priority if the standard of living of the continent's population overall is to rise.[10] The emergence of the novel Coronavirus and the ensuing global pandemic in 2020 injected further uncertainty into the extractives sector, creating demand and higher prices for several metals while at the same time making their supply chains precarious, particularly for the artisanal and small-mid-scale sectors. At the same time the remoteness and relative isolation of many mining endeavours has meant that with strict protocols in place they have continued to operate and have proven quite resilient during the pandemic.[11] Since the onset of COVID-19, the significant emphasis must be focused on redoubling efforts to spur inclusive, just and sustainable development in their economies as soon as possible.

This is not a new need. Nearly a decade ago, the Africa Progress Panel's (APP) report ***"Equity in Extractives"***[12] called for bolder and more proactive national strategies to support inclusive growth and poverty reduction, and highlighted countries that were "resource-rich but poverty-stricken." The Panel noted that despite some laudable progress in overall economic management, increases in investment flows and impressive rises in the terms of trade in resource-intensive countries because of the commodity super cycle, Africa was unable to make significant sustainable capital from this upturn and subsequently unable to transform the gains of the last super cycle into enduring wealth. In many countries, the Panel noted revenues from oil, gas and mining were also reportedly widening the gap between rich and poor.

The APP's findings and recommendations remain relevant. A World Bank study from 2017 found that most resource-rich countries still had relatively poor human development outcomes. The report underlined that designing a strong foundation for prosperity over the long term, requires countries to implement policies that can transform revenues from the sale of their resources into "smart investments in Africa's people" who, the Bank emphasised, are the continent's greatest wealth.[13] The Third Commission supports this perspective. Building on the recommendations of the APP, a strong argument is made for policy approaches and innovations that emphasise a bold pursuit of greater inclusiveness and reductions in income inequalities.
This chapter focuses on four economic drivers that, if given the proper policy attention and implementation, will deliver on the promise of inclusive growth: tax and transparency, artisanal scale mining (ASM), beneficiation and gender or, more specifically, women in mining.

"Ensuring long term robust economic performance in resource-intensive countries, where most Africans live, remains a priority if the standard of living of the continent's population overall is to rise."

[10] Sub-Saharan Africa Regional Economic Outlook: Recovery Amid Elevated Uncertainty IMF April 2019 ISBN 9781484396865.

[11] Rouget V. (2020) For better ore worse – mining takes centre stage in Africa's COVID-19 recovery CONTROL RISKS, Accessed from the web: https://www.controlrisks.com/our-thinking/insights/for-better-ore-worse-mining-takes-centre-stage-in-africas-covid19-recovery

[12] Watkins K. (2013) Equity in extractives: stewarding Africa's natural resources for all: Africa Progress Report ISBN 9782970082125.

[13] From Mines and Wells to Well Built Minds" World Bank Report 2017 ISBN (paper): 978-1-4648-1005-3.

The continued plunder of the continent's abundant resources by some foreigners and some Africans, and persistent large-scale illicit financial flows, was also cited by the APP as a cause of concern and a disturbing rising trend in inequalities. Systemic tax evasion, the outright plunder of valuable assets and the extensive use of off-shore tax havens by foreign and domestic investors (documented by the APP in reports from 2013, 2014 and 2017), has undoubtedly been another obstacle preventing Africans from making the most of their continent's extraordinary resource wealth. The international community through SDG 16 now emphatically acknowledges the negative impacts of illicit financial flows (IFFs) on development and affirms the global responsibility of all relevant actors in reducing illicit flows significantly by 2030.[14]

In this area, The Commission highlights several innovations, including new blockchain technologies, that can play an important role in addressing this challenge and recommends that their use be scaled up. During the same time period the World Bank commissioned a study *Transfer Pricing in Mining with a Focus on Africa*,[15] which outlined with considerable clarity the mechanisms of transfer pricing or more accurately transfer mispricing by multi-national enterprises (MNEs) and the negative consequences of the same that include:

- "the tax base of the country hosting the mining may be eroded as profit is shifted abroad;
- the functions of MNEs' mining subsidiaries are often stripped down to mostly routine activities utilising primarily less skilled personnel and tangible assets;
- few mining companies are fully vertically integrated and frequently export crushed and screened ore (as for instance iron ore and coal), or base metals and other concentrates or intermediate products after limited processing to related smelters or marketing hubs; and
- mining companies have increasingly entered into a significant number of cross-border transactions for the provision of high-value, specialised services and assets, and/or financing, many of which are conducted with related entities or part of the same MNE group."

"The Third Commission supports calls for an increased focus on investment and improved access to finance in areas where they impact the lives of the most Africans as a channel towards the rapid improvement of livelihoods of most people living on the continent."

The majority of IFFs are however through over-invoicing of imported inputs (IFFs are more difficult to hide with outputs that have terminal prices on LME, Nymex, SHME, etc.) by localising the supply of inputs (backward linkages) a country/region removes the largest opportunity for IFFs.[16] Of related concern is intercompany invoicing particularly service fees.[17] The APP consistently called for bold action to eradicate extreme poverty and achieve transformative human development on the continent. It emphasised that for this to happen Africa's leaders must bring the poorest and most marginalised sections of society in from the periphery to the centre of policy design. A special focus on greater inclusion of women and young people was also urged. A condition of "poverty amidst plenty" in Africa's resource-intensive economies is often exacerbated due to insufficient financial investment (notably in human capital and infrastructure). The Third Commission supports calls for an increased focus on investment and improved access to finance in areas where they impact the lives of the most Africans as a channel towards the rapid improvement of livelihoods of most people living on the continent. The impact on the environment was also addressed comprehensively by the APP in the context of the extractives sector and it urged countries to translate the African Mining Vision's call for "a transparent and inclusive mining sector that is environmentally and socially responsible … which provides lasting benefits to the community and pursues an integrated view of the rights of various stakeholders" into practice. Such lasting benefit speaks to intergenerational equity and the importance of not only bequeathing benefits but the avoidance of inherited liabilities both social and environmental.

At the end of the APP's operations in 2017, Kofi Annan and his fellow panel members advocated for this agenda to be taken forward by all African political leaders, African civil society practitioners, private sector leaders and the global African diaspora community, four groups with great individual and collective potential for advancing progress in Africa. They called on African governments to seize the moment and implement the policies that will transform the continent's prospects. The governments must remain accountable to their people and working closely with a vibrant civil society and with regional organisations and the international community nested in an increasingly global world. Given the continent's dynamic links with the rest of the world, the APP also strongly urged that the agenda be coherently supported by the international community, in both the public and private sectors.[18]

In that light, The Third Commission aims to help the advancement of this agenda through a strong focus on presenting innovative ideas as well as tested new modalities for promoting greater equity in the extractives sector in various interconnected ways. By doing so it seeks to make a small but notable contribution to take forward key elements of APP's final agenda for action—encompassing the opportunities, priorities and challenges that it identified over the past decade as crucial to Africa's transformation, which will continue to be vital in the coming decade.

[14] UN General Assembly Resolution 70/1, 21 October 2015.

[15] Guj.P. Martin, S. and Readhead A. (2017)Transfer Pricing in Mining with a Focus on Africa (This publication is a summary of the handbook entitled 'Transfer Pricing in Mining with a Focus on Africa: A Reference Guide for Practitioners')

[16] Pers. Comm., Paul Jourdan.

[17] Favourate Sebele-Mpofu, Eukeria Mashiri & Samantha Chantelle Schwartz | (2021) An exposition of transfer pricing motives, strategies and their implementation in tax avoidance by MNEs in developing countries, *Cogent Business & Management*, 8:1, 1944007, DOI: 10.1080/23311975.2021.1944007.

[18] "Making Progress Towards Attaining the Sustainable Development Goals in Africa", APP *Final Report.*

‘Inclusive Economies are Possible’[19]

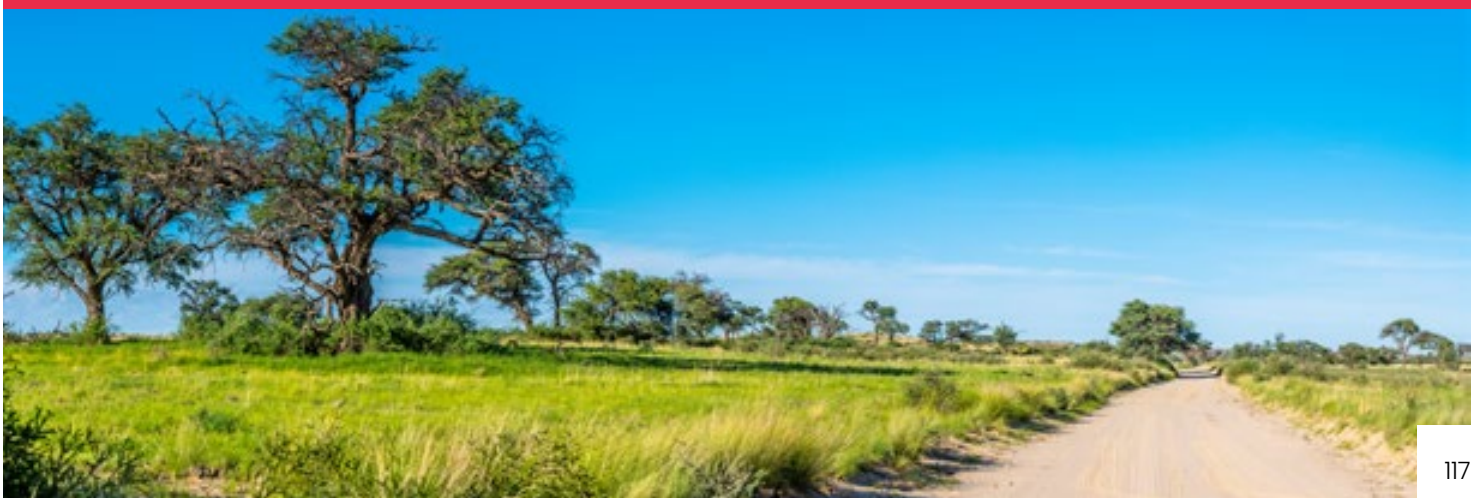
When the presence of a mineral resource is accompanied by productive agricultural land suitable for foreign direct investment, extractives companies can act as social investors and catalysts for inclusive agribusiness opportunities. Over time this can lead to smallholder farmers supplying local, regional, and international markets. Base Titanium (Base) is a junior Australian extractives company operating Kenya’s largest mine (mineral sands) in Kwale. Base secured the mining license from an exploration company that resettled 400 households without delivering positive livelihood outcomes for them. Consequently, Base wanted to regain the goodwill of the resettled households, neighbouring communities, and government representatives. Of the 400 resettled households, 350 were farmers. Base committed to securing their social, actuarial, and political licenses to operate in Kwale through engaging in the county’s primary economic activity: agriculture. It was in this context that Base engaged an Australian NGO, Business for Development (B4D), to design a community development programme whereby Base could directly fund rural livelihoods projects. A public-private partnership (PPP) was formed to implement an inclusive agribusiness model in Kwale County in partnership between the local community members, the Australian Department of Foreign Affairs and Trade (DFAT), the Cotton On Group, and B4D. DFAT’s contribution of A$313,000 leveraged the A$1,411,500 private sector investment, with key support from the Kwale County Government, the Kenyan Fibre Crops Directorate, the Kenyan Agricultural and Livestock Research Organisation, the Competitive African Cotton Initiative, Cotton Made in Africa, and additional funding from German, Dutch, and British funding partners DEG, FMO and DFID.

Extractives-led development programmes in Africa can create sustainable income earning opportunities beyond that of the mine, reducing poverty, improving women’s empowerment, enhancing food security and building post-mine economies. In addition to direct engagement through agricultural community-based projects, extractives companies also invest indirectly through infrastructure for their mines (new roads, airports, ports, power, water, and transportation). This can enable agricultural producers to gain access to new markets, even after the mine has ceased operation.

Base structured their approach to target community development programmes that attempted to address issues around resettlement and to improve livelihoods. B4D designed and implemented a rural livelihoods project with a farmer-owned co-operative at its core. They intentionally involved the local communities and political leaders from the implementation phase through to the operational and post-operation phase. They were mindful of establishing the co-operative with a governance model and directors that are ethical, reliable, focussed on gender equity, and is as apolitical as possible to avoid known issues associated with co-operative politicisation.

Given Kwale’s two rain seasons and historical cotton production, farmers were retrained to grow cotton, but also crop rotations with potato, sorghum, and pulses for a diversity of cash crops and local foodstuffs. With sufficient smallholder farmers joining the co-operative that functions independently from Base, a reliable supply of produce is provided that is suitable for off-take partners to value-add for retail (i.e. cotton produced to the quality and quantity of off-take partner Cotton On). Base and the many other partners continue to create livelihoods for ongoing impacts through productivity and income increases. It demonstrates extractives companies can catalyse the development of inclusive agribusinesses by assisting access to credit, training, tools, inputs; aggregating farmer groups; and facilitating direct market connections with buyers and other partners.

[19] See Spencer, R. (2019). Resourcing Rural Livelihoods in Kenya: Intersections between mining, agriculture and development. Case Reference No. 719-0064-1 https://www.thecasecentre.org/educators/products/view?id=166276; Eabrasu, M., Brueckner, M. and Spencer, R. (2021). A Social Licence to Operate Legitimacy Test: Enhancing Sustainability Through Contact Quality, Journal of Cleaner Production https://doi.org/10.1016/j.jclepro.2021.126080



1.1 Equity in Employment & Wealth Creation: Promoting Inclusive, Shared Transitions

Inclusive growth as commonly understood, is the literal meaning of the two words and refers to both the pace and the pattern of the economic growth. An inclusive growth approach takes a longer-term perspective as the focus is on productive employment rather than on direct income redistribution, as a means of increasing incomes for excluded groups. Inclusive growth may also make the poverty reduction efforts more effective by explicitly creating productive economic opportunities for the poor and vulnerable sections of society.[20] In more recent years however, inclusive economies and inclusive transitions are increasingly being used as descriptors for just development that more accurately focuses on increased social benefits that flow from economic activity rather than the implication that growth must occur. Within that context, any attempt to truly promote inclusive economies in the extractive sector requires artisanal and small-scale mining (ASM) at its core in addition to a thorough-going evidence-based set of policies supporting upstream and downstream beneficiation as well as capacity building to audit effectively (and hold accountable) MNE activities on the continent. To date, with many countries overwhelmingly focused on responding to the needs of large-scale mining only, this has not been the case. The Third Commission urges a significant rebalancing in policy action and attention to address this.

[20] Based on the definition advanced by K. C. Chakrabarty, former Deputy Governor of Reserve Bank of India

ASM Capacity Building Case Study

In 2016, Murdoch University, Western Australia, in partnership with North West University in South Africa, hosted the *Managing Mine Closure* short course, funded by Australia Awards Africa.* As part of the curriculum, awardees were part of an intensive seminar, 'Formalising Artisanal and Small-Scale Mining in Sub-Saharan Africa', led by Professor Gavin Hilson. Prof. Hilson is a leading global authority on artisanal and small-scale mining (ASM) in sub-Saharan Africa, based at the University of Surrey, UK. It brought together 26 mid-level government and NGO officials who can facilitate change in the ASM policy space in sub-Saharan Africa.

The program is a testament to the power of knowledge sharing and creating a community built around a shared vision to make a genuine difference. The group pushed each other to think much deeper about *why* ASM is persistently informal across sub-Saharan Africa and reflect more critically on the merits of adopting regional solutions and how program design was *stifling* the formalisation of the sector's operations.

The seminar inspired several attendees to acquire further knowledge of and do what is necessary for their countries to wield influence in the ASM policy space. Dominique Bally from Cote d'Ivoire used the seminar to expand his knowledge on the link between formalisation and mercury management. It provided him with an opportunity to share experiences with colleagues on the statuses of their countries' National Action Plans.

Domonique used this momentum to establish, in Cote d'Ivoire, the *Centre Africain pour la Santé Environnementale*, an NGO which assists small-scale miners in the area of health and environment.

He used his newfound knowledge to secure contracts from the Global Environmental Facility to assist Senegal, Mali and Cote d'Ivoire with preparing their Mercury Inventories and National Action Plans. At the time of writing, Dominique was still assisting all three countries. Moreover, in a bid to wield more influence in the policymaking and donor spaces on ASM, he has decided to pursue a PhD at the University of Surrey, under the supervision of Professor Hilson.

Yvonne Anokwa, another attendee, works for the Ghana Geological Survey Authority tasked, as part of a US$50 million World Bank' Ghana Land Restoration and Small-Scale Mining Project', with prospecting and demarcating areas for ASM where licensees can be assured of security of tenure and supported. For Yvonne, the seminar emphasised the importance of ASM formalisation being *geologically led.* Recognising Yvonne's experience and drive, the Director of the Geological Survey Authority appointed her the organisation's representative on the Ghana Land Restoration and Small-Scale Mining Project.

While there are numerous individual accomplishments from the alumni, perhaps the most significant impact from the seminar was the collaborative effort of attendees to establish an NGO, the aim of which was to operationalise the plans and ideas hatched during the program. The journey began with establishing a WhatsApp group. It led to the official registration in Nigeria of the 'Association of Managing Mine Closures Ambassadors (AMCA)', established to facilitate ASM formalisation across the African continent. Dominique was appointed Chairperson of the organisation, which was established officially in 2017. Through this organisation and with the continued input of Professor Hilson, officers carried out a project in Cameroon called **'Strengthening the implementation of Internationally acceptable Mine Closure best Practices in pursuit of Sustainable (Small-Scale) Mining in Africa'.**

Closure, the team believes, is an integral though neglected part of the ASM formalisation process. Its inclusion in policy puts added pressure on governments and miners to ensure formalisation is appropriately planned and executed. A grant by the Australian Government (under the call, Small Grants: Australian Awards, Africa Round 2) financed work in 2018 and 2019.

With this funding, the group visited 27 ASM sites in the country and conducted surveys to determine awareness among small-scale miners of mine closure practices and rehabilitation activities. AMCA also conducted a workshop on mine closure in Batouri, where the NGO engaged with regional mining authorities, representatives from CSOs, and members of miners' groups. Finally, AMCA developed a formalisation plan on small-scale mine closure, designed to be built into Cameroon's broader national strategy for ASM formalisation.

Funds also supported the consolidation of the cooperative structure created in the locality of Minton for better assistance on rehabilitation activities and the gold trade.

Attendees see the successes of Cameroon's ASM closure program being a showcase intervention: AMCA is now a networked NGO based across several countries.

* Information about the program can be accessed at https://www.australiaawardsafrica.org/awards/short-courses/

2. Artisanal Mining: Promote Greater Respect and Protection through Greater Understanding and Formalisation

Greater political support for the growth and transformation of Africa's artisanal and small-scale mining (ASM)—low-tech, labour-intensive mineral extraction and processing—is an essential prerequisite towards promoting inclusive shared growth in the extractives sector. Emphasis must be placed on making the 'invisible visible' and increasing the impact of the small-scale. Research must prioritise broadening understanding of ASM's importance in SSA and how it links to other areas of the region's rural economy.[21,22] It must also—and perhaps more importantly—identify ways that speak to a policy framework, which, at least on paper, highlight the critical importance of ASM, of 'getting ASM right', within Africa's overall development transformation and underscore the importance of formalising its activities. The cornerstones of this policy framework already exist in the African Mining Vision, Minamata Convention on Mercury and the Sustainable Development Goals. Again, here too, as the APP Agenda for Action states, clear focus needs to be placed on implementation. The Third Commission recommends further research and policy innovations to support the implementation of an effective ASM understanding and formalisation agenda across the region over the next decade.

[21] Burch, D. and McInroy, N. (2018) We need an Inclusive Economy not Inclusive Growth Policy Provocation https://cles.org.uk/wp-content/uploads/2018/12/Policy-Provocation_We-need-an-inclusive-economy-not-inclusivegrowth_191218.pdf

[22] Mqondisi, S. and Mathe, B. (2021) Alternative Livelihoods: Small Scale Mining in Hope Fountain, Umguza Rural District, Zimbabwe June 2021 International Journal of Multidisciplinary Research Review 2(3):205-213.

ASM plays an indispensable role developmentally, providing incomes to a large share of the SSA population and sustaining a host of rural economies. Research conducted over the past two decades[23] has captured in considerable detail the sector's economic impact in the region: not only does its activities employ over ten million people directly but they have also spawned a series of interconnected downstream and upstream industries, including equipment repair, transport, accommodation services and catering.[24,25,26,27] Moreover, even without the application of advanced machinery, ASM accounts for a sizable share of Africa's mineral production. This includes nearly all of its development minerals (ranging from aggregates, which service local markets and semi-precious stones such as amethyst that supply markets in Europe, North America and China);[28] all of West Africa's rough diamonds; in a country such as Ghana, in most years, one third of the country's gold; in Liberia and Ethiopia, where all gold production has, over the past decade, taken place on an artisanal and small-scale outside of that linked to one commercial operation in the former (New Liberty), and two in the latter (Lega Dembi and Sakaro); and all outputs in locations such as Rwanda, Cameroon and Central African Republic, none of which has the geological resources to sustain a capital-intensive mining sector comparable to that found in the likes of South Africa or Tanzania. Scholars have also showcased, across a range of African countries, ASM's inseparable links with subsistence agriculture, including how the two activities dovetail one another seasonally and how finance from the former is often used to *sustain* production from the latter.[29] On the back of these contributions alone, there is a compelling case for building ASM into, with a view to making it more of a centrepiece of, development strategies and policies in SSA. The case becomes even stronger when considering that most ASM activities in the region, which is the location of some of the poorest areas on the globe, are 'poverty-driven', galvanising around the efforts of, and providing a platform for wealth creation for, people who are otherwise-jobless.

From the evidence available, there is little disputing that ASM is the most important rural non-farm activity in SSA. The way in which it has not only provided much-needed income for struggling farmers but also attracted an array of redundant large-scale mine workers, university graduates and redundant public sector workers in all corners of SSA over the years is a true testament to its 'poverty-driven' nature in the region.

In an area, which is the world's most impoverished and is desperate for an infusion of fresh ideas on how to tackle poverty and facilitate economic growth, failure to adequately integrate ASM into the region's development programs and policies should be characterised as a ***missed opportunity***.

For more than three decades, there has been a push by the World Bank, UNDP, UNECA and a multitude of bilateral organisations (USAID, AUSAID, GIZ and SWISSAID) to prioritise, with their funds earmarked for ASM, formalisation of activities. Broadly speaking, formalisation in the context of ASM is now understood to be a ***process*** that transcends regulatory frameworks and licensing. This process "can include the introduction of legal and regulatory frameworks, providing legal access to minerals, information about geological data, organising miners into flexible and dynamic organisations, and providing access to capital, equipment, and technical assistance."[30] Licensing is, however, a centrepiece of ASM formalisation, and if implemented properly, should provide individual operators with the security of tenure they so desperately covet and open up avenues of technical and financial support previously unrealisable. Over the past two decades, however, a sizable body of literature has emerged that points to a combination of inappropriate licensing schemes (exorbitant costs with securing permits and bureaucratic application processes) and a lack of mineralised plots on which to house operations, stifling efforts to formalise the sector.[31] The latter point in particular is significant for two reasons, the first being—and very obviously—that there is genuinely very little land available to award prospective licensees in most mineral-rich countries in SSA due to areas suitable for ASM being included as part of concessions demarcated to foreign mineral exploration and mining companies; Table 2 provides a glimpse of what is unfolding in West Africa alone. The second reason is that this outcome is emblematic of the region's longstanding and preferred mining-led development strategy. Most development policies adopted in mineral-rich SSA nations exhibit what is often referred to as 'large-scale mining bias',[32] in reference to host governments' tendency to promote capital-intensive, export-driven resource extraction. A conspicuous pattern of rent-seeking is typically associated with the 'large-scale mining bias', which, despite impeding the formalisation of ASM, yields continuous flows of money for government in the form of permit fees, taxes and royalties.

[23] Banchirigah, S.M., Hilson, G. (2010) De-Agrarianization, Re-Agrarianization and Local Economic Development: Re-Orientating Livelihoods in African Artisanal Mining Communities. Policy Sciences 43(2): 157-180; Bakia, M. 2014. East Cameroon's artisanal and small-scale mining bonanza: How long will it last? Futures 62A: 40-50; Childs, J. 2014b. A new means of governing artisanal and small-scale mining? Fairtrade gold and development in Tanzania. Resources Policy 41(1): 128-136.

[24] Dreschler, B. (2001) Small-scale Mining and Sustainable Development within the SADC Region. International Institute for Environment and Development, London.

[25] Mutemeri, N., Petersen, F. (2002) Small-scale mining in South Africa: Past, present and future. Natural Resources Forum, 26, 286-292.

[26] Hilson, G., (2016) Farming, small-scale mining and rural livelihoods in Sub-Saharan Africa: a critical overview. The Extractive Industries and Society 3(2): 547–563.

[27] Mondlane S (2017) Report On Artisanal & Small-Scale Mining In Africa Selected Countries Policy Profile Review On ASM African Minerals Development Centre Asm Sector Report available at https://knowledge.uneca.org/ASM/sites/default/files/docs/ASMStudyReport2017.pdf

[28] United Nations Development Program. (2016) Development Minerals in Africa, the Caribbean and the Pacific: Background Study. ACP-EU Development Minerals Program, Brussels; Franks, D.M. (2020) Reclaiming the neglected minerals of development. The Extractive Industries and Development 7(2): 453-460.

[29] Maconachie, R., Binns, T. (2007) 'Farming miners' or 'mining farmers'? Diamond mining and rural development in post-conflict Sierra Leone. Journal of Rural Studies 23(3): 367-380; Dondeyne, S., Ndunguru, E. 2014. Artisanal gold mining and rural development policies in Mozambique: Perspectives for the future. Futures 62A: 120-127; Cartier, L. E., Burge, M. 2011. Agriculture and Artisanal Gold Mining in Sierra Leone: Alternatives or Complements? Journal of International Development 23: 1080–1099.

[30] Singo, P., Seguin, K. (2018) Best Practices: Formalization and Due Diligence in Artisanal and Small-Scale Mining. IMPACT, Ottawa., p. 7.

[31] See e.g. International Labour Office (ILO). (1999) Social and labour issues in small-scale mines. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mine, International Labour Office, Geneva; Hentschel, T., Hruschka, F., Priester, M. (2002) Global Report on Artisanal and Small-Scale Mining, Minerals Mining and Sustainable Development (MMSD) Project. International Institute for Environmental Development, London; United Nations Economic Commission for Africa (UNECA). 2002. Compendium on Best Practices in Small-Scale Mining in Africa. United Nations Economic Commission for Africa (UNECA), Addis Ababa; Van Bockstael, S. 2019. Land grabbing "from below"? Illicit artisanal gold mining and access to land in post-conflict Côte d'Ivoire. Land Use Policy 81: 904-914.

[32] Hilson, G. (2019) Why is there a large-scale mining 'bias' in sub-Saharan Africa? Land Use Policy 81: 852-861.

Table 2: Total surface (km²) used by large-scale mineral exploration and mining activity in selected gold-producing developing countries[33]

	Côte d'Ivoire	Burkina Faso	Mali	Ghana
Total surface Exploration licences	59,262.46	55,969	55,863.65	*No data*
Total surface Production licences	3353.62	*No data*	*No data*	*No data*
Total surface Exploration + production	62,616.08	55,969	55,863.65	68,325
Total Surface Country	322,463	274,200	1,240,192	238,535
Total surface mining concessions as % of total surface country	19.42%	20.41%	4.50%	28.64%
Total number of concessions	176	451	585	592

For decades, donors have worked with governments in SSA to simplify licensing schemes for ASM with a view to encouraging, rather than stifling, formalisation. It began with scholars stressing, at the time when ASM formalisation first emerged in the international development manifesto, that "Governments must be prepared to move beyond the establishment of legal frameworks, to identify deposits and areas amenable to small-scale development, including the preliminary evaluation of their technical and economic viability at different levels of operation", and that "Security of tenure should be respected in such areas."[34] Approximately a decade into the mining sector reform project in SSA, officials at the International Labour Organization (ILO) commented, in the organisation's landmark report Social and Labour Issues in Small-Scale Mining, that "If small-scale mining is to be encouraged to operate legally, legislation must be (at least) even-handed in allowing small-scale miners access to suitable land for prospecting and mining activities and "must be 'user friendly' as far as the issuing of permits and the granting of licences are concerned—permits that provide clear security of tenure for a reasonable period so that small-scale mining can become established".[35] However, in SSA the iterative process of policy reform is hindered by a 'large-scale mining bias' and a focus on what they have branded the 'illegal' ASM sector and the many environmental problems and social 'ills' (crime, child labour, violence, health and safety concerns, etc.) associated with its activities.

"The case becomes even stronger when considering that most ASM activities in the region, which is the location of some of the poorest areas on the globe, are 'poverty-driven', galvanising around the efforts of, and providing a platform for wealth creation for, people who are otherwise-jobless."

[33] Data extracted from Extractive Industries Transparency Initiative (EITI). (2014) Extracting value in transparency. The Third PH-EITI Report (FY2014). Extractive Industries Transparency Initiative (EITI), Oslo; Extractive Industries Transparency Initiative (EITI). 2017a. Burkina Faso. Rapport ITIE 2015. Extractive Industries Transparency Initiative (EITI), Oslo; Extractive Industries Transparency Initiative (EITI). 2017. Cote d'Ivoire. Rapport ITIE 2015. Extractive Industries Transparency Initiative (EITI), Oslo. Extractive Industries Transparency Initiative (EITI). 2017. République du Mali. Rapport ITIE 2015. Extractive Industries Transparency Initiative (EITI), Oslo. The Ghana data were obtained from the Ghana Minerals Commission, Accra.

[34] Davidson, J., (1993) The transformation and successful development of small-scale mining enterprises in developing countries. Natural Resources Forum 17(4): 315–326, p. 317.

[35] ILO, (1999), *Social and labour issues in small-scale mines* Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines Geneva, 1999 p. 87. ISBN 92-2-111480-5 Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_714371.pdf

Novel and creative policy solutions will, therefore, be needed if formalisation of ASM is to gain any traction in the region's challenging policy environments, and where government officials have not given the sector's livelihoods dimension the spotlight it deserves. The adoption of the SDGs, however, has provided an unexpected boost for the sector speaking directly to the livelihoods dimension of ASM.[36] In a bid to fortify the case for formalising the sector's activities, this chapter calls for the prioritisation of research that aligns with, and which can be packaged as work that responds directly to these concerns. Heading this list are the many concerns that researchers have investigated but, which need to be reconceived in the language of the SDGs, including the sector's link with poverty, ties with agriculture and food security, its gender dimension and work practices.[37] Whilst host governments will likely continue prioritising large-scale mining, what the SDGs provide ASM—that even their predecessors, the more rigid MDGs could not—is a platform of core priorities in which *all* planning and policies implemented will be firmly anchored in for at least the next decade. Specifically, with the opportunity to package formalisation of the sector as part of a livelihood with the potential to positively impact food security, alleviate poverty and empower women, it is bound to enter the realm of, and gain traction within, the region's central development policy and planning space. The COVID-19 pandemic has illuminated many of the issues and concerns that researchers have been raising about ASM in SSA for decades, which can no longer be ignored because they have been thrust into the global spotlight. The pandemic offers further rationalisation for a critical rethink, refocus and reset of the ASM formalisation agenda. The World Bank, through its *Emergency Support Window for Artisanal and Small-Scale Mining (ASM) Communities Impacted by COVID-19*,[38] seems to be encouraging this in the sector worldwide.

With these developments, ongoing and planned work that aims to showcase the barriers inhibiting the formalisation of ASM in SSA and that pressures the region's governments to respond accordingly should be more impactful. The remainder of this section outlines the areas of research that should be prioritised alongside these efforts. Each speaks directly to the SDGs and is bound to yield fresh legislation and programs of action, which could be nestled within the region's existing policy architecture.

"The pandemic offers further rationalisation for a critical rethink, refocus and reset of the ASM formalisation agenda."

[36] De Haan, J., Dales, K, McQuilken, J. (2020) Mapping Artisanal and Small-Scale Mining to the Sustainable Development Goals. University of Delaware (Minerals, Materials and Society program in partnership with Pact), Newark; Hilson, G., Maconachie, R. (2020) Artisanal and small-scale mining and the Sustainable Development Goals: Opportunities and new directions for sub-Saharan Africa. Geoforum 111: 125-141.

[37] Hilson, G., Van Bockstael, S., Sauerwein, T., Hilson, A., McQuilken, J. (2020) Artisanal and Small-Scale Mining, and COVID-19 in Sub-Saharan Africa: A Preliminary Analysis. World Development https://doi.org/10.1016/j.worlddev.2020.105315

[38] "Emergency Support Window for Artisanal and Small-Scale Mining (ASM) Communities Impacted by COVID19", www.worldbank.org/en/programs/egps/brief/notice-upcoming-launch-of-round-2-emergency-window-for-support-to-artisanal-and-small-scale-mining-asm-communities-impacted-by-covid-19 (Accessed 23 November 2020).

Priority 1: New ASM Formalisation Models: Interface First, Incubation Second

The rationale for formalising ASM extends well beyond the need to develop programs that align with the SDGs. The *Minamata Convention on Mercury*, demands, in Annex 3, that ratifying countries must detail, in their National Action Plans (NAPs),[39] "Steps to facilitate the formalisation or regulation of the artisanal and small-scale gold mining sector."[40] Although most governments in SSA have ratified the *Minamata Convention*, few are in a position to state, with conviction, that they have outlined effective "Steps to facilitate the formalisation or regulation of the artisanal and small-scale gold mining sector". Whilst this requirement may be widely seen as being specific to mercury management, it has much wider implications for the sector's development because it requires there to be an effective ASM formalisation model in place which, in most cases, is not the case. This could explain why the World Bank is prioritising, under its *Emergency Support Window for Artisanal and Small-Scale Mining (ASM) Communities Impacted by COVID-19* call, the development of new formalisation models for ASM.

The World Bank itself has, very importantly, provided significant finance over the past two decades to support ASM in a number of countries in SSA. In most cases, these funds have been included as part of much larger mining sector reform and technical assistance projects (Table 3). However, the emphasis has been placed on making available financial assistance, technological support, and training to operators. Whilst potentially transformative, the work is being financed under the assumption that individual operators have routes to licenses, which, as already mentioned, is not often the case. The architects of the Africa Mining Vision (AMV) have very importantly drawn attention to how "There have been notable attempts to develop and deploy appropriate assistance to the ASM sub-sector in several parts in Africa, but most were technology-oriented", largely because "Many past interventions in ASM were top-down, short, ad-hoc, lacked continuity and adequate funding."[41] Anchoring formalisation frameworks in the SDGs will provide the needed traction in policymaking circles that they have never had in SSA. However, before doing so and more fundamentally, wholesale changes in design are needed.

"The pandemic offers further rationalisation for a critical rethink, refocus and reset of the ASM formalisation agenda."

[39] The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury, which again, is used to amalgamate gold. It was officially adopted on 10 October 2013 at a Diplomatic Conference held in Kumamoto, Japan (See "Text and Annexes", https://www.mercuryconvention.org/Convention/Text/tabid/3426/language/en-US/Default.aspx, Accessed 3 November 2020). The guidelines for signatories are as follows: "Pursuant to Article 7.3 of the Minamata Convention, a Party that at any time determines that artisanal and small-scale gold mining and processing in its territory is more than insignificant shall notify the Secretariat. Such Party shall also develop and implement a national action plan in accordance with Annex C of the Convention; submit its national action plan to the Secretariat no later than three years after entry into force of the Convention for it or three years after the notification to the Secretariat, whichever is later; and thereafter, provide a review every three years of the progress made in meeting its obligations under Article 7 and include such reviews in its reports submitted pursuant to Article 21". See "National Action Plans", http://www.mercuryconvention.org/Countries/Parties/NationalActionPlans/tabid/7966/language/en-US/Default.aspx (Accessed 3 October 2020).

[40] United Nations Environment Program. (2013) Minamata Convention on Mercury. United Nations Environment Program, Paris, p. 51.

[41] African Union. (2009) Africa Mining Vision. African Union, Addis Ababa, p. 27.

Table 3: Selected World Bank-funded mining sector reform and technical assistance in SSA (US$ million), 1988–2011[42]

Fiscal Year	Country	Project Name	Financing (US$ millions)
1988	**Ghana**	Mining Sector Rehabilitation Project	**40**
1993	**Mali**	Mining Sector Capacity Building Project	**6**
1995	**Ghana**	Mining Sector Development & Capacity Building	**12**
1995	**Tanzania**	Mineral Sector Development	**13**
1996	**Zambia**	Economic Recovery & Investment Promotion TA	**23**
1997	**Burkina Faso**	Mining Sector Capacity Building & Environmental Management Project	**21**
1999	**Mauritania**	Mining Sector Capacity Building	**15**
1999	**Zambia**	Public Sector Reform & Export Promotion	**173**
2001	**Mozambique**	Mineral Resources Project	**18**
2002	**DR Congo**	Economic Recovery Credit (Begin restructuring of mining sector)	**100***
2003	**Madagascar**	Mineral Resources Governance Project (2007)	**32 + 8**
2003	**Mauritania**	2nd Mining Sector Capacity Building	**18 + 5 (2006)**
2003	**Ethiopia**	Energy Access Project (Mining Sector Reform)	**2.5***
2003	**Burkina Faso**	Competitiveness and Enterprise Development (Mining Sector Reform)	**3.9***
2004	**Uganda**	Sustainable Management of Mineral Resources	**25 + 5 (2009)**
2005	**Nigeria**	Sustainable Management of Natural Resources	**120**
2005	**Sierra Leone**	4th Economic Rehabilitation & Recovery Project (Capacity Building & Regulatory Reform)	**3.8***
2006	**DR Congo**	Transitional Support for Economic Recovery (Improve mining sector governance)	**13.5***
2007	**Sierra Leone**	Programmatic Governance Reform & Growth (Capacity building)	**2***
2009	**Tanzania**	Sustainable Management of Mineral Resources	**50**
2010	**Sierra Leone**	Mineral Sector Technical Assistance	**4**
2011	**DR Congo**	Growth with Governance in the Mineral Sector	**50**
2011	**Malawi**	Mining Growth and Governance Support (under preparation)	**12.5**

* In the last column = this amount is the part that was or is for the mining sector activities of a bigger loan. For such projects a description of the mining component is given in parentheses after the project name in column 3.

Additional financing for a project is captured by +X followed by the year.
For example the Uganda 2004 project received $5 million of additional finance in 2009.

[42] McMahon, G. (2010) The World Bank's Evolutionary Approach to Mining Sector Reform. The World Bank, Washington DC.

The World Bank can usher in these changes through its more recent series of standalone ASM support projects in Tanzania, Ghana and to a certain extent, Mali, under the *Sustainable Management of Mineral Resources Project, Ghana*: *Artisanal and Small-Scale Mining Formalisation* and *Mali Governance of Mining Sector Project*, respectively. Autonomous exercises that are fairly detached from wider mining sector reform and technical assistance projects, these undertakings seek to make available support, and catalyse complementary assistance of various kinds for ASM operators through Centre's of Excellence or incubation units. The success of the ENAMI model in Chile has provided inspiration for this setup, although it is unclear why. ENAMI, which has been in existence for over 60 years, has the full backing of government, which ringfences assistance for and supports individuals obtaining small-scale mining licenses.[43] However, in SSA comparative levels of assistance are, as indicated, virtually non-existent. Moreover, in making available support ***only*** to those in possession of a license, these centres are simply a rebranding of the 'top-down' technical assistance programs that the architects of the AMV, and officials at the ILO before them, single out as short-lived and ineffective. In countries such as Sierra Leone, Liberia and Mozambique, this would first entail securing an entirely *different* license (a *Small-scale Mining License, Class B License and Certificado Mineiro*) if the holder intends to use heavy machinery and technology, the securing of which costs tens of thousands of US dollars. In locations such as Mali and DR Congo, where artisanal miners are only permitted to work in designated ***corridors***, in which use of heavy machinery is also banned, individuals would need to be put on to an entirely different licensing track.

In formalising ASM in poor areas of the world, donors have encouraged individuals to form cooperatives to better position themselves to secure licenses.[44] However, this is unlikely to have much of an impact because it fails to establish a much-needed ***interface*** between unlicensed miners on the one hand, and the governments, which refuse to dialogue with them because of their 'illegality' on the other hand. Therefore, priority should be placed on designing and testing alternative frameworks such as the 'formalisation bubbles' model,[45] which tackles this issue directly by using the small groups of miners as platforms to bring together the two parties to initiate dialogue and develop amicable relationships with prospective licensees. This would facilitate a brokering of dialogues that would ultimately lead to more streamlined user-friendly permitting schemes and build the confidence of sceptical financiers and providers of technical assistance because of the association with legal miners.

Some donors, foremost UNECA, believe that large-scale mining should take the lead and *mentor* ASM. The *International Study Group Report on Africa's Mineral Regimes* produced by the United Nations Economic Commission for Africa states the following:

Productive collaboration between ASM and LSM [large-scale mining] has not been fully exploited. Mentoring offers gains to both sides. For LSM, it boosts the corporate image and community acceptability, offers financial returns from sub-contracting out non-core functions and improves relations with small-scale mining companies. For ASM operations, it helps to transfer technology and skills (entrepreneurship and expertise) cheaply. Further, it allows small-scale miners access to working capital, promotes legal, environmental and regulatory compliance, and improves overall workings as miners adopt best practice.[46]

The continued insistence that large-scale miners lead the push to formalise ASM in SSA, however, is far-fetched when considering the organisational setup and priorities of the

[43] World Bank. (2015) Project Paper On a Proposed Additional Credit to the United Republic of Tanzania For The Sustainable Management of Mineral Resources Project. The World Bank, Washington DC.

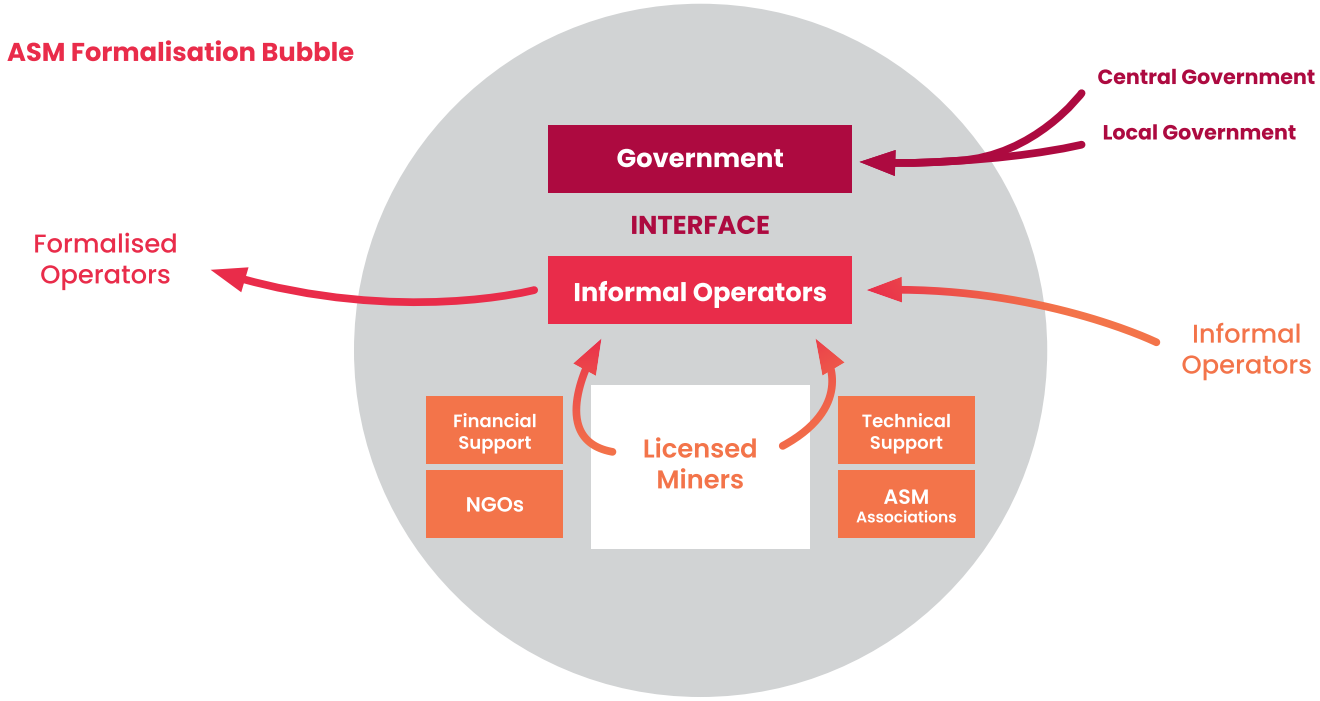
[44] De Haan, J., Turner, B. (2018) Handbook for Developing National ASGM Formalisation Strategies within National Action Plans. UNITAR & UN Environment, Geneva.

[45] Hilson, G. (2020) 'Formalisation bubbles': A blueprint for sustainable artisanal and small-scale mining (ASM) in sub-Saharan Africa. *The Extractive Industries and Society*. https://doi.org/10.1016/j.exis.2020.11.001

[46] United Nations Economic Commission for Africa. (2011) International Study Group Report on Africa's Mineral Regimes. United Nations Economic Commission for Africa, Addis Ababa.

former. Being headquartered elsewhere, with multiple layers of management, operations in-country having multiple owners over short periods of time, and commodity prices fluctuating, make forging long-term agreements with ASM parties virtually impossible. This explains why no formalised agreements have ever been reached between ASM and large-scale miners in SSA. It is also why within the 'formalisation bubbles' framework, the licensed small-scale miner, who often already works with unlicensed groups and is familiar with what they must go through to legalise, *replaces* the large-scale operator. A conceptualisation of the 'formalisation bubbles' framework is provided in Figure 1.

Figure 1: Graphic depiction of the ASM "formalisation bubbles" framework[47]



[47] Hilson, G. (2020) 'Formalisation bubbles': A blueprint for sustainable artisanal and small-scale mining (ASM) in sub-Saharan Africa. *The Extractive Industries and Society*. https://doi.org/10.1016/j.exis.2020.11.001

Priority 2: Transparency, Networks and Ethical Production – Towards Inclusive Development

The struggle to launch ethical mineral schemes that empower the poorest of operators is no longer a secret. Organisations such as the Alliance for Responsible Mining, Fairtrade Foundation, and the OECD have launched schemes in a bid to connect producers to Western markets. However, with so few formalised licensees, 'Fair Trade' mining initiatives more usually connect only those who are in possession of the requisite permits. As these individuals are mostly well-connected and already empowered, these schemes do not deliver pro-poor interventions on their own.

The COVID-19 pandemic, which has cut-off traffic into and out of sites across SSA, has exposed how multi-layered the region's ASM supply chains are. As donors and host governments hit the reset button, and legislation and policy frameworks for ASM begin to soften, making licenses more accessible, there will be a need to better understand the networks, nodes and power structures embedded in the sector. Research has shown that, in the informal economy where most of the region's ASM activities are found, many of the relationships that are the 'glue', which keeps the sector together are entrenched and not as parasitic as believed.[48] There is a need to move beyond the '*middlemen are exploiting miners*' narrative, and refocus research to identify different groups of operators, their needs and circumstances, as well as where they are located within complex ASM supply chains. The strategy of *organising*, *empowering* and *assisting* those whom donors have pursued in a bid to formalise and support the sector over the past 30 years need not change; it rather needs to be rethought, with a view to putting the different groups of people engaged in the sector in positions to make decisions on their own. This represents therefore a genuine opportunity for both research and the extension of traceability initiatives.

The reset that COVID-19 should bring about, buoyed by funds such as the World Bank's *Emergency Support Window for Artisanal and Small-Scale Mining (ASM) Communities Impacted by COVID19*, should provide the platform for more critical thinking around pro-poor ethical mineral schemes capable of facilitating more inclusive development in ASM communities across SSA. These efforts should start with the poorest and/or most vulnerable groups. The SDGs should also be used to incubate moves to develop production schemes and accompanying narratives/storylines, which could excite Western jewellers, manufacturers and suppliers who are being pressured by consumers to source responsibly.

It is recommended here that, under the auspices of focused policy interventions such as the *Minamata Convention* and the *OECD Due Diligence Guidance for Responsible Supply Chains*, and World Bank mining sector reform and technical assistance projects, that research be conducted on, and relationships cultivated with, these vulnerable groups, with a view to incubating them in ethical mineral schemes. Research that uncovers more closely the struggles of individual groups is imperative and fresh storylines are needed, which analysis around women's struggles and the youth will also provide.[49] It is also recommended that the design of these schemes is informed by detailed analysis of ASM networks. Here, the Global Production Network (GPN), which is now heavily featured in Economic Geography, should be used to map and articulate the relationships between key actors who populate these informal ASM supply chains. The GPN is a 'broad relational framework' which, in a bid to map linkages in a given industry, "go[es] beyond the very valuable but, in practice, more restricted, global commodity chain (GCC) and global value chain (GVC) formulations"[50] by "captur[ing] the multi-stranded connections between producers, traders, retailers and consumers".[51] A value chain framework focusing on ***value***, ***power*** and ***embededdness***, helps to articulate ***horizontal*** relationships, and we believe, provides a useful lens for understanding how different levels of an informal sector—in this case, those in and linked to informal ASM in SSA—interact with one another and operate.[52] It is believed that the GPN can provide guidance here for constructing a stakeholder 'map' of the key actors from the two worlds, and for articulating how their interactions with one another, both within and across nodes, sustain informal ASM activities in the region and stimulate economic development. At this stage, blockchain schemes can be developed that are anchored in pro-poor experiences, which could map social relationships as well as the minerals from the source (and include monitoring of tailings[53] and post-mine reporting) through the different actors in-country, to international retailers and manufacturers.

[48] McQuilken, J. (2016) 'Ethical gold' in sub-Saharan Africa: a viable empowerment strategy? International Development and Planning Review 38(2): 179-199; McQuilken, J. 2018. Small-scale mining and production networks in sub- Saharan Africa: reconceptualising a framework for 'pro-poor' ethical mineral certification. Unpublished Doctoral Thesis University of Surrey, UK.

[49] See the 2021 special issue of The Extractive Industries and Society entitled Mining legacies: Still 'breaking new ground'.

[50] Coe, N.M., Dicken, P., Hess, M. (2008) Global production networks: realizing the potential. Journal of Economic Geography 8: 271-295, p. 272.

[51] Hughes, A., Wrigley, N., Buttle, M. (2008) Global Production Networks, Ethical Campaigning, and the Embeddedness of Responsible Governance. Journal of Economic Geography 9: 345-367, p. 348.

[52] Henderson, J., Dicken, P., Hess, M., Coe, N, Yeung, H.W.C. (2002) Global production networks and the analysis of economic development. *Review of International Political Economy* 9(3): 436-464;

[53] ICCM GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT AUGUST 2020 available at: https://www.icmm.com/website/publications/pdfs/environmental-stewardship/2020/global-industry-standard-on-tailings-management.pdf

Priority 3: ASM and Food Security

Once the overhaul of ASM formalisation frameworks is underway, attention can then turn to rebranding this exercise in ways that speak more specifically to the SDGs. The most visible means of doing so is through work that maps and fortifies the links between ASM and subsistence farming in SSA. This comes with a view to capturing how income builds rural resilience and makes communities more food secure, in the process contributing directly to targets set under SDG1 ('No Hunger') and SDG2 ('No Poverty').

More broadly, inclusion of ASM in debates on climate change, adaptation and resilience would provide a much-needed boost to an otherwise stagnating discussion, as well as bolster dialogue around rural livelihoods and poverty alleviation in the context of the SDGs. A careful reading of the literature and policy documents on the subject reveals very clearly the reason why: that discussions on the resilience of a family or household in rural SSA rarely consider the external, yet local, factors that may impact the rural agriculture they rely on for their subsistence. This has, consequently, spawned a very specific course of action, specifically, work aimed at making rural agriculture more sustainable and households more food secure. Rarely has work on community resilience in the region, particularly that which has been carried out in impoverished areas, explored diversification and livelihood portfolios as a strategy for buffering against the economic shocks and food insecurity. This is explored explicitly in Chapter 1 "A Healthy and Food Secure Africa Built from the Ground Up."

It is in this area where ASM could already be playing an important yet largely undocumented role. Research that provides a more nuanced analysis of the region's ASM, which specifically revisits the sector's links with agriculture, with a view to capturing how, through injections of capital, it is stabilising rural households in times of shocks and stresses and in ways that align with the adaptation to climate change and the SDGs agenda, could stimulate a 'rethink' and potentially, an overhaul, of rural development and poverty alleviation policies. Whilst showing outward appreciation for ASM's ability to provide employment to millions of otherwise-jobless people, policymakers and to some extent, donors, still appear unconvinced about the sector's embeddedness in the region's rural settings. If evidence did emerge that pointed to informal ASM activities stabilising rural households financially—particularly during times of shocks and stresses—would their thinking change? Would this lead to action at the country level aimed at supporting (formalising) the sector in ways more conducive of the actual role it may be playing in this context? Could it have resonance in more region-wide policy dialogues centred on rural poverty alleviation, such as that linked to the New Economic Partnership for Economic Development and Africa Union Climate Change Strategy, which do not mention the ASM sector's economic impact in SSA? This evidence is especially important during the pandemic, when it appears income from ASM is becoming increasingly relied upon for income to purchase food, as supply chains delivering supplies to sites have become ruptured due to curfews, border closures and crackdowns on travel.[54]

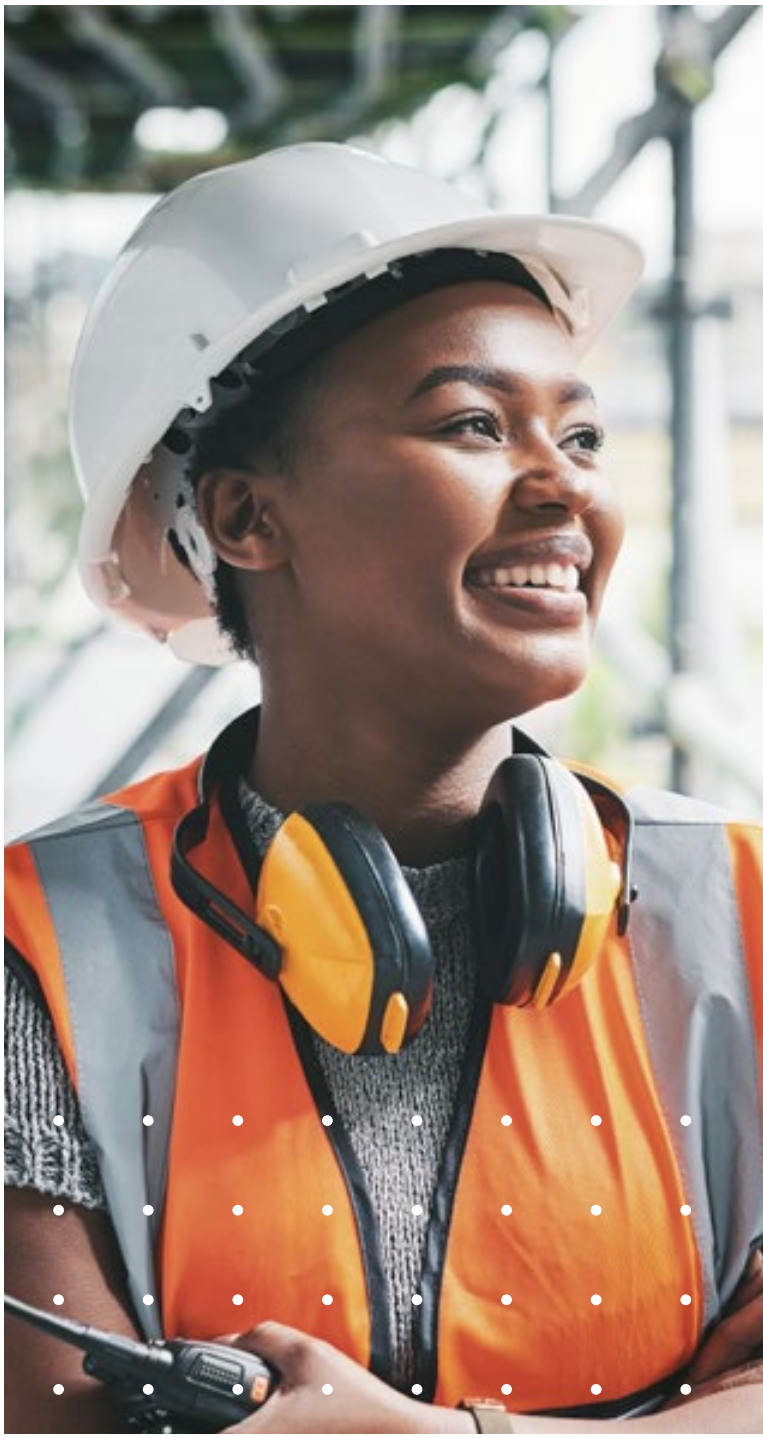
What evidence could initiate a change? Evidence that delves beyond simply conceptualising ASM as a sector that dovetails farming, but which more importantly illustrates with a rich range of data, how its connections with family-oriented agriculture yields diversified livelihood portfolios that help to buffer against the ubiquitous shocks and stresses brought about by economic crisis and climatic extremes. Specifically, work which explores in depth how engagement in ASM stabilises rural livelihood portfolios in ways that enable rural families to cope with stresses and shocks and improve household-level food security is needed. Data that examine very clearly how ASM improves food security in rural areas, particularly during times of shocks and stresses, is a key to fortifying the case for formalising the sector in ways that resonate with the thinking of donors and policymakers. It must emphasise the collection of both quantitative data and qualitative data, guided by a conceptual framework akin to those now being used by donor bodies such as the UNDP, USAID, the World Bank and GIZ to examine community resilience in the context of climate change in SSA. Which information is needed to construct the ASM-food security nexus in SSA? First, data which paint a fuller picture of the precise economic contributions farming and ASM make to rural households are needed, and capital and financial flows must be mapped across each. Second, and at a more micro-level, better articulation of the roles played by individual family members vis-à-vis ASM and agriculture is needed. The relatively new Individual Deprivation Measure (IDM) is a good tool to adapt for this purpose as it recognises that you cannot simply survey at the household level because that can miss individual household members (particularly women and youth), in terms of that more nuanced and granular picture of wellbeing, food security, poverty and health.[55] Do these roles change during times of shocks and stresses?

[54] Hilson, G., Van Bockstael, S., Sauerwein, T., Hilson, A., McQuilken, J. (2020) Artisanal and Small-Scale Mining, and COVID-19 in Sub-Saharan Africa: A Preliminary Analysis. World Development https://doi.org/10.1016/j.worlddev.2020.105315.

[55] Bessell S (2015) The Individual Deprivation Measure: measuring poverty as if gender and inequality matter, Gender & Development, 23:2, 223-240, DOI: 10.1080/13552074.2015.1053213.

There is especially a need to share the experiences of women, who endure the widely-documented 'triple burden'—i.e., reproductive work, productive work, and community work—at the household level. What roles do women play in diversified rural systems, how do these enhance household resilience, and what policy interventions can be taken to support them, which speak to an SDGs apparatus that is heavily anchored in the theme of gender equality? Gender equality in ASM is an emerging topic, which is attracting significant scholarly attention. The bulk of this work has showcased women's struggles and vulnerabilities,[56] which has spawned a policy dialogue centred on alternative livelihoods[57] that has sought to identify pathways out of ASM for vulnerable groups, foremost women.[58] With ASM being ***the*** alternative livelihood, however, there is a need to focus more on identifying ways in which to improve working conditions for women. Research shows that women who occupy the middle tiers of the sector's labour hierarchy, whilst vulnerable, are unwilling to abandon their work because of the good financial returns, which cover most of their household expenses.[59] Formalisation will ultimately lead to improvements in work conditions at sites overall but more targeted programs could be implemented in the interim, guided by policy such as the ***Minamata Convention***, which demands that ratifying countries include specific strategies for "vulnerable groups" in their NAPs. How can women found working in these middle tiers be empowered, protected and assisted?

As the overarching objective of this research is to build resilience in 'diversified rural systems' (i.e., communities where ASM and farming intersect), there is a need to gather data that detail more clearly the realities of these systems. Data that provide a much clearer idea of the roles played by each of these activities, how they impact households and more importantly, how they are inseparable using language that speaks to the SDGs. Clear data can go a long way toward ushering in the wholesale policy changes needed to build resilience in these diversified rural systems, in the process, positioning policymakers to alleviate significant poverty in rural SSA.



[56] Kelly, J.T.D., King-Close, A., Perks, R. 2014. Resources and resourcefulness: Roles, opportunities and risks for women working at artisanal mines in South Kivu, Democratic Republic of the Congo. Futures, 62: 95-105; Bashwira, M. R., Cuvelier, J. 2019. Women, mining and power in southeastern Democratic Republic of Congo: The case of Kisengo. The Extractive Industries and Society 6(3): 960-967; Romano, R.B., Papastefanaki, L. 2020. Women and Gender in the Mines: Challenging Masculinity through History: An Introduction. International Review of Social History, 65(2): 191-230; Byemba, G.K. 2020. Formalisation of artisanal and small-scale mining in eastern Democratic Republic of the Congo: An opportunity for women in the new tin, tantalum, tungsten and gold (3TG) supply chain? The Extractive Industries and Society 7(2): 420-427. Hilson, G., Banchirigah, S.M. 2009. Are alternative livelihood projects alleviating poverty in mining communities? Experiences from Ghana. Journal of Development Studies, 45 (2), pp. 172-196; Siegel, S., Veiga, M.M. 2010. The myth of alternative livelihoods: Artisanal mining, gold and poverty. International Journal of Environment and Pollution 41(3-4): 272-288; Adonteng-Kissi, O., Adonteng-Kissi, B. 2018. Precarious work or sustainable livelihoods? Aligning Prestea's Programme with the development dialogue on artisanal and small-scale mining. Natural Resources Forum 42(2): 123-137.

[57] Hilson, G., Banchirigah, S.M. 2009. Are alternative livelihood projects alleviating poverty in mining communities? Experiences from Ghana. Journal of Development Studies, 45 (2), pp. 172-196; Siegel, S., Veiga, M.M. 2010. The myth of alternative livelihoods: Artisanal mining, gold and poverty. International Journal of Environment and Pollution 41(3-4): 272-288; Adonteng-Kissi, O., Adonteng-Kissi, B. 2018. Precarious work or sustainable livelihoods? Aligning Prestea's Programme with the development dialogue on artisanal and small-scale mining. Natural Resources Forum 42(2): 123-137.

[58] World Bank. (2009) Mining Together: Large-Scale Mining meets Artisanal Mining. The World Bank, Washington DC; Noetstaller, R., Heemskerk, M., Hruschka, F., Dreschler, B. 2004. Program for Improvements to the Profiling of Artisanal and Small-Scale Mining Activities in Africa and the Implementation of Baseline Surveys. The World Bank, Washington DC; International Finance Corporation. 2014. Sustainable and Responsible Mining in Africa - A Getting Started Guide. International Finance Corporation, Washington DC.

[59] Kumah, C., Hilson, G., Quaicoe, I. (2020). Poverty, adaptation and vulnerability: An assessment of women's work in Ghana's artisanal gold mining sector. Area 52(3): 617-625; Rutherford, B. 2020. The Moral Politics of Gendered Labour in Artisanal Mining in Sierra Leone. Development and Change 51(3): 771-793; Hilson, G., Hu, Y., Kumah, C. 2020. Locating female 'Voices' in the Minamata Convention on Mercury in Sub-Saharan Africa: The case of Ghana. Environmental Science and Policy 107: 123-136; Reichel, V. 2020. Financial inclusion for women and men in artisanal gold mining communities: A case study from the Democratic Republic of the Congo. The Extractive Industries and Society 7(2): 412-419.

2.2 ASM Summary

This section has highlighted major research priorities for ASM in SSA. The SDGs have provided an opportunity to critically rethink how to go about formalising ASM, which has been the main focus of donors' work on the sector for more than three decades. However, most of these approaches have been technically oriented and, as technocratic interventions, have failed to empower those in the greatest need of support. The COVID-19 pandemic offers a rare opportunity to study the sector more closely, and to redesign formalisation schemes. The key is creating the interface between government officials and the unlicensed miners they refuse to dialogue with. New formalisation models are desperately needed, which the 'bubbles' framework provides. The second priority is developing ethical mineral schemes that are 'pro-poor', gender inclusive and empower those who are in need. Finally, more work is needed that broadens understanding of the ASM and food security nexus, which fortifies the case for formalisation in ways that speak to the SDGs. Research in these three areas is bound to be more impactful as licensing schemes soften and become more user-friendly in the wake of pressure.

" Therefore, food systems must be based on healthy, resilient, profitable, and productive farming systems that integrate processing and consumption decisions to ensure maximum benefits to rural and urban society. "

"Research, awareness-raising and activism have highlighted the complex interplay between the benefits to women from employment in the extractives industries and negative impacts arising from their marginalisation from decision-making processes."

3. Gender Equity in Extractives: towards achieving gender equality

Extractives industries all over the world are faced with the imperative of inclusive transition towards gender equity—access to the same opportunities—within the sector. Countries with significant mineral and petroleum endowments are seeing some progress in efforts to understand the size and scope of the challenge. Research, awareness-raising and activism have highlighted the complex interplay between the benefits to women from employment in the extractives industries and negative impacts arising from their marginalisation from decision-making processes.[60] COVID-19 has exacerbated the existing challenges for women working in and alongside the extractives industries in Africa[61] who, through advocacy networks, are sharing their struggles, solutions and transformative agendas.

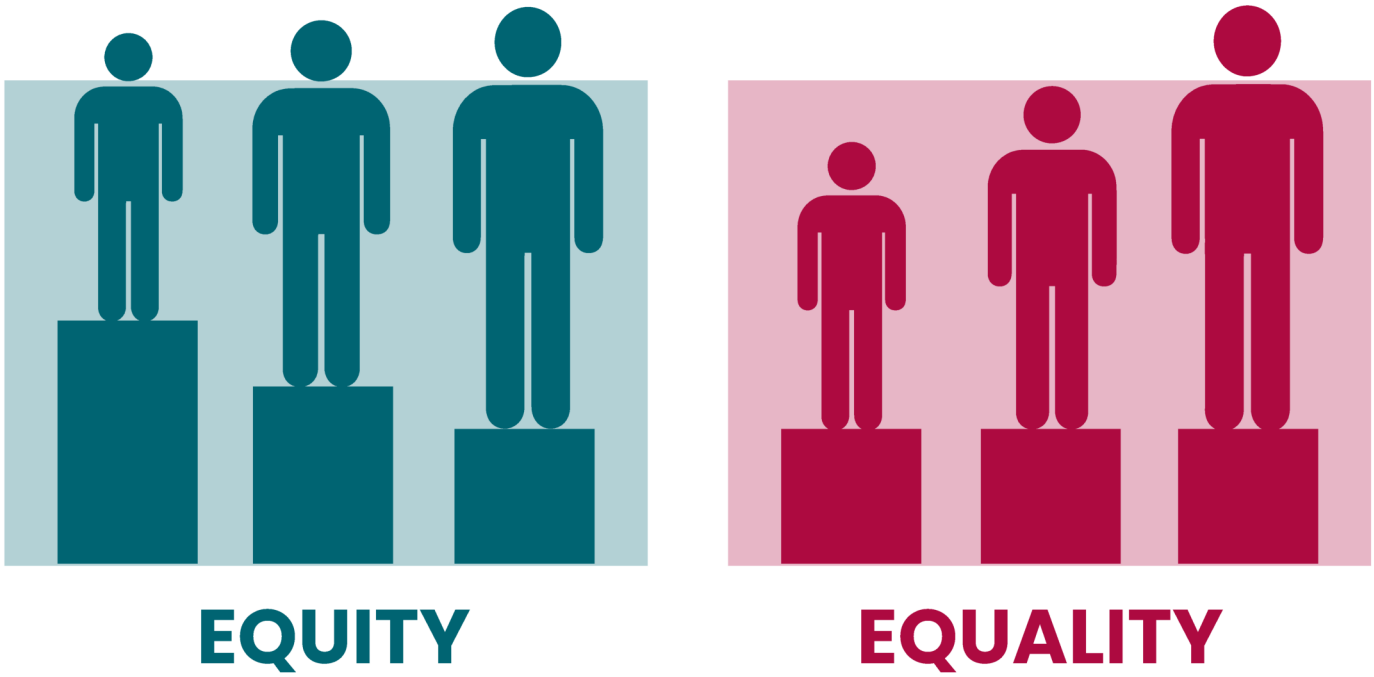
[60] Kentse Sesele, Lochner Marais, Deidre van Rooyen,(2021) Women and mine closure: A case study of policy in South Africa, Resources Policy, Volume 72 102059, ISSN 0301-4207, https://doi.org/10.1016/j.resourpol.2021.102059.

[61] Gavin Hilson, Steven Van Bockstael, Titus Sauerwein, Abigail Hilson, James McQuilken(2021) Artisanal and small-scale mining, and COVID-19 in sub-Saharan Africa: A preliminary analysis, World Development, Volume 139, 2021, 105315, ISSN 0305-750X, https://doi.org/10.1016/j.worlddev.2020.105315.

On a global scale, several calls to action and guidance tools for gender equity as a pathway to equality[62], both in the extractives sector and in broader society, have been elaborated over the last two decades (see Figure 2). Gender equality is recognised as an essential pillar for development; a cross-cutting goal to improve the lives of communities around the globe. The rationale for gender equality varies amongst the initiatives, depending on their focus and strategic alignments. The prevalence of gender-based violence, discrimination, and high levels of unpaid work responsibilities experienced by women necessitate a human rights approach to advocate for societal change, economic freedom and self-determination for women.[63] Others make an economic case that gender equality "makes good business sense" and is "smart development."[64]

"A sustainable and well-governed mining sector that effectively garners and deploys resource rents and that is safe, healthy, gender and ethnically inclusive, environmentally friendly, socially responsible and appreciated by surrounding communities."

Figure 2: Graphic depiction of equity vs equality[65]



[62] Gender equity strives to ensure that individuals are provided with the opportunities they need to be successful (these vary from person to person). Equality is the pursuit of equity whereby people have the same choices and access to opportunities regardless of their gender https://www.iucn.org/news/commission-environmental-economic-and-social-policy/202104/gender-fisheries-equality-vs-equity

[63] For example: https://www.unwomen.org/en/how-we-work/intergovernmental-support/world-conferences-on-women; https://sdgs.un.org/goals/goal5

[64] World Bank Group. (2015). World Bank Group Gender Strategy (FY16-23) : Gender Equality, Poverty Reduction and Inclusive Growth, 7. https://openknowledge.worldbank.org/handle/10986/23425

The Africa Mining Vision (AMV), the African Union Agenda 2063 policy framework for governance of natural resources, has the overarching objectives of "broad-based sustainable growth and socio-economic development."[66] The seven point agenda addresses gender equality in one ambitious vision component: "A sustainable and well-governed mining sector that effectively garners and deploys resource rents and that is safe, healthy, gender and ethnically inclusive, environmentally friendly, socially responsible and appreciated by surrounding communities." Gender inequality is almost exclusively regarded through the lens of negative impacts of artisanal and small-scale mining (ASM) but does include a broader-reaching policy to "initiate empowerment of women through integrating gender equity in mining policies, laws, regulations, standards and codes."[67]

To reflect on what frameworks such as the SDGs or the AMV mean for women is a complex task; even though they have many common experiences of gendered roles, power relations and their impacts, women are not a homogeneous group. Their relationships to mining, intersect with gender and other social inequalities,[68] which require understanding and analyses of power relationships and how they are challenged or reinforced at every stage of extractives governance, project planning and implementation. "For the SDGs to be transformative, they must radically change the global political economy system through a redistributive framework that aims to reduce inequalities of wealth, power and resources between countries, within countries, between rich and poor, and between men and women".[69] This includes the need for understanding the gender and power relations when community interests do not align with large-scale extractives projects,[70] and how gender justice and transparency are integral to the defence of the rights of free, prior and informed consent.[71]

[65] African Women in Science and Engineering https://aawse.org/gender-equity-and-equality-ii-the-role-of-the-society/

[66] http://www.africaminingvision.org/amv_resources/AMV/Africa_Mining_Vision_English.pdf, v

[67] Africa Mining Vision (English Version), 32.

[68] Rutherford, B., & Buss, D. (2019). Gendered governance and socio-economic differentiation among women artisanal and small-scale miners in Central and East Africa. Third World Thematics: A TWQ Journal, 4(1), 63-79. doi:10.1080/23802014.2019.1646614.

[69] Women's Major Group. (2014). 'Women's "8 Red Flags" Following the Conclusion of the Open Working Group on Sustainable Development Goals (SDGs)', 3. https://www.womensmajorgroup.org/wp-content/uploads/2014/07/Womens-Major-Group_OWG_FINALSTATEMENT_21July.pdf

[70] The WoMin Collective (2017) Extractives vs development sovereignty: building living consent rights for African women, Gender & Development, 25:3, 421-437, DOI: 10.1080/13552074.2017.1379782.

[71] Oxfam International (2017). Position Paper on Gender Justice and the Extractive Industries.

The absence of sex-disaggregated measures in the monitoring indicators of the AMV Action Plan reduces the scope for achieving the aims of gender equity by omitting the pathway to know how much work is required and where efforts are most needed. The importance of sex-disaggregated data in the extractives sectors has been brought sharply into focus by global institutions,[72] civil society[73] and increasingly, Women in Mining advocacy networks (WIMs).[74] Such data are recognised as key tools for understanding the scale of the challenges for women in the sectors, setting goals for a more inclusive industry and monitoring the progress or lack thereof over time. In African artisanal and small-scale mining (ASM), women's participation attains levels higher than 50 per cent[75] and up to 90 per cent for certain gender-segregated activities.[76] When we consider that over 20 million people work in the sector across the continent,[77] such significant numbers of women participating dispels the idea that mining is a male-dominated industry in purely numerical terms. In contrast, for large-scale mining (LSM), women are estimated to participate at rates ranging from a few per cent to 12 per cent in South Africa, where the South African Mining Charter of 2002 required mining companies to ensure that 10 per cent of their total workforce were women by the year 2009.[78] These figures only consider direct employment. There is a significant challenge of having reliable continent-wide data for LSM, and for services and value chain activities that are integral to extractives industries.[79]

The extractives industries are dynamic, subject to many external forces that impact the economic viability of projects and can result in rapidly changing workforce scales. Technological advances and the increasing adoption of automation in LSM are potential sources of tension between competing priorities of sector modernisation and efficiency with local content imperatives and to outpace the development of African educational programs in automation technologies.[80] Commodity prices greatly impact the size and scale of workforces and COVID-19 is another external force that is further impacting the sector. It is essential that the roles and statuses of women are understood and monitored in this shifting landscape.

As important as gender data and statistics are for evaluating participation rates and conditions for women in the extractives sector, data alone has limitations for understanding mining governance and policy implications, as "measurement processes strip out complexity to render social phenomenon comparable."[81] Addressing gender inequality of the extractives sector requires recognition and understanding of "the multiplicity of ways in which different women experience and negotiate the mining industry and its impacts, in relation to their own distinct geographies and changing positionalities."[82] Research that foregrounds women's experiences of the extractives sector in African contexts examines their diverse roles and perspectives both in artisanal and large-scale activities. Such work is necessarily nuanced and context-specific because gender relations and roles both within and alongside the industry are complex. These include historical recognition of women as miners,[83] their motivations for participation,[84] and crucially, analyses of the power dynamics of gendered relations.[85] Knowledge of the many difficulties, barriers, and forms of discrimination, oppression and inequality women miners are confronted with[86,87] are important for 'linking laws to realities,'[88] because seemingly gender-neutral policy reforms in extractives governance tend to have unintended consequences for women whose roles and experiences are poorly understood.[89]

" Addressing gender inequality of the extractives sector requires recognition and understanding of "the multiplicity of ways in which different women experience and negotiate the mining industry and its impacts, in relation to their own distinct geographies and changing positionalities." "

[72] https://www.iisd.org/system/files/publications/igf-women-asm-challenges-opportunities-participation.pdf

[73] https://eiti.org/document/guidance-note-30-towards-genderresponsive-eiti-implementation

[74] The Women in Mining Guinea Index Using Data to Measure and Improve Gender Considerations in the Extractive Sector Available at: https://developmentgateway.org/casestudy/wim-guinea-index/

[75] Hilson, G. (2002). Small-scale mining and its socio-economic impact in developing countries. Paper presented at the Natural Resources Forum.

[76] Maconachie, R., & Hilson, G. (2011). Artisanal gold mining: a new frontier in post-conflict Sierra Leone? The Journal of Development Studies, 47(4), 595-616.

[77] Hilson, G. (2020). The Africa Mining Vision: a manifesto for more inclusive extractive industry-led development? Revue canadienne d'études du développement, 41(3), 417-431. doi:10.1080/02255189.2020.1821352

[78] https://www.mineralscouncil.org.za/industry-news/publications/fact-sheets

[79] Perks, R., & Schulz, K. (2020). Gender in oil, gas and mining: An overview of the global state-of-play. The Extractive Industries and Society, 7(2), 380-388. doi:https://doi.org/10.1016/j.exis.2020.04.010

[80] Kansake, B. A., Kaba, F. A., Dumakor-Dupey, N. K., & Arthur, C. K. (2019). The future of mining in Ghana: Are stakeholders prepared for the adoption of autonomous mining systems? Resources policy, 63, 101411. doi: 10.1016/j.resourpol.2019.101411

[81] Buss, D. (2015). Measurement Imperatives and Gender Politics: An Introduction. Social politics, 22(3), 381-389. doi:10.1093/sp/jxv030

[82] Jenkins, K. (2014). Women, mining and development: an emerging research agenda. The Extractive Industries and Society, 1(2), 329-339. doi:http://dx.doi.org/10.1016/j.exis.2014.08.004

[83] Werthmann, K. (2007). Gold mining and Jula influence in precolonial southern Burkina Faso. The Journal of African History, 48(3), 395-414. doi:10.1017/S002185370700326X.

[84] Werthmann, K. (2009). Working in a boom-town: Female perspectives on gold-mining in Burkina Faso. Resources policy, 34(1), 18-23.

[85] WoMin Collective, T. (2017). Extractives vs development sovereignty: building living consent rights for African women. Gender & Development, 25(3), 421-437.

[86] Benya, A. (2017). Going underground in South African platinum mines to explore women miners' experiences. Gender & Development, 25(3), 509-522. doi:10.1080/13552074.2017.1379775.

[87] Hilson, G., Hilson, A., Siwale, A., & Maconachie, R. (2018). Female Faces in Informal 'Spaces': Women and Artisanal and Small-scale Mining in sub-Saharan Africa. Africa Journal of Management, 4(3), 306-346. doi:10.1080/23322373.2018.1516940.

[88] Smits, K. M., McDonald, L., Smith, N. M., Gonzalez, F., Lucena, J., Martinez, G., . . . Rosas, S. (2020). Voces Mineras: Clarifying the future of artisanal and small-scale mining collaborations. *The Extractive Industries and Society*, 7(1), 68-72. doi: https://doi.org/10.1016/j.exis.2019.12.003

[89] Rutherford, B., & Buss, D. (2019). Gendered governance and socio-economic differentiation among women artisanal and small-scale miners in Central and East Africa. Third World Thematics: A TWQ Journal, 4(1), 63-79. doi:10.1080/23802014.2019.1646614.

Women in mining (WIM) networks of solidarity and advocacy are very active in most African countries with an extractives sector and are supported by regional,[90] pan African[91] and global organisations[92] advocating for participation, representation and leadership for women across ASM and LSM sectors. National WIM associations organisation for advocacy, capacity building, networking and promotion so that the mining sector can be used to leverage sustainable development for the benefit of all women.

Comprised of women working in the extractives sector, WIMs have first-hand experience and knowledge of barriers to equitable participation by females in the mining sector such as health (exposure to neurotoxins, dust, lack of reproductive health services), poor access to land and land negotiation rights, inadequate facilities and personal protective equipment in the workplace, less access to education training and skills and socio-cultural barriers such as superstition, chauvinism that lead to discriminatory hiring practices and gender-based violence. WIM networks play a crucial role in advocating for women at industry forums and to governments and the wider community.

COVID-19 has brought significant changes to work and family responsibilities for women miners in Africa. The importance of women's advocacy groups for information sharing between members, and for getting information out to policymakers has been highlighted by the ways in which they have been called upon to identify challenges and opportunities presented by the crisis. Challenges are wide-spread and varied across sectors.[93] In ASM, restrictions to travel have resulted in many challenges for women including restricted access to buyers and profit losses as commodity prices at the site do not reflect market values.

In LSM, reductions in shift hours, job losses, increased childcare responsibilities combined with working from home or extended quarantine-related swings onsite that increase time spent away from families have created increased financial and personal pressures on women who work in the industry. These added pressures have also highlighted how women have been able to adapt to the changes and to maintain their roles where possible; "no mining operation has come to a standstill because a woman is a mother."[94]

For women entrepreneurs in exploration and mining services, entering into the market was challenging before COVID-19 and is even harder now as social distancing has increased operational expenses that are susceptible to periods of low activity. Increased levels of fear and stress for women regarding their financial security as well as their ability to fulfil their triple roles as workers, care providers and community leaders is a common theme that has been highlighted in COVID-19 discussions and action plans.[95] Recognising that women choose to mine[96] and have been mining in many contexts and geographies for many years,[97,98] one is required to reframe ideas about women's agency in mining sectors. Applying a gender lens to inquiry into mining contexts has helped shift the focus from women viewed solely as victims of mining industry practice, which lead to protectionist development approaches rather than recognise, value and centre women's roles as experts in their own lives. In the context of COVID-19, considerations of the gendered impacts of mining, crystallise the urgency to better understand and support women's leadership and equal participation in decision-making processes. This requires an intentional approach at every level and stage of extractives governance and industry.

[90] For example: http://wimowa.org/

[91] https://awimaafrica.org/

[92] https://internationalwim.org/ (LSM) and

[93] https://awimaafrica.org/voices-of-african-women-in-mining-webinar-june-4th-2/

[94] Pers. Comm. Zenzi Awases, President WIM Namibia

[95] https://www.afdb.org/en/news-and-events/press-releases/affirmative-finance-action-women-africa-impacther-and-un-women-policy-brief-exposes-disadvantages-women-entrepreneurs-post-covid-19-era-offers-solutions-36891

[96] Werthmann, K. (2009). Working in a boom-town: Female perspectives on gold-mining in Burkina Faso. Resources policy, 34(1), 18-23

[97] Benya, A. (2017). Women of the mines: apartheid and post-apartheid lived realities of South African women. Storia delle Donne, 13, 79. doi:10.13128/SDD-23957--CCBY4.0IT,2017.

[98] Lahiri-Dutt, K. (2020). The act that shaped the gender of industrial mining: Unintended impacts of the British mines act of 1842 on women's status in the industry. *The Extractive Industries and Society*, 7(2), 389-397. doi:https://doi.org/10.1016/j.exis.2019.02.011

A participatory approach to developing gender-sensitive monitoring tools in EI

Women and girls in mining areas live in generally difficult and disadvantaged conditions and are rarely involved in decisions of mining revenue expenditures. At the enterprise-level, they rarely access managerial positions and capacity strengthening opportunities, and in the artisanal mining sector their health and that of their families may be impacted by using harmful products.

For example, in Guinea, women and girls in mining areas enjoy very few economic opportunities (often due to low education rates, stereotypes, and socio-cultural burdens of their environment). This situation has led Development Gateway (DG), in partnership with Women in Mining (WIM) Guinea, with the financial support of Open Society Initiative in West Africa (OSIWA) to pilot the development of an index designed to capture the barriers hindering women's involvement and empowerment in the mining sector. The WIM Guinea Pilot Index and online visualisation tool was based on national indicators and variables for three mining prefectures: Siguiri, Boké, and Kérouané. The Index focussed on six themes: government commitment to address women's issues; mining companies' commitment to improve women's inclusion and promote their empowerment; the role of civil society organisations (CSOs) in advocating for women's rights; the role of women in communities, and the impact of mining on women's health. Each prefecture displays a different score, derived from the compilation of indicator values for each of the themes.

The approach was based on a key premise: it would evaluate the impact within the broader socio-cultural context if it is to sustainably and comprehensively address issues of gender inequity. It would not simply measure inclusion, such as counting the number of women who work in mining companies, sit on boards of directors, or own mining licenses. As every country has different social, cultural, religious contexts, it is very important to take that into account to ensure women are more involved in the extractives sector.

Guinea has a very strong legal framework with clear requirements of how many nationals should be employed in private companies. The data revealed that for private companies the local capacity is not available, even when companies wanted to hire women for their mining companies. Assessments with stakeholders (private companies, government agencies, communities) generated significant findings:

1. Women spontaneously refuse some corporate or business opportunities due to historical cultural reasons and obligations;

2. Attendance levels for women in educational institutions is in some cases below 10 per cent, and many do not complete their studies.

During the pilot phase, significant findings included that while the laws, strategies, and legal frameworks may exist and be world-class, in practice those laws may not be applied, monitored, or enforced. Currently, many nations do not really have the resources to conduct thorough monitoring of mining activities. Some mining companies are not evaluating their compliance and are not being sanctioned for their lack of compliance with their legal obligations. The Index is designed to publish reported data on cross-cutting extractives sector issues, including the environment, health conditions, and gender.

Reporting invites private companies to report on their gender figures, but also publish their own reports with the data. Being open and sharing information about how mining companies are putting in place mechanisms to ensure that women are protected, their rights are protected, and also encouraged is a step in the right direction for gender equity. The Index aims to make information legible for lay people to understand and verify, including those people who may be affected. Beyond this first experimental phase, the WIM Guinea Pilot Index aims to be a large-scale advocacy tool and a reference to address women's issues in the extractives industries at country-level.

4. Beneficiation

4.1 Beneficiation and manufacturing

Beneficiation is the adding of value to a commodity (mineral, metal or other natural resources). What is of critical importance in the analysis and decision-making around beneficiation is the net value addition at each step, and where that beneficiation occurs. Beneficiation occurs both downstream and upstream—it is not only transformation of an ore to a final product; it includes all inputs in those activities, including inter alia, capital equipment, infrastructure, services, and all the consumables, such as chemicals and fuels etc.[99] The crucial element to beneficiation upstream and downstream is knowledge linkages, which are primarily human capital development, and the associated research development and innovation.

> **"A crucial opportunity for maximising higher quality jobs for African nations derived from mineral extraction industries is through mechanisation using local technologies and equipment or systems to tackle currently sub-economic resources and thereby transforming as many manual underground jobs as possible."**

[99] Mjimba V., (2011) The Nature and Determinants of Linkages in Emerging Minerals Commodity Sectors: A Case Study of Gold Mining in Tanzania. Making the Most of Commodities Programme (MMCP) Discussion Paper No 7.

Beneficiation can be confusing and misunderstood. If a nation has a mineral, it does not automatically mean it is crucial for that nation's development or is necessarily attractive to pursue its beneficiation. The Southern African Development Community's (SADC) Regional Mining Vision (RMV) is instructive here and asks the question: 'What are the key minerals that need to be beneficiated for use in our economy?', which is derived from the observation that all advanced economies ensured that they produced their key economic inputs.[100] Key inputs are steel (by far the most essential metal), polymers, energy minerals (including, in the short perhaps medium term, fossil fuels and radioactive), and other infrastructure minerals (such as those used in cement), base metals (commonly for electrification such as copper and aluminium), clays and aggregates, and finally agricultural inputs, primarily nitrogen, phosphate, potassium (NPK), and agricultural lime. Countries seeking to maximise the opportunity for inclusive development should aspire to produce their critical feedstocks (particularly relevant since the global impact of COVID-19); they create downstream and upstream jobs in manufacturing, construction and agriculture. In this regard, due to the ever-increasing volumes for economies of scale, regional and pan-African strategies are a critical economic aim and driver and could contribute significantly to inclusive economies and development. Several advanced economies invested heavily in beneficiation even when they had no minerals. For example, South Korea[101] and Taiwan invested in steel and polymer industries to underpin their manufacturing sectors that were crucial to their development. Both countries imported iron ore and petrochemical pre-cursors as well as created the energy to transform the raw ingredients into steel and polymers. By doing so, both countries benefited economically and socially by creating jobs in the beneficiation of the materials that were then consumed in construction and manufacturing.

At the same time, a number of minerals also enable niche beneficiation that can attract additional investment from further value addition in their 'home' country, which may otherwise be exported (i.e. diamonds in Botswana and more recently South Africa[102] and tin in Rwanda) and new industries can be created around such developments. However, beneficiation, for it to be sustainable, must always make economic sense. The more valuable the mineral, the less your endogenous ownership matters as transport becomes relatively less costly, and you lose your geographic advantage. Many mineral beneficiation processes are also energy or water intensive and the cost and abundance of those inputs are also rate limiting with regard to beneficiation. The economics of beneficiation are also dependent on ore grade and the particular local mineral complexes.

In some cases, where a country or group of countries has a significant share of global resources of a mineral, producer power can be used leverage investment into downstream value-addition by giving preferential supply to local beneficiation facilities, as Botswana has done in migrating diamond sorting and polishing from Europe. Another potential case could be for cobalt beneficiation (Li-ion batteries) on the Copperbelt which holds 60% of global resources (DRC and Zambia).

A crucial opportunity for maximising higher quality jobs for African nations derived from mineral extraction industries is through mechanisation using local technologies and equipment or systems to tackle currently sub-economic resources and thereby transforming as many manual underground jobs as possible into high quality skilled occupations (manufacturing machinery, associated ICT, components, service and support, etc.) in the mining supply-chain. Several studies indicate that mechanisation could be job neutral in number[103] (jobs lost at the face are gained in the supply-chain) and job positive in quality (shift to above ground manufacturing and services). Maximisation of the potential is only possible with the appropriate enabling higher education environments, which leads to many multipliers and a platform for a modern minerals sector. For example, the RMV advises 'Let's concentrate on steel and polymers because we want to create manufacturing jobs,' and such an exhortation implies extracting the full benefits of local production, both downstream and upstream of the mining activity. Maximisation of the potential is also critically dependent on scale economies, underlining the need for regional economic integration.

Furthermore, realising the creation of manufacturing jobs often implies successfully implementing and achieving targets for 'local content' or 'rules of origin' in the production of key inputs for an economy. Local content outcomes however, require more than legislation and success relies on the critical role of capacity development. For example, Mozambique's legislation and regulations that gives 'local' preferential treatment. Similarly, South Africa has the 'MC3' (the Mining Charter Three), which has procurement rules about origin and associated targets. These 'local content' or 'rules of origin' policies are transferable to any nation but only work if there is a clear plan for the development of skilled local and regional labour and capital to support the requirements.

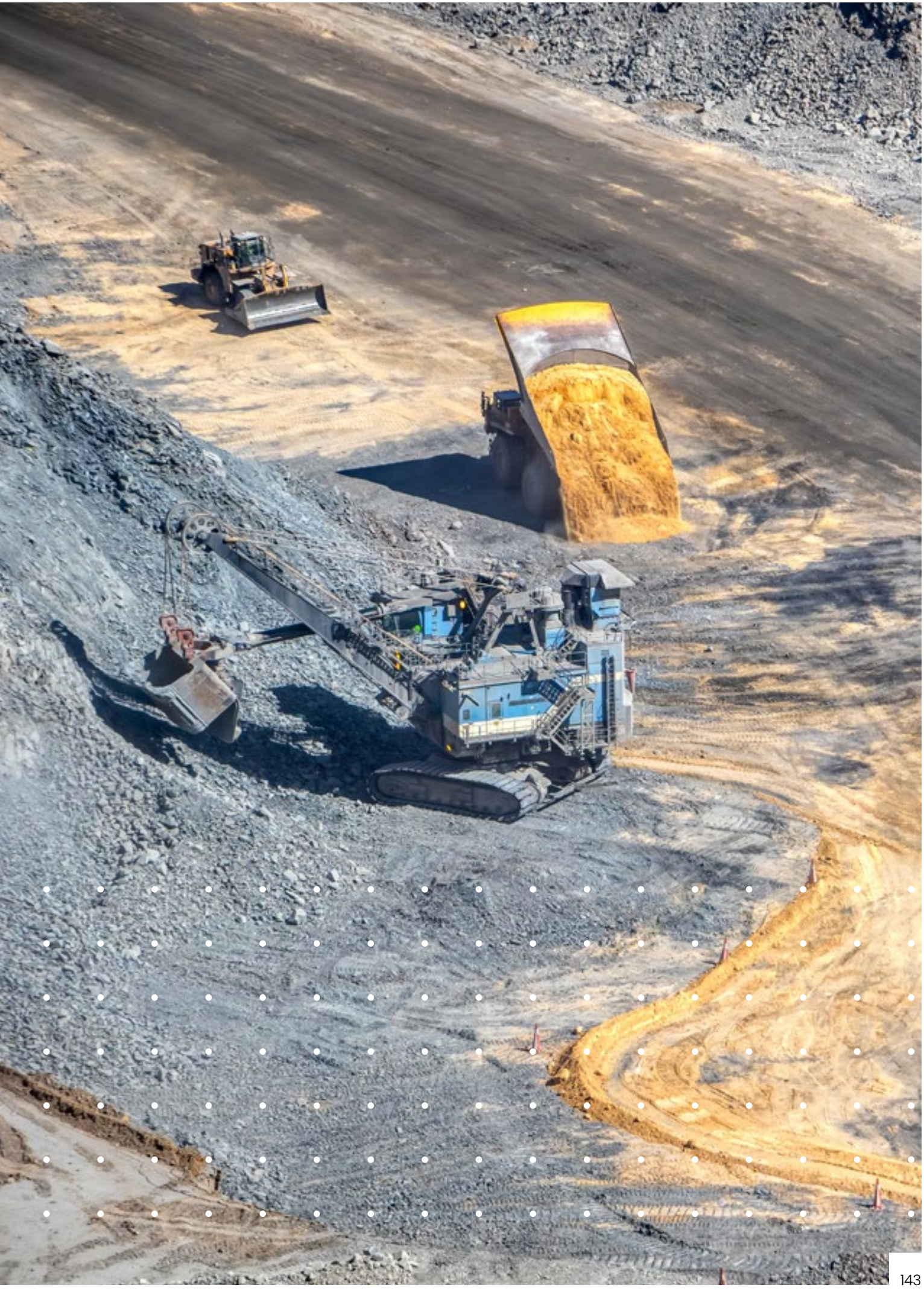
"Maximisation of the potential is only possible with the appropriate enabling higher education environments, which leads to many multipliers and a platform for a modern minerals sector"

[100] Pers. Comm. Jourdan, P. (2020).

[101] D'Costa, Anthony. (1994). State, steel and strength: Structural competitiveness and development in South Korea. The Journal of Development Studies. 31. 44-81. 10.1080/00220389408422348.

[102] https://www.miningweekly.com/article/de-beers-invests-further-in-growing-diamond-beneficiators-2020-10-09/rep_id:3650

[103] Table 3.4.10 of "National and sector specific social and economic implications of selecting capital or labour intensive methods of coal production", Task 7.14.1, 2002, by S G E Ashworth, N M H C MacNulty and A Adelzadeh (CSIR: Mining Technology and National Institute for Economic Policy).



Mali's Lime as an Extractives and Agricultural Investment Opportunity

Gold mining and agribusiness (in particular cotton) are significant contributors to Mali's GDP and foreign exchange earnings. One of the upstream inputs into gold production is quicklime, which is used to modify the pH level, control utilisation of cyanide and inhibit production of highly toxic hydrogen cyanide gas. Lime (CaO) is derived from calcium carbonate ($CaCO_3$), which characteristically occurs in nature as limestone ($CaCO_3$) or dolomite ($MgCO_3$). More specifically the calcined or burned form of limestone is known as quicklime or calcium oxide (CaO) that form calcium hydroxide ($Ca(OH_2)$). The conversion of limestone to quicklime occurs through 'calcining' in kilns with a ratio of approximately two tonnes of pure limestone to one tonne of quicklime.

Traditionally Mali gold producers have relied on imported quicklime from Europe (and some from Ghana) as an input into the gold extraction value chain. This dependence on importation is despite the presence of significant lime deposits in country. Overall West African consumption of quicklime is estimated at over 200,000 tonnes per year for commercial operations. In addition, Mali has an estimated agricultural lime requirement of over one million tonnes per year to improve productivity in acidic soils. The associated change in soil pH makes other minerals bio-available to plants resulting in higher yields.[104]

The International Finance Corporation (IFC) with support from the IDA Private Sector Window,[105] is providing financial and advisory assistance to the Malian private sector by investing €8.9 million in Carrières et Chaux du Mali (CCM). This investment will allow CCM to double its annual production capacity of locally produced quicklime to 30,000 tonnes, while developing the capacity to produce 50,000 tonnes of agricultural lime per year. CCM currently employ 146 workers. Local product substitution into the gold value chain can deliver an equal agricultural benefit that would not otherwise be available. It will also make Mali "a local and regional champion in the production of quality quicklime at competitive prices."[106] Within the framework of the IFC/CCM project, the consequences (intended and unintended) of the introduction of locally produced quicklime will be assessed, and how this market disruption affects imported product pricing as a result of the imposition of tariffs and the application of

[104] H. Shahandeh, F. M. Hons, L. R. Hossner & M. D. Doumbia, (2004). Effect of Diamou Lime, Gypsum, and Tilemsi Phosphate Rock on Acid Soils of the Sudano-Sahelian Region of Mali, Arid Land Research and Management, 18:1, 77 88, DOI: 10.1080/15324980449024503l.

[105] https://ida.worldbank.org/financing/ida18-private-sector-window/local-currency-facility-lcf

[106] https://pressroom.ifc.org/All/Pages/PressDetail.aspx?ID=26073

Local Content Rules (LCRs) and international mining company compliance. LCRs are a mechanism increasingly used by national governments to "facilitate wealth creation, local participation, domestic linkages and clusters growth, and socio-economic development linked to mineral exploitation."[107] One of the factors that determine the extent of positive impact of natural resource extraction is the level of local content in the industry.[108] CCM, estimates that IFC's support will help the company cut production costs by up to 20 per cent to better satisfy the increasing local demand for quicklime and agricultural lime. It will "also strengthen our exports of agricultural lime to farmers in neighbouring Côte d'Ivoire, Guinea, and Senegal."[109]

IFC is also developing a soil management advisory program to strengthen CCM's commercial and technical capacity[110] to help it increase sales. A second phase of the program will include training for thousands of the country's smallholder farmers on the use—and benefits—of agricultural lime. For example, the use of agricultural lime at the rate of 300 kg/ha on farmers' fields yielded a relative increase of 19.2 to 79.5 per cent in maize yield, representing an overall average of about 45.1 per cent increase in maize yields in Bougouni, Koutiala, and Sikasso. Similarly, the use of aglime at a rate of 1,000 kg/ha in Sikasso increased potato yields from 24,761 kg/ha to 28,388 kg/ha, representing a relative yield growth of about 15 per cent.

A recent study by IFC on the financial analysis of aglime on maize production in Mali indicated that with an additional investment of 18,000 XOF in purchasing aglime, a farmer could increase her/his profit by about 46,458 XOF/ha. This assumes that aglime is sold at 60,000 XOF/tonne, whereas the maize is sold at 125 XOF/kg. IFC has concluded some initial studies on soil testing. This first phase of advisory project targets CCM staff and key partners for 'training of trainers'. CCM technical staff will in turn, extend the knowledge to agrodealers and farmers.

Finally, over the last decade, the Economic Community of West African States (ECOWAS) has been developing a regional regulatory and policy framework with the ultimate objectives of harmonising national regulations and policies across member states. This effort is in line with the regulations stressed in the recent Regional Agricultural Investment Plan for Food Security and Nutrition (RAIP-FSN, 2016-2020). ECOWAS supports and encourages the development of a strong private fertiliser sector in West Africa. The USAID West Africa Fertilizer Program (WAFP)[111] worked with public officials to harmonise national fertiliser regulations and implement quality control programs to meet the regional standards by ECOWAS. The case of the West African Fertiliser Association (WAFA) exemplifies this support from ECOWAS to which CCM belongs.

"Finally, over the last decade, the Economic Community of West African States (ECOWAS) has been developing a regional regulatory and policy framework with the ultimate objectives of harmonising national regulations and policies across member states."

[107] Oliver P. Maponga, Chilombo Musa (2021) Domestication of the role of the mining sector in Southern Africa through local content requirements, The Extractive Industries and Society, Volume 8, Issue 1, Pages 195-210,ISSN 2214-790X, https://doi.org/10.1016/j.exis.2020.06.001.

[108] Owusu, R.A. and Vaaland, T.I. (2021) Achieving Local Content in Extractive Industries of African Countries. International Journal of Innovation and Economic Development, 7(1), pp.28-36.

[109] Personal communication Mr. Madani Diallo, CEO of CCM.

[110] IFC Annual Report, (2020) accessed from the web: https://www.ifc.org/wps/wcm/connect/d18d6d6e-72d5-41ae-b46b-e3afad488254/IFC-AR20-Country-Stories.pdf?MOD=AJPERES&CVID=nmZ3WGw

[111] https://2012-2017.usaid.gov/sites/default/files/documents/1860/WAFP%20Fact%20Sheet%20Oct%202015.pdf

Steeling Zimbabwe's Future: China, Zimbabwe and Tsingshan Holding Group

Zimbabwe's steel production has declined gradually from above 500,000 metric tonnes annually in the early 1990s to effectively zero[112] with the closure of Ziscosteel in 2016,[113] and the remaining production recycling scrap materials only. At the same time Zimbabwe imports over a billion USD in steel products annually. Economic revival of Zimbabwe's steel production has been explored as a major opportunity,[114] and in June 2018 an agreement between Chinese industrial giant Tsingshan Holding Group and Zimbabwe was signed. The deal involves three projects in Selous, Hwange, and Mvuma that may revive steel-making and additional industrial transformation in Zimbabwe.

Tsingshan Holding Company in Zimbabwe

Tsingshan is a privately-owned company based in Wenzhou, Zhejiang province, China. Its core business is the production and sales of stainless steel flat and long products (steel castings, bars, wires, plates and other products). The company ranks in the 300-range of the Fortune 500 list, and is the world's top producer of nickel, which is an important component of lithium-ion batteries within their recent expansion into electric vehicle components and related systems.[115] Tsinghan established a presence in Zimbabwe in 2012 with the establishment of local subsidiary Afrochine Smelting (Pvt) Ltd with two 16.5 MVA smelters for ferrochrome smelting in Selous, Mashonaland West province, a short distance from Harare[116] (Figure 3). These have an initial capacity to produce 50,000 metric tonnes of ferrochrome per year and employ about 400 local people. It is intended to build four bigger furnaces (4 x 25MVA) for high carbon ferrochrome production of 200,000 tonnes per annum, and employing more than 1,000 people.[117] Construction of two of these, in Selous, was completed in May 2021.[118]

Afrochine aims to establish Zimbabwe's ferrochrome industry for both domestic and export demand. In mid-2021 Afrochine's 150,000 tonnes of ferrochrome annual production was a small fraction of Tsingshan's 3 million tonne ferrochrome consumption: "The potential is huge and even after we set up a plant in Chivhu, it is not enough to satisfy our internal consumption, which means there is a lot of room to fill up in the future," a spokesperson for Tsingshan said.[119] Furthermore, a Memorandum of Understanding signed between Afrochine and Zimbabwe in June 2018 points to a bigger ambition related to steel.[120] The announcement of the US$1bn deal centred around developing an iron ore deposit and planned carbon steel plant with an initial annual capacity of 1 million tonnes by 2022, and 2 million tonnes by 2026.[121] The plant will cover a site of some 3,000 hectares and will be located in Manhize, Mvuma, some 200km south of Harare on a greenfield site.[122,123] Production is expected to replace Zimbabwe's steel imports of up to US$1bn a year and also enable export, hence helping Zimbabwe to earn foreign exchange, create thousands of jobs, and foster industrialisation.

[112] Mlambo, A. 2015 FROM AN INDUSTRIAL POWERHOUSE TO A NATION OF VENDORS: OVER TWO DECADES OF ECONOMIC DECLINE AND DE-INDUSTRIALIATION IN ZIMBABWE 1990-2015 presented at: "Africa and Asia Entanglements in Past and Present: Bridging between History and Development Studies", Kansai University, Osaka, Japan, 31 July – 1 August, 2015. https://repository.up.ac.za/bitstream/handle/2263/60780/Mlambo_From_2017.pdf?sequence=1

[113] https://www.newzimbabwe.com/zimbabwe-losing-us1b-annually-in-steel-imports-due-to-ziscosteel-closure-minister/

[114] Gudukeya, L., Mbohwa, C., & Mativenga, P. T. (2019). Industrial sustainability in a challenged economy: the Zimbabwe steel industry. *Procedia Manufacturing*, 33, 562-569.

[115] https://www.reuters.com/article/us-xcmg-tsingshan-nev-idUSKBN299075

[116] https://zimvest.org/service-provider/afrochine/

[117] It has been reported in local media in Zimbabwe that Tsingshan has also been granted a series of chrome special grants, by mid-2021 making it one of the largest chrome claim holders in the country. https://www.theindependent.co.zw/2021/06/04/locals-lose-77-mine-claims-to-afrochine/

[118] http://www.chinagoabroad.com/en/market_review/china-s-tsingshan-completes-two-big-zimbabwe-projects

[119] https://www.herald.co.zw/open-for-business-mantra-charms-chinese-steel-giant/

[120] http://www.xinhuanet.com/english/2018-06/11/c_137246923.htm

[121] https://africabusinesscommunities.com/news/tsingshan-holding-group-starts-work-on-$1-billion-steel-project-in-zimbabwe/

[122] https://www.herald.co.zw/open-for-business-mantra-charms-chinese-steel-giant/

[123] https://www.sundaymail.co.zw/tsingshan-deal-shows-the-way

Figure 3: Map, Zimbabwe

Mvuma is also proximate to a range of raw materials, including quality iron ore, limestone, coking-quality coal, fluorite for the flux, chrome for stainless steels, and smaller quantities of other metals such as nickel and vanadium. Following the 2018 agreement to develop the steel plant in Mvuma, two more major projects have been advanced in Zimbabwe by Tsingshan, in Hwange and Selous. By April 2021 Selous was newly home to two high carbon ferrochrome furnaces, and construction of a 150,000-tonne coke battery in Hwange had been completed by June 2021. A third Hwange coke battery and power station are also expected to be operational in 2021.[124] Tsingshan expects to become a net exporter of electricity by 2023 through the contribution of coal mining, coke production, and energy generation capital projects, mostly located in Hwange.[125] Tsingshan has also been granted some mineral concessions, for example to explore for coal in Hwange and nickel in Mvuma. A fluorite and limestone production plant have also been discussed, as has a lithium concession.[126] Overall, Tsingshan compares its ambition in Zimbabwe with its success in Indonesia. In Indonesia, Tsingshan has already invested over $10bn. In Zimbabwe, after the first deal of 2013 Tsingshan Holdings agreed to invest $2bn in Zimbabwe, and now it is in the range of $5bn.[127] Tsingshan is also investing and co-investing in railways and highways, logistics and electricity transmission in Zimbabwe. National Railways of Zimbabwe, for example, has been charged with drawing up the design for a railway line linking Mvuma and Manize , the latter being the town where the steel plant is to be based.[128]

[124] https://www.herald.co.zw/milestone-reached-as-chinese-mining-giant-starts-coking-coal-production/
[125] https://www.chronicle.co.zw/tsingshan-constructs-second-150-000t-coking-plant-in-hwange/
[126] https://businesstimes.co.zw/tsingshan-expedites-mvuma-steel-plant-project/; https://www.reuters.com/article/zimbabwe-mining-tsingshan-idINL8N2L768P
[127] https://www.newsday.co.zw/2019/04/govt-pens-5-billion-mining-deal/
[128] https://businesstimes.co.zw/tsingshan-expedites-mvuma-steel-plant-project/

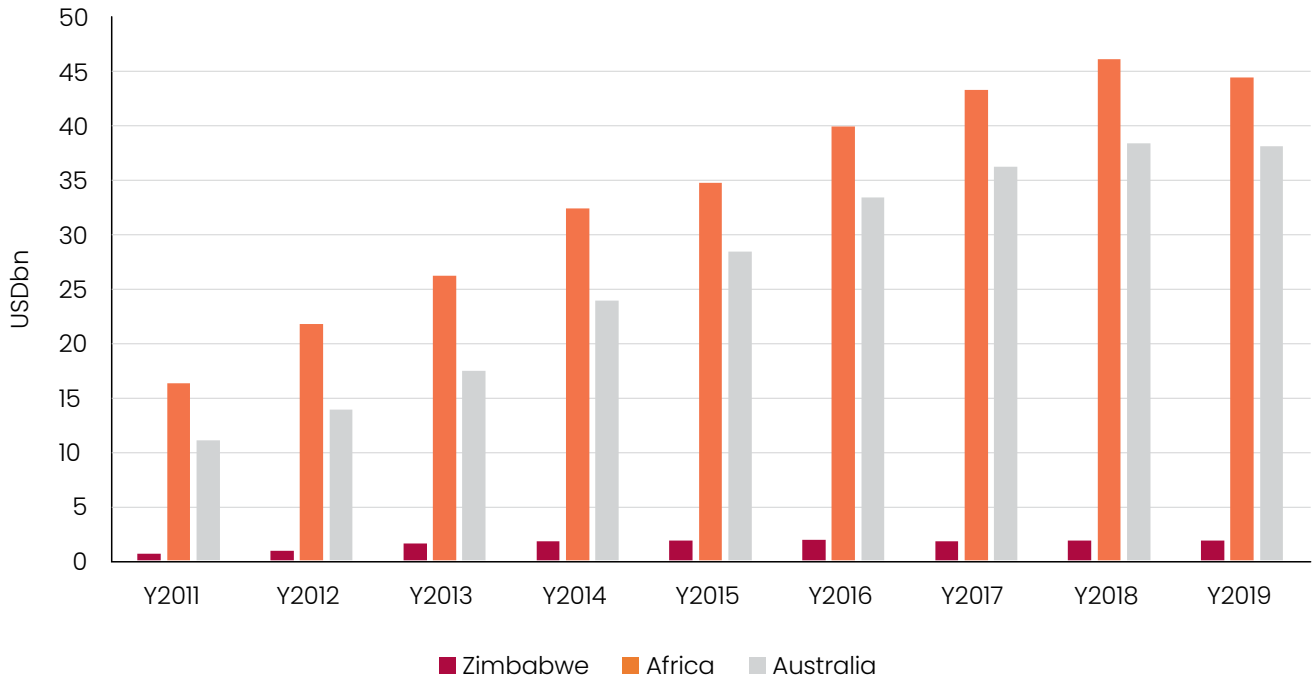
The China-Zimbabwe and Pan-African Context

The solid footing of Tsingshan in Zimbabwe is undoubtedly underpinned by long-standing close political ties between Harare and Beijing since Zimbabwe gained independence from the UK in 1980. China's support for Zimbabwe's liberation cause began from the 1960s and included military hardware and guerrilla training assistance, financial assistance, and ideological solidarity. This produced a lasting bilateral legacy[129] strengthened by a concomitant distancing between Zimbabwe and the UK from the later 1990s including in 2002 Zimbabwe's suspension from the Commonwealth, and the European Union imposed a travel ban on President Mugabe in 2003. These changes fostered a newly prioritised 'Look East Policy' in Zimbabwe, with China in particular, in focus.[130]

Where Western countries were imposing targeted sanctions on Zimbabwe, China-Zimbabwe relations became ever closer, if also more contentious.[131,132] Political turbulence with the West saw a dramatic drop in FDI, which fell from USD444mn in 1998 to just $5.4mn in 2001. Normalisation of ties began in 2008, although FDI has remained constrained.[133] In contrast, China and Zimbabwe agreed a bilateral investment treaty, which has been in force since 1998.[134] Over the last decade China's FDI in Africa has experienced tremendous growth—up from USD1.6bn in 2011 to USD44.4bn by 2019 (China MOFCOM, 2020) (Figure 4).[135]

Over the decade the sum of Chinese investment in Africa has exceeded that into Australia, but with Zimbabwe itself absorbing just a small share of total Chinese FDI into Africa, in the range of 3.5 to 5.2 per cent. This equates to an increase from USD576mn in 2011 to USD1.77bn by 2019 (Figure 4). Recently more investment is being encouraged in the mining sector. This reflects Zimbabwe's own push to take advantage of its minerals endowment to achieve higher economic growth rates.[136] It also reflects trade tensions between China and Australia, as China seeks to retain sufficient supplies of chromium, manganese, and nickel for its steel and renewables industries.[137] In the first three months of 2021, China imported 141,184 tonnes of chrome from Zimbabwe, a year-on-year increase of 36.4 per cent. Zimbabwe's export of high-carbon alloys increased by 9.6 per cent, to 27,632 tonnes, and nickel ore exports increased by 30.8 per cent to 12,079 tons.[138]

Figure 4: China's Foreign Direct Investment, 2011-2019



Source: China, Ministry of Commerce, Yearbook on Foreign Direct Investment 2020.

[129] https://media.africaportal.org/documents/saia_sop_202_alao_21041017.pdf

[130] Ojakorotu, V., & Kamidza, R. (2018). Look East Policy: The case of Zimbabwe–China political and economic relations since 2000. *India Quarterly*, 74(1), 17-41.

[131] Johnson-Thomas, Brian, Peter Danssaert, and International Peace Information Service (Antwerp). *Zimbabwe: Arms and Corruption: Fuelling Human Rights Abuses*. International Peace Information Service, 2009; Hodzi, O., Hartwell, L., & De Jager, N. (2012). 'Unconditional aid': Assessing the impact of China's development assistance to Zimbabwe. *South African Journal of International Affairs*, 19(1), 79-103.

[132] https://onlinelibrary.wiley.com/doi/abs/10.1111/polp.12373

[133] Gochero, P., & Boopen, S. (2020). The effect of mining foreign direct investment inflow on the economic growth of Zimbabwe. *Journal of Economic Structures*, 9(1), 1-17.

[134] UNCTAD (2021). https://investmentpolicy.unctad.org/international-investment-agreements/treaties/bilateral-investment-treaties/998/china---zimbabwe-bit-1996-

[135] Some scholars, however, argue that China's investment has brought problematic local results and generally been disappointing (eg. Gochero, P., & Boopen, S. (2020). The effect of mining foreign direct investment inflow on the economic growth of Zimbabwe. *Journal of Economic Structures*, 9(1), 1-17). It is not known if much more recent Chinese investment is having a different impact.

[136] Gochero, P., & Boopen, S. (2020). The effect of mining foreign direct investment inflow on the economic growth of Zimbabwe. *Journal of Economic Structures*, 9(1), 1-17.

[137] https://www.mining.com/china-faces-risks-due-to-high-chrome-manganese-nickel-import-reliance-report/

[138] https://finance.sina.com.cn/money/future/roll/2021-06-09/doc-ikqcfnca0068182.shtml

Of vital importance for both China and also Zimbabwe, and Africa more broadly, is what share of the minerals being invested by Tsingshan and other companies are intended for value-added processing in the African country of origin, and what share is exported within and outside of the continent.

Closer China-Zimbabwe ties are not without issues. In April 2021 *Mining Intelligence* reported that "Mnangagwa indulges Chinese miners despite growing unrest"[139] including the presence of at least 500 Chinese expatriate workers part of the initial phase of Tsinghua's steel plant and iron ore mining plans in Manhize. The company, however, highlights that the project will lead to employment of about 4,500 locals.[140] Prominent cases of Chinese mining bosses in Zimbabwe treating local staff poorly, with a case of a shooting ending up in an attempted murder case in 2020[141] have led to accusations of "colonial tactics & habits."[142] There were also concerns that Tsinghua via Afrochine had hoped to mine in Hwange National Park. Concessions had earlier been granted in 2019 to carry out exploratory drilling for coal, but mining in the park was banned in 2020. Locals and civil society were angered that Chinese-owned firms (Afrochine and Zimbabwe Zhongxin Coal Mining Group) had been granted such a concession to mine in what is Zimbabwe's oldest national park home to its largest elephant population.[143] Moreover, one of the concessions had incorporated two dams, Deteema Dam and Masuma Dam, which would have further strained already precarious water resources available to the animals.[144] China itself is now seeking to move toward a 'greener' economic model, and China's cooperation with Africa generally will enjoy a smoother trajectory if environmental damage during industrialisation is avoided.

China's investment in iron ore and steel production in Zimbabwe is part of a broader China-Africa push that is now two to three decades mature. It is also evident in other countries, including Guinea and Sierra Leone. In the case of the latter the development of iron ore resources has stalled.[145] In the case of the former most iron ore output is presently exported to China without additional local value-added processing. One factor behind the iron ore-related push might be trade tensions between China and Australia. Not only may this deepen China's interest to invest in alternative sources of iron ore, but also to reduce demand for iron ore domestically to reduce pollution and the need for importing energy. Between a potential shift of China's economy away from energy- and infrastructure-intensive investments, and also a shift toward reliance on recycled steel scrap, it is estimated that China's steel demand will peak by 2022, and that scrap will boom after 2030.[146]

In contrast to China, an increasing number of African countries (26 of 54) are now at least lower-middle income countries and home to growing young populations. African economic development will be typically relatively heavy in infrastructure investment, industrialisation, and urbanisation, and hence elevated demand for metals, such as steel.[147] In 2021, Zimbabwe media noted such factors in the context of China's investor interest: "this is after all one reason why Tsingshan wants to be in the middle of Southern Africa rather than build yet another mill in China, import some raw materials from Zimbabwe, and ship the steel a quarter the way round the world."[148]
For Zimbabwe, adding value to minerals locally is also important in it being understood that Zimbabwe does not offer the scale of geographic advantages of, for example, Australia, as an iron ore exporter.[149]

[139] https://www.africaintelligence.com/mining-sector_state-strategy/2021/04/26/mnangagwa-indulges-chinese-miners-despite-growing-unrest,109660493-art

[140] https://allafrica.com/stories/202106020151.html

[141] https://www.business-humanrights.org/en/latest-news/zimbabwe-workers-and-lawyers-association-accuse-chinese-mining-firms-of-gross-human-rights-violations-and-exploitation/

[142] https://www.business-humanrights.org/en/latest-news/zimbabwe-unions-calls-on-chinese-mining-firms-to-desist-from-using-colonial-tactics-habits-in-labour-disputes-after-shooting-incident/

[143] https://zimfieldguide.com/matabeleland-north/zimbabwe-government-makes-correct-call-and-bans-coal-exploration-within-hwange

[144] https://www.liberianews.net/news/266337899/zimbabwe-gives-coal-miners-concessions-in-national-park

[145] Johnston, L. A. (2017). Steel pipe dreams: A China-Guinea and China-Africa lens on prospects for Simandou's iron ore. *The Extractive Industries and Society*, 4(2), 278-289.

[146] Song, L., Wang, P., Hao, M., Dai, M., Xiang, K., Li, N., & Chen, W. Q. (2020). Mapping provincial steel stocks and flows in China: 1978–2050. *Journal of Cleaner Production*, 262, 121393.

[147] Hurst, L. (2013). West and Central African iron ore development and its impact on world prices. *Australian Journal of Agricultural and Resource Economics*, 57(4), 521-538.

[148] https://www.sundaymail.co.zw/tsingshan-deal-shows-the-way

[149] https://www.sundaymail.co.zw/tsingshan-deal-shows-the-way

RWANDA TIN SMELTER New Approach to the Added Value Generation in Africa – LuNa Smelter Ltd. Rwanda

African mining is a major socioeconomic driver on the continent. Africa produces more than 60 different metals and minerals, hosts about 30 per cent of the world's total mineral reserves, but is yet to fully unlock its potential for mineral extraction and processing. Most minerals are exported as raw materials or unprocessed concentrates with no added value in hosting countries. Lack of industrialisation and advanced processing is often given as one of the reasons for a well-defined 'resource curse' observed in Africa.[150]

There are several critical conditions for the in-country added value generation to be optimised and sustained. Adding value requires a significant involvement of all key stakeholders, coordination of joint actions executed simultaneously by hosting country's governmental representatives, investors, and in-country private sector partners. Quality infrastructure, adequate power supply and ICT services, a skilled labour force, improved shipping and visa procedures, represents a simple 'starting package' for the development of an advanced processing industry. Therefore, deep reforms, deliberate actions, and implementation of effective strategies are needed.

Rwanda Case – Tin Industry

Rwanda, together with Ethiopia and Côte d'Ivoire, represent the fastest growing economies on the continent. Rwanda is often called 'a Switzerland of Africa' not only due to its beautiful hills and surroundings, but due to its strategy to become the regional trade hub by capitalising on its landlocked location between East, West, and Central Africa. Mining is the second largest export sector in the Rwandan economy after tourism, and Rwandans have identified the importance of the in-country added value generation in mining.

The Rwandan mining sector is primarily based on producing '3TG' minerals—tin, tantalum, tungsten, and gold. Rwanda also possesses a variety of other minerals such as silica sands, kaolin, vermiculite, diatomite, clays, limestone, talcum, gypsum, and pozzolan. The foundations of the Rwandan tin industry were laid in the 1930's with cassiterite mines in Rutongo. With many other mines opening since, and a tin smelter developed proximal to the Rutongo mines in the 1980's in Kigali operating under one company. However, after the Rwandan genocide and liberation war in the 1990's, the smelter never operated successfully and became primarily a trading facility for export of unprocessed materials.

Recognising the need for new mineral processing investment, the Rwanda Mines, Petroleum and Gas Board actively sought investors for 3TG minerals with financial resources and a mining and metallurgy background. Luma Holding Ltd., a European industrial fund with more than 20 years of experience in the metallurgy sector, was selected to partner with the Board to unlock Rwanda's frozen tin metal potential.

[150] Good Governance Africa - "Reversing the Resource Curse" Campaign 2020/2021, https://gga.org

LuNa Smelter – Rwanda

LuNa Smelter Ltd. was established in 2018 by Luma Holding Ltd. and its Rwandan partner Ngali Holdings Ltd., which is a state-owned investment company. Within a year the former LuNa Smelter recommissioned the Karuruma tin smelter as part of an investment plan for a vertically integrated tin business. For more than 30 years Rwandan minerals were exported unprocessed with no beneficiation or added value generation. The plan was part of a Rwandan Governmental strategy to position the country as the central mineral and metal hub on the back of the national potential in tungsten and tantalum. Luna Smelter is listed as conformant under the Responsible Minerals Assurance Process (RMAP) as a global effort to responsibly source 3TG minerals. It is the only conformant African production facility, which processes cassiterite ore up to casting of the tin ingots to an average quality of 99.96 percent Sn.

LuNa Smelter not only processes minerals, but it also creates added value: it employs over 70 people in the Eastern Province; pays all applicable taxes and benefits; procures locally available products, inputs, and equipment; aims to limit its CO_2 footprint, and; develops highly needed corporate social responsibility (CSR) projects. In 2019 and 2020, LuNa Smelter directly contributed to the Rwandan State over 1,000,000 USD through payment of applicable fees and contributions.

Successful Added Value Generation – Critical Issues

Being an investor in LuNa Smelter, Luma Holding identified the primary risks, barriers, and opportunities for successful added value generation in Rwanda. Bottlenecks included raw materials access, fair business conditions (including taxation systems), access to a skilled work force, and especially issues with operating in a 'Conflicted Affected and High Risk Area' (CAHRA).[151] Although LuNa Smelter is the only smelter in Rwanda, access to key raw material (cassiterite concentrate) was insecure until Rutongo could be integrated with the smelter. LuNa Smelter developed its own cassiterite concessions in Rwanda, initiated numerous partnerships with various producing mines, and has started regional dialogue for sourcing the material, and also cooperating with mining cooperatives to build capacity, introduce best practice mining, and attract geological and mining engineering expertise to the junior mining operations. Tin smelting consumes a large amount of electrical energy, representing the second largest input cost in LuNa's tin production. Improved electrical efficiencies will significantly improve the profitability of the operations. With a high power factor, smarter management of electricity consumption at the smelter can also reduce power losses in the Rwandan national power grid and improve system stability/reliability.

Taxation challenges

Since its establishment, the mineral tax of 4 per cent has been imposed on the tin metal produced at LuNa Smelter, paid based on the export value of the metal. In contrast, LuNa's competitors (exporters of unprocessed cassiterite concentrate) attract the same mineral tax rate, which is calculated on the significantly lower value of their material (also reduced by transport and insurance costs). Therefore, LuNa Smelter has faced a challenge of validating its business case and competing with other 'low-cost' exporters of raw materials. Supported by the Rwanda Mines, Petroleum, and Gas Board, LuNa Smelter has been negotiating a more equitable tax regime with the Rwanda Government.

Focus on education

Being part of Luma Holding investments, LuNa Smelter employees have benefited from knowledge transfer of advanced metallurgical processing to bolster the workforce capabilities in Rwanda through experts and technology teams supporting the project development and local employee training. After 2 years of continuous training and development, smelter operations are currently conducted by Rwandans only, with LuNa Smelter having only three expatriates based in Kigali. Luma Holding has invested in employee education by supporting university education, funding research scholarships for Rwandans domestically and abroad, and closely cooperating with the University of Rwanda.

[151] Conflicted Affected and High Risk Area. The list of CAHRAs must include, at a minimum: 1) The Democratic Republic of the Congo (DRC) and its nine adjoining countries as outlined in Section 1502 of the Dodd Frank Act, namely Angola, Burundi, Central African Republic, Republic of the Congo, Rwanda, South Sudan, Tanzania, Uganda, and Zambia; and 2) the indicative list of CAHRAs provided by the European Commission pursuant to Article 14.2 of the European Union Regulation 2017/821. Responsible Minerals Assurance Process Tin and Tantalum Standard, 2020, p. 20.

4.3 Fiscal Measures for Successful Regional Coordination to Achieve Scaled Beneficiation Investments

First and foremost, the aim is that resources that comprise African infrastructure come from Africa, being extracted and transformed into final goods at a regional level, not at a national level if conditions are not conducive. Regional beneficiation centres for beneficiation have largely failed because each host nation captures the indirect and direct fiscal benefits at the expense of others. The Third Commission recommends that one solution may be multi-state-ownership, where different countries own the investment on a pro-rata basis on product delivered. Therefore, agreement from governments surrounding fiscal benefits from a facility (including income taxes, corporate tax, goods and service taxes etc.) is reallocated as a form of the total fiscal benefit from the activity, rather than a 'dividend' to each nation as a 'shareholder'. By pooling total fiscal benefits and distributing it according to the feedstock supplies would avoid single nation attempts to replicate smaller sub-optimal beneficiation investments that do not meet commercial scales needed to be competitive globally. Nations within a region need to negotiate and agree how to equitably distribute the total benefits of such investments. The arrival of the Africa Continental Free Trade Area (AfCFTA) is a new catalyst and then enabler in such negotiations.

> **"The Third Commission recommends that one solution may be multi-state-ownership, where different countries own the investment on a pro-rata basis on product delivered."**

Without appropriate regional investments at scale, development of beneficiation projects on a commercial basis is difficult. Achieving appropriate commercial scales that are globally competitive is at the heart of the beneficiation challenge in Africa due to relatively small nation states and associated resources, and the relatively small size of the current local demand. That does not mean however that increased self-reliance in the first instance should not be a goal—it should. However, opportunities such as copper production are viable at smaller scales, in particular copper rolling plants, and copper manufacturing and continuous cross rod (CCR) production. For example, Zambia has two CCR rod plants. In contrast, a steel rolling plant should not be scaled below two million tonnes p.a. Other than South Africa, there is no African country with a large enough current demand for steel, which is why a regional strategy is crucial for any steel production industry to meet key development supply security. Zimbabwe has addressed this conundrum in a different manner with Chinese partners that will deliver locally produced steel for Zimbabwe construction and manufacturing (which it currently imports) and steel for export delivering greater balance of trade much needed foreign currency reserves. This is also why the Regional Mining Vision (RMV) in Africa is important; to achieve appropriate scale and share benefits of local industrialisation equitably and fairly.

And in Nigeria, with minimal copper ores and no bauxite, there is a strong domestic cabling industry, initially built on demand from the oil and gas industry but also serving the building and transportation industry. Represented by the Cable Manufacturers Association of Nigeria the various companies are currently under threat from counterfeit and substandard imported products, not to mention the threat to life as a result of installation of such products.[152,153] The issue of counterfeit and substandard importations requires a joined-up government approach between customs, standards regulators and enforcers and local industry as well and the promulgation of public campaigns directed at the serious consequences of using such materials. With the projected growth in low-voltage cabling for the burgeoning renewable energy market and localised deployment of mini and micro-grids[154] as well as adoption of small-scale battery-operated electrified machinery and lighting (for households, agriculture and transport[155]) significant encouragement of this domestic beneficiation industry should be a priority of governments across the continent.

[152] https://thenationonlineng.net/why-substandard-cable-market-thrives/

[153] Ugura, H. and Obukoeroro, J (2020) A Survey of Residential and Mini-industrial Wiring Systems in Nigeria: A Case Study of Bayelsa State, Southern Nigeria *Direct Research Journal of Engineering and Information Technology*. Vol. 7, 2020, 148-154 ISSN 2354-4155.

[154] Rural Electrification Agency, Nigeria. Accelerating access to sustainable energy for all: Scaling-up sustainable rural electrification in Nigeria. http://rea.gov.ng/. Accessed August 17, 2018.

[155] McHenry, Mark P. & Doepel, David (2015). "The 'low power' revolution: Rural off-grid consumer technologies and portable micropower systems in non-industrialised regions," *Renewable Energy*, Elsevier, vol. 78(C), pages 679-684.

4.4 Supply Security and Resource Rents

Innovative mineral and energy tax regimes stimulate exploration, development, transportation, and infrastructure investment. In contrast, non-progressive mineral and energy tax regimes hinder potential tax revenues, economic development, infrastructure investment, and reduce supply security. Investors seek a reasonable rate of return over time, after which they are more amenable for taxation, particularly on profits. Negotiating key locally extracted minerals and energy access at a purchase price of supply cost plus a reasonable return, in combination with an appropriate taxation regime will improve domestic supply security. It is critical that mineral and energy investments ensure local supply security for key economic resources, but which does not deter investment. It is one reason why resource rent taxes are an attractive means of sharing both risks and benefits between investors and nations states.

By negotiating a tax regime based on metrics other than vagaries of ores and concentrates and moving towards terminal prices that enable transparency and activity validation, mineral and energy production can maximise investment and supply security while minimising illicit exploitation.

> **"Negotiating key locally extracted minerals and energy access at a purchase price of supply cost plus a reasonable return, in combination with an appropriate taxation regime will improve domestic supply security."**

4.5 Barriers to beneficiation

Arguably, the single largest barrier to all types of downstream and upstream mineral beneficiation are illicit financial flows. It is estimated that the illegal financial flows leaving Africa through over invoicing inputs and under invoicing outputs is greater than all foreign direct investment in Africa. With no downstream beneficiation the ore or concentrate enables an obfuscation of transparent pricing (mispricing) and avoids terminal pricing. Because each ore or concentrate is unique, there is no standard price. However, with terminal prices for a standard product of a certain grade, there is a very definite international market price, and therefore an associated tax burden. With upstream inputs and avoiding use of local content, overseas trading companies can be used to minimise taxes. Quite simply you cannot over invoice inputs if they are sourced from the host country.

Throughout history, mining companies needed to be involved in upstream and downstream beneficiation, not solely focussed on extraction, known as a 'core competency', as they are often today. In greenfield sites, mining companies constructed foundries, roads, schools, farms, etc. At the present time the very high profits from mineral extraction are themselves a barrier to beneficiation. With the recent focus on 'core competency' of mineral extraction return on investment, exceptional profits and return on investments can be made. This contrasts with the relatively low returns from every other industry. This provides very little incentive for mineral extraction companies to invest in upstream and downstream beneficiation outside of the 'core competency' of extraction.

International agreements and subsidies are also barriers to beneficiation. The quickest and easiest means to encourage local beneficiation are export taxes. However, international governments negotiating economic partnership agreements with African nations are preventing African nations from using these forms of incentives for local beneficiation (the SADC EPA, for example). This is despite most countries successfully using them in the past to their own development benefit. This ensures the benefits of unencumbered global access to raw materials from Africa.

Appropriate scale and the appropriate location are essential. The RMV puts forward that we locate the larger industrial investments in the cheapest possible location based on raw material access (while arrangements equitably share benefits of these single large investments). However, the RMV has only been approved at the level of the Ministers rather than at the highest level. Mining ministers from each country in Africa often include the industry and trade portfolios, and do not have a frequent platform to meet with each other frequently. This engenders challenges in garnering support for the larger regional projects that require interjurisdictional support. Again, AfCFTA is a promising new catalyst and then enabler for the creation of appropriate government-to-government structures.

Exploring linkages with the mining sector can further catalyse discussions around associated supporting infrastructure, including both hard and soft infrastructure such as education, R&D, finance, etc. Mining infrastructure usually focusses on rail or port developments. However, less obvious are the associated benefits from the supporting infrastructure of the rail and/or ports and the feeder roads. Development negotiations for these smaller feeder roads should always ensure they remain accessible to other sectors of the economy. Even roads, which may or may not have been constructed as a public-private partnership (PPP) and may have restricted access such as a toll road. Crucially, all roads will have public access negotiated. In agricultural regions new roads are an absolute lifeline, reducing time and costs, and opening major new inter-sectoral opportunities on the largely agriculturally dominant African continent.[156]

"The Third Commission recommends that one solution may be multi-state-ownership, where different countries own the investment on a pro-rata basis on product delivered."

[156] McHenry, M.P., Doepel, D., Zhou, E., Murray-Prior, R. and Dixon, J. (2015) *Agricultural land use changes through inter-sectoral and international engagement: The interface of mining and agriculture in Mozambique.* In: McHenry, M.P., Kulshreshtha, S.N. and Lac, S., (eds.) Land Use, Land-use Change and Forestry. Nova Science Publishers, pp. 135-147.

5. Enhanced Governance and Transparency

Africa reportedly loses an estimated US$70 billion annually to illegal transactions.[157] In its 2013 report the APP detailed how billions of dollars were leaving Africa every year, particularly through illicit transfers in the oil, gas and mining industries. In a 2015 Summit Declaration, the African Union expressed concern that an estimated US$1.8 trillion was lost by the continent between 1970 and 2008.[158] In their Declaration, African leaders also called for greater capacity building in African states in *"contract negotiation, tax management, regulatory and legal frameworks, policies, money laundering, asset recovery and repatriation, and resource governance"* to improve governance of the extractives sector.

Momentum has been building in recent years through the activities of a cross section of stakeholders to improve governance and transparency in the sector. The High-Level Panel on Illicit Financial Flows from Africa, led by former President of South Africa, Thabo Mbeki, has undertaken notable measures to create awareness at the national level within the continent as well as internationally, and to initiate steps to strengthen institutions to counter these practices. Additionally, the African Development Bank, in its High 5s Agenda, has committed to doing more in the fight against illicit financial flows.

[157] Kar D. & Spanjers J., (2015) Global Financial Integrity, Illicit Financial Flows from Developing Countries: 2004-2013, at vii, Dec. 2015, http://www.gfintegrity.org/wp-content/uploads/2015/12/IFF-Update_2015-Final-1.pdf

[158] African Union, Assembly Special Declaration on Illicit Financial Flows, Doc. Assembly/AU/17(XXIV), at para. 1, Jan. 31, 2015, available at http://www.au.int/en/sites/default/files/documents/29831-doc-assembly_declaration_on_illicit_financial_flow_-_english.pdf

5.1 Blockchain solutions

Blockchain is one promising technology that has potential to significantly promote transparency and help reduce fraud and corruption, where "countries are calling out for transparency and accountability for what deals are being made behind closed doors. There needs to be a way to fight illicit financial flows."[159] Paradoxically while creating privacy via encryption, it also creates transactions in plain sight (to anyone). The values associated with them are also unalterable and persistent—meaning that prior transactions are never deleted. The issue of transfer pricing where much discussion on corporate illicit flows is often focused, is one where it could help to bring much greater clarity for all.[160] Through providing a means by which transfer pricing rules can be applied using smart contracts between a network of parties involved in frequent transactions, it provides scope for significant simplification of compliance and tax reporting processes. Tax related blockchain applications remain still in relatively early stages of development globally, however.

One area where significant progress has been made is in supply chain transparency. In the United States, the 2010 California Transparency in Supply Chains Act has played an important role in propelling companies and consumers to address the crimes of slavery and human trafficking within the product supply chain.[161] The legislation highlighted that some companies based in the state of California were breaking the law, as they were including supplies produced as a result of slavery and human trafficking in their supply chain, and that consumers were sanctioning these crimes by buying the products. Blockchain's distributed database makes it possible for supply chains to be fully transparent and many leading global companies are moving to these platforms to address this need.

> **"Blockchain's distributed database makes it possible for supply chains to be fully transparent"**

Blockchain is a promising new technology to address transparency needs in Africa too. To date, blockchain adoption has been sporadic across Africa, but that is changing. Studies have revealed that blockchain technology could solve a number of fundamental political and societal challenges facing Africa. Furthermore, recent advances in blockchain technology such as Proof of Stake (PoS)[162]—driven by sensitivities regarding the energy consumption of consensus mechanisms using Proof of Work (PoW)[163]—will allow not only for significant energy reduction but also reduction in cost of operations. The area of responsible sourcing and creating trust in Africa's extractives value chain is one such challenge affecting a range of minerals extracted in the region. Another is the role it can play in exposing transfer (mis)pricing via smart contracts, which are a "sophisticated self-executing computer program with the capability of automatically adapting itself throughout the contract life cycle to achieve the contractual objectives of the parties."[164]

Traceability Questions and 'Conflict Minerals' Supply Chain Due Diligence

LuNa Smelter's smelting activities are in the middle of a CAHRA and are a challenge for added value generation, and thus its investors place a strong focus on traceability. Luna Smelter is also a full member of iTSCi (ITRI Tin Supply Chain Initiative), and cooperates with the Better Sourcing Program (RSC Global). LuNa Smelter also reports on an annual basis in order to provide public confidence that company operations are in accordance with the OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

A new blockchain tool for mineral traceability has been developed and implemented together with Minespider AG in 2020. LuNa Smelter has partnered with Minespider, Google, and the Rwanda Mines, Petroleum and Gas Board to pilot the OreSource blockchain tool in Rwanda. The partnership is an important step in redesigning the mining industry and transforming mining resources into key drivers of the country's growth**.** It is anticipated it will enhance the sustainable growth of mining communities and will enable clear and traceable cooperation among all supply chain participants and because it uses a consensus protocol called Proof of Authority (PoA),[165] the corresponding energy requirements are trivial.

[159] Quote from Former President of Nigeria Olusegun Obasanjo from keynote address at the 2018 Africa Australia Research Forum "Blockchain and Africa"

[160] Bilaney,S.K (2018) International Transfer Pricing Journal, (Volume 25), No 4 From Value Chain to Blockchain – Transfer Pricing 2.0.

[161] Does Blockchain Provide The New Standard For Transparency? Available at: https://www.forbes.com/sites/paulmartyn/2018/03/28/does-blockchain-provide-the-new-standard-for-transparency/#11b601433921

[162] Fahad Saleh (2021) Blockchain without Waste: Proof-of-Stake, *The Review of Financial Studies*, Volume 34, Issue 3, March, Pages 1156–1190, https://doi.org/10.1093/rfs/hhaa075

[163] M. Saad, Z. Qin, K. Ren, D. Nyang and D. Mohaisen, (2021) "e-PoS: Making Proof-of-Stake Decentralized and Fair," in *IEEE Transactions on Parallel and Distributed Systems*, vol. 32, no. 8, pp. 1961-1973, 1 Aug. doi: 10.1109/TPDS.2020.3048853.

[164] van Eck M.M. (2020) The Disruptive Force of Smart Contracts. In: Doorsamy W., Paul B., Marwala T. (eds) The Disruptive Fourth Industrial Revolution. Lecture Notes in Electrical Engineering, vol 674. Springer, Cham. https://doi.org/10.1007/978-3-030-48230-5_2

[165] Sivleen Kaur, Sheetal Chaturvedi, Aabha Sharma, Jayaprakash Kar, (2021) "A Research Survey on Applications of Consensus Protocols in Blockchain", Security and Communication Networks, vol. 2021, Article ID 6693731, 22 pages. https://doi.org/10.1155/2021/6693731

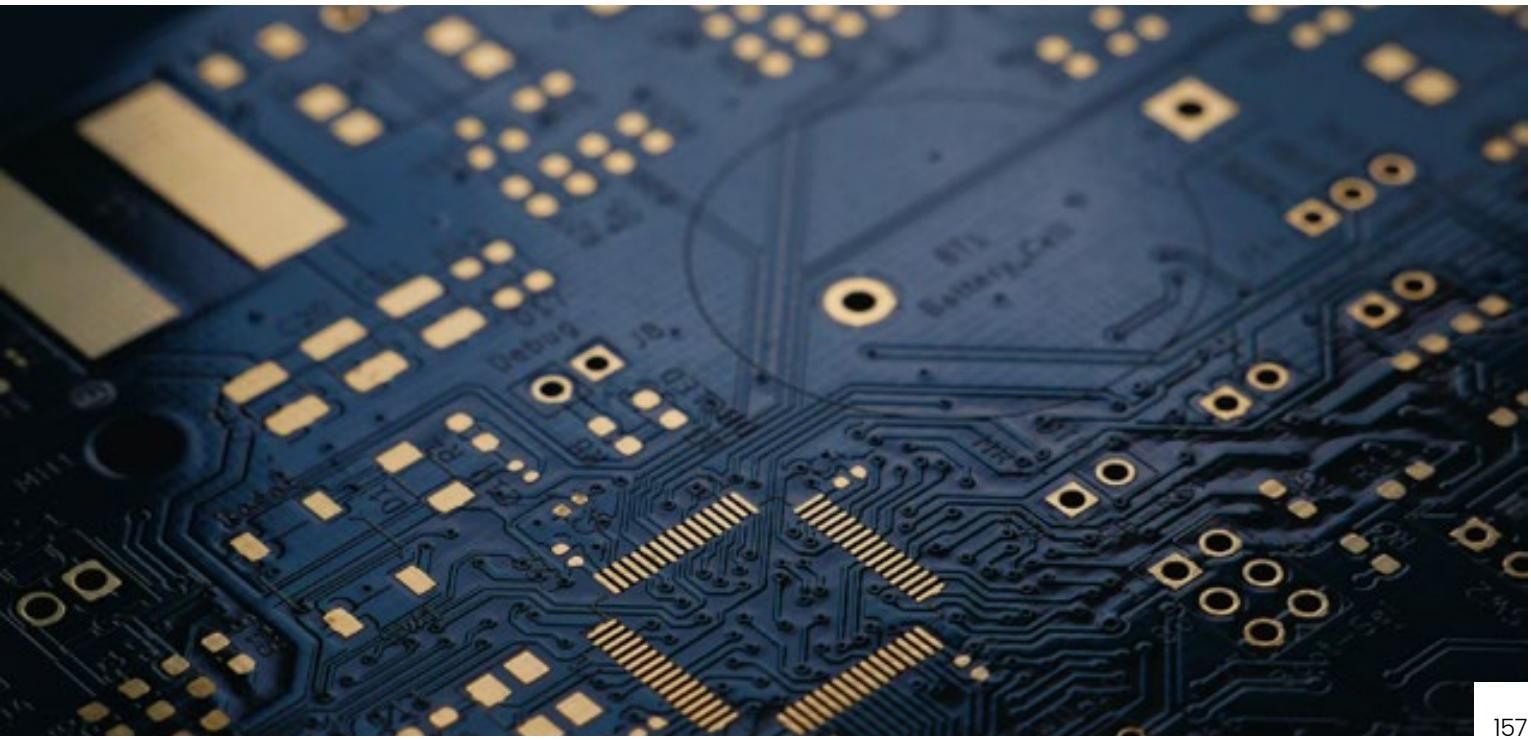
5.2 Blockchain as an answer for traceability and transparency

The use of blockchain for traceability and transparency has been a point of key interest for responsible mineral sourcing in recent years. Blockchain-based systems hold the potential to be a magic bullet, reducing costs for miners, securing the supply chain for downstream actors against risk of fraud and corruption, and increasing efficiencies for the middle of the supply chain. The number of players involved, and their diverse set of interests mean that these traceability projects can be slow to implement, requiring a consortium of companies to agree to share data before the project begins. The complexity involved means that traceability projects either run with a limited set of participants as an artificially constructed supply chain or require a lengthy mapping and 'onboarding' process to familiarise participants before the traceability can begin.

Minespider and LuNa Smelter initiated their cooperation in 2020 (with funding provided by EIT Raw Materials) to test a new blockchain approach to traceability. The concept was to create digital blockchain certificates at the smelter level with all the documents and information required to demonstrate this responsibility. LuNa would attach QR codes to outgoing shipments of tin to allow customers downstream to create accounts and access the documents in these certificates. Minespider stores and permissions data using encrypted digital certificates divided into three layers ('public', 'transparency', and 'private'). The public layer contains the QR code, information about the material, and hashes of the other layers. Data in this layer is visible to anyone using the blockchain and is important to ensuring that the certificates are immutable. The transparency layer is only visible to the company, their customers, and other downstream members of the same supply chain; it is not visible to companies outside of this supply chain. The private layer contains information visible only to the sending company and their immediate customer. The transparency and privacy layers are symmetrically encrypted, and the keys are then themselves encrypted with the public key of the data owner. This allows permissioned access to data on a public blockchain without the use of a central gatekeeper.

It was necessary to identify a set of data that could be valuable to companies downstream from LuNa Smelter. Data would be stored in a certificate with recipient details and attach a QR code to the outgoing tin shipments that would link to the certificate. Anyone would be able to read the public layer of data in the certificate; however, the recipient could also see the transparency and private layers. From this point there were two possibilities: the recipient participates in the tracked supply chain and does the same as LuNa Smelter (upload their own data to a new certificate specifying their own recipients and attach a new QR code to the shipment). The new certificate would link to the original LuNa certificate, creating a chain of custody. Alternatively, the recipient did not wish to participate. Then the original QR code remains on the shipment, and the subsequent customer would only see the public information. However, if they create an account, they will have the option to request the transparency and private layers. In this way a single non-participating company would not break the traceability chain. Once these mechanics allowed the tracked supply chain to propagate, the next step was to identify an appropriate data set. With the EU Conflict Minerals Regulation (Regulation 2017/821)[166] in force from January 2021, importers into the EU needed relevant sourcing information included with their materials purchases.

[166] Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high risk areas, *Official Journal of the European Union*, L130, Volume 60, 19 May 2017, ISSN 1977-0677.



5.3 Developing the Oresource Dataset

The EU Conflict Minerals Regulation was developed based on OECD guidelines and obligates EU importers of 3TG minerals to conduct due diligence according to the OECD's five-step framework. This requires companies to prove that their 3TG imports were sourced responsibly. In the case of Rwanda, mines and exporters of 3TGs are already undergoing audits according to the International Conference of the Great Lakes Region (ICGLR) traceability scheme. As a result, the necessary data is readily available. In addition to the OECD framework, the requirements of the ICGLR were considered and these data were uploaded by LuNa Smelter's traceability team in order to have all necessary data in one place. Minespider and the LuNa team sent first shipments of registered material in December 2020, informing the customer beforehand, and following up after they had received the data.

Establishment of further transparency in processing activity would generate significant new revenue streams for African economies and strengthen their comparative advantage to achieve greater economic diversification. Nevertheless, it takes not only a brave investor or new technology, but a well-coordinated collaboration of trust and transparency between key stakeholders including miners, suppliers, intermediate beneficiators, and end users. Implementation of the traceability project at the LuNa Smelter level was successful due to the relevant data being already compiled, and a willingness to share it. However, it is likely implementation with other smelters could prove more challenging. Some of the challenges include overcoming scepticism among the mining community, and garnering acceptance with the downstream companies and regulators.

Use your smart phone to access a sample shipment certificate

5.4 Financing: Increasing and retaining investment in the Extractives

The more expensive and complicated (risky) to extract a mineral from the ground, the less economic value it has. One needs to backwards engineer from the price of the final product to understand the value of a particular mineralisation, i.e. location, depth, complexity of mine logistics to where it is needed etc. That said, the atoms should never be given away for free.[167] The task is to make sure that when all of the costs are counted that the nation (owner of the atoms) has a net positive result. This calculation must also include the costs associated with the closure of the mining activity at some future date. While mining itself may not be a sustainable activity (it is based on a finite resource), its legacy can result in sustainable communities if environmental and social factors are fully included in life-of-mine calculations.

"Establishment of further transparency in processing activity would generate significant new revenue streams for African economies and strengthen their comparative advantage to achieve greater economic diversification."

[167] Advice given by Premier of Western Australia the Hon. Colin Barnett in a keynote speech at Mining Indaba - 2014.

6. Environmental Equity (intergenerational and present day)

The potential long-term negative impact of the extractives sector on the environment and local communities is well acknowledged. Often communities suffer the environmental consequences of mining activities in their vicinity during the life of the mine and for years afterwards, with very little positive benefits. However, it is also clear that this can be mitigated. The Africa Progress Panel and the African Mining Vision have noted that doing so can avoid significant negative impacts on communities, lower the cost of doing business and provide opportunities for fruitful relationships between mining firms and local communities. The Commission recommends the promotion of a more proactive approach to mine closure as one way in which long term environmental equity can be enhanced.

> **"Often communities suffer the environmental consequences of mining activities in their vicinity during the life of the mine and for years afterwards, with very little positive benefits."**

"Building a solid foundation for prosperity over the long term requires countries to implement policies that can transform revenues from resources into investments in Africa's people."

CONCLUSIONS

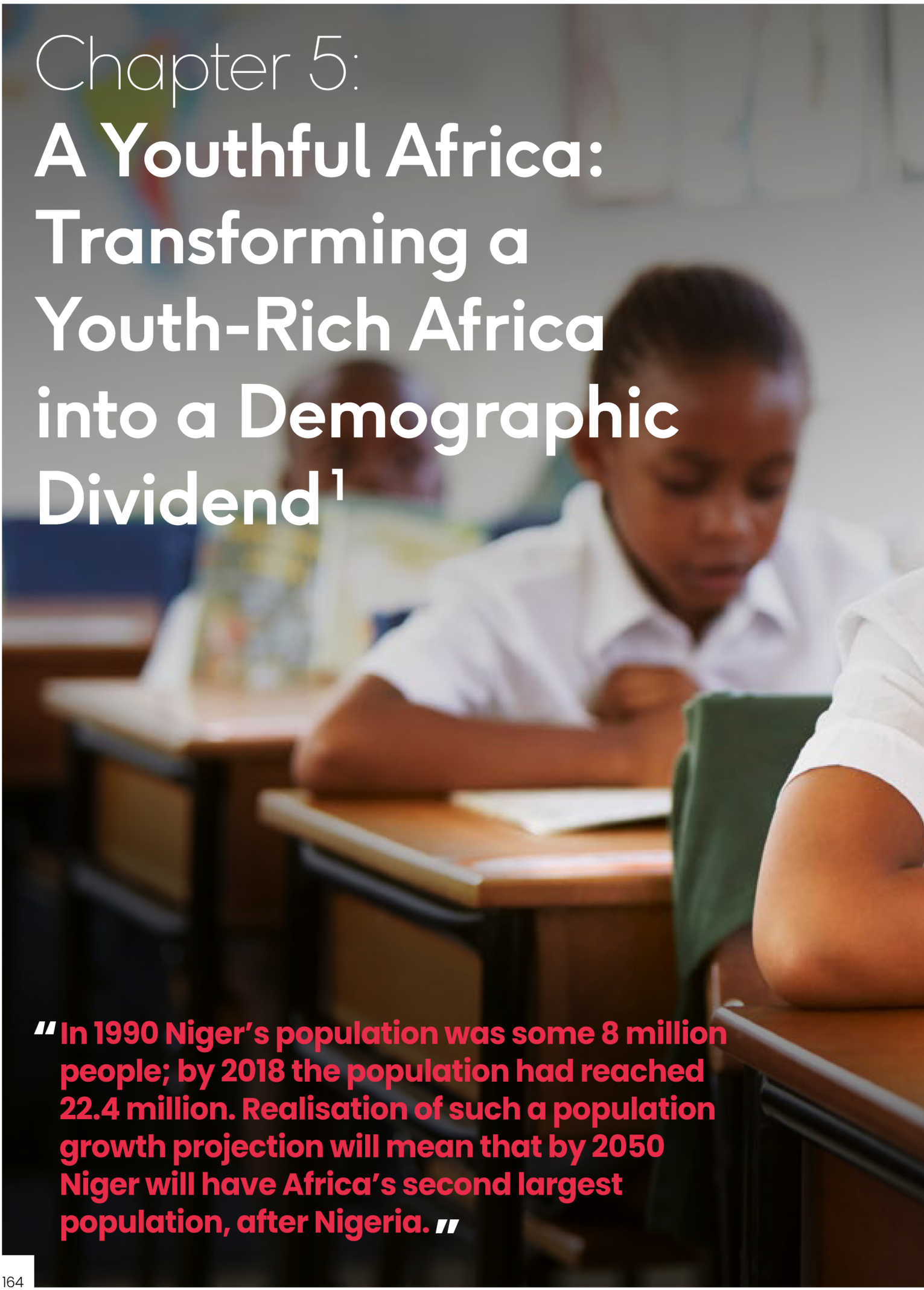
The Third Commission insists that the goal of the utilisation of mineral resources is to provide inclusive growth to the countries and regions that can benefit from the cooling of Earth's random dispersal of the minerals that now define the fourth industrial revolution. Increasing the likelihood that the outcome of a robust extractives sector will be wealth creation for all rather than the increased disparity between peoples depends on several factors. Factors that support inclusive growth include policy innovations that:

- **empower small-scale and artisanal mining enterprises and women;**
- **create and support transparency along the value chain that allows for appropriate levels of taxation and societal benefit; and**
- **build an enabling environment to beneficiate in an economically and just manner.**

For example, greater political support for Africa's artisanal and small-scale mining (ASM) growth and transformation is an essential prerequisite towards promoting inclusive shared growth in the extractives sector. There is a growing appreciation of the need to understand how ASM links to rural economies and policies that aim towards 'getting ASM right' within the context of Africa's overall growth transformation. Prospective areas in need of research include how the ASM and food security nexus can fortify the case for ASM formalisation in ways that speak to the SDGs. There is a similar challenge for understanding gender roles and how they respond to and inform the SDGs and the AMV and how gender intersects with other social inequalities. Additional data and analysis on female participation rates and working conditions can positively inform extractives industry governance and policy change over time.

Building a solid foundation for prosperity over the long term requires countries to implement policies that can transform revenues from resources into investments in Africa's people. There are several policy approaches and innovations that emphasise greater inclusiveness and reductions in inequalities where they can have an immediate and significant impact on most people's lives. Another example is the opportunity to revisit regional beneficiation via countries owning an investment on a pro-rata basis on the product delivered. Such regional cooperation requires agreement from governments surrounding reallocating all financial benefits from a facility according to the feedstock supply and may achieve a fairer return to all investors involved. It may also avoid the common pitfall of smaller beneficiation investments that cannot commercially compete globally. Transparency, fairness, and equality are at the heart of stemming illicit financial flows, and several nascent innovations reduce the negative impacts it has on African livelihoods.

The Third Commission has sought to present new advances, modalities, and policy approaches to promote greater inclusiveness and equity in the extractives sector. By encompassing the priorities, challenges, and opportunities crucial to Africa's mineral resource development and assist the transformation of the extractives industries into a highly valued investment in the people of Africa.



Chapter 5:
A Youthful Africa: Transforming a Youth-Rich Africa into a Demographic Dividend[1]

"In 1990 Niger's population was some 8 million people; by 2018 the population had reached 22.4 million. Realisation of such a population growth projection will mean that by 2050 Niger will have Africa's second largest population, after Nigeria."

INTRODUCTION

More than two centuries ago, Thomas Malthus expressed his now famous fears that exponential population growth combined with linear food supply growth would lead to premature deaths via war, starvation, and disease.[2] Developing countries, home to populations facing exponential population growth, have since become considered as being stuck in a 'Malthusian Trap'. Rising agricultural productivity and trade in most locations has mostly defied Malthus' predictions. However, in the present era, dangerous climate change may also shift food production assumptions and risk returning to a Malthusian reality. Ironically, West Africa's landlocked, dry, and climatically hot Least Developed Countries (LDCs), responsible for an insignificant amount of historical greenhouse gas emissions and home to some of the world's fastest-growing populations, are at greatest risk for Malthus' predictions coming true. For example, Niger has the world's highest total fertility rate (TFR)[3] of 6.91 (Table 1). In 1990 Niger's population was some 8 million people; by 2018 the population had reached 22.4 million.[4] Realisation of such a population growth projection will mean that by 2050 Niger will have Africa's second largest population, after Nigeria. Niger's President, Mahamadou Issoufou, noted in 2019: "In Niger we are already living with the practical results of climate change. Floods alternating with droughts [are] already having huge consequences for agricultural production. There is a degradation of soil, forests are getting lost, there is less land, and an advance of desert. Lake Chad has lost as much as 90 per cent of its water, and there are more problems with domestic rivers. Niger loses 100,000 hectares of agricultural land every year."[5] The combination is an ominous one for policymakers.

After centuries of broadly continuous growth, the world's human population is expected to peak this century. Estimates vary as to what decade in the second half of the century this transition will arise.

1 We use the terms bonus and dividend interchangeably throughout the document.

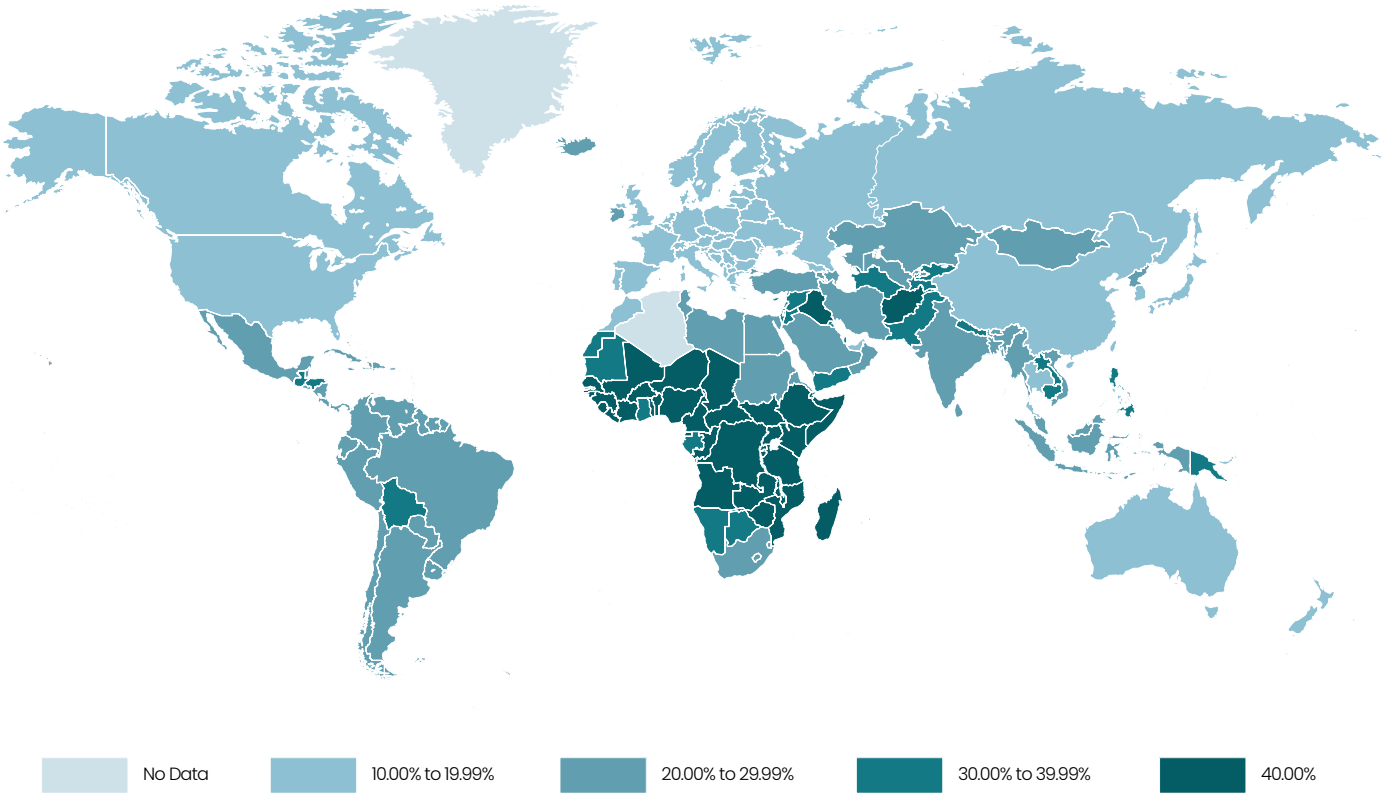
2 Thomas R. Malthus. *An essay on the principle of population*. (Printed for J. Johnson. *St. Paul's church-yard, London*, 1-126 (1798).

3 In simple terms, the TFR refers to the total number of children born or likely to be born to a woman in her lifetime if she were subject to the prevailing rate of age-specific fertility in the population (UN, Population Division). A TFR of about 2.1 children per woman is called 'replacement-level fertility'.

4 World Bank, *World Development Indicators*, (2019). Available: http://datatopics.worldbank.org/world-development-indicators/

5 The Guardian, Niger's President blames explosive birth rate on a misreading of Islam. Oct 17, 2019. Available: https://www.theguardian.com/global-development/2019/oct/17/nigers-president-blames-explosive-birth-rate-on-a-misreading-of-islam

Figure 1: Share of population of children (0-14 years) by country, 2017.



Data source: *World Development Indicators*, World Bank (2018).

Table 1: Highest and lowest TFRs, Africa (2018)

Country	TFR	Country	TFR
Niger	6.91	**Algeria**	3.02
Somalia	6.07	**Eswatini**	2.99
Congo, Dem. Rep.	5.92	**Botswana**	2.87
Mali	5.88	**Djibouti**	2.73
Chad	5.75	**Morocco**	2.42
Angola	5.52	**Seychelles**	2.41
Burundi	5.41	**South Africa**	2.41
Nigeria	5.39	**Cabo Verde**	2.27
Gambia, The	5.22	**Tunisia**	2.20
Burkina Faso	5.19	**Mauritius**	1.41

Data source: World Bank, World Development Indicators (latest available year).

More than half of the projected remaining growth of the world's population over years 2019-2050 is likely to come from the SSA region.[6] Presently the world's 'youngest' region (Figure 1), Africa has not only 'demographic momentum' for future population growth, but almost all countries in Africa retain a TFR above replacement level. Table 1 lists twenty African countries by the ten highest and ten lowest TFRs. Only one country in Africa has a TFR below the replacement rate of 2.1: Mauritius, with Tunisia almost there at 2.2.

More than half the projected total increase in the global population over those years will come from just nine countries, five of which are African: Democratic Republic of Congo, Egypt, Ethiopia, Nigeria and Tanzania (Table 1). Not all countries in Africa have high population growth, as three of the five lowest TFR countries are geographically and demographically small island nations: Mauritius, Cabo Verde, and Seychelles. In contrast, half of the countries with the highest TFRs are land-locked: Niger, Mali, Chad, Burundi, and Burkina Faso. It has been argued that Congo DRC is functionally landlocked, given that most of the population live far from the country's narrow coastal access point.[7] Nigeria and Congo DRC, have large populations within an African context, and thus, fast population growth in these two countries has a more significant overall impact.

[6] United Nations, *World Population Prospects 2019 Highlights* (New York 2019) Available: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf

[7] *"Commission on Growth and Development. 2008. The Growth Report : Strategies for Sustained Growth and Inclusive Development. Washington, DC : World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/6507 License: CC BY 3.0 IGO."(p.74).*

In addition to monitoring TFR, understanding per capita growth and productivity changes across Africa over coming decades will be especially important. A shift in preferences toward lower TFRs, for example by encouraging marriage at a later age, and prioritising girl's educational achievement will propel a more sustained process of per capita material livelihood improvement. The specific issue of ending child marriage (as a sub-set of early marriage) as well as access to equitable education for girls and young women are critical for women's health and autonomy. Addressing these issues culturally and at a policy level will also directly contribute to a reduction in the TFR.[8] Alongside, a greater awareness of rapid population growth, ageing in Europe and East Asia is also drawing attention to complementarity in divergent stages of demographic transition across countries and regions.[9] For example, not only are Chinese investors aware that their demographic dividend is slipping away, but also that one may—depending on demographic trends over coming decades—lie on the horizon in uniquely youth-filled Africa. The concept of the demographic dividend, essentially a temporary window for a productivity and output windfall arising from a high working-age population share—is elaborated in Section 2. Meantime, that population ageing is helping flat-line interest rates in high-income countries, and beyond may help to incentivise investors to seek riskier but higher prospective rates of return in emerging markets.

Directly and indirectly, the rise of China is important to the emergence of this narrative regarding Africa. Recent change in China's economy and population—away from low-wage, energy-intensive production, away from demographic dividend, and toward increasing population ageing—help explain why China has become a leading investor in the continent.[10] Moreover, and fundamentally, China also offers a remarkable and prominent precedent for proactive capture of a demographic dividend for economic development.[11,12] That set of changes are part of the global set of changes helping to catalyse greater international investor interest in the continent, alongside the even more significant African-led push also to develop the continent's economic potential. No matter what happens in and with China, or between Africa and the rest of the world, or even between African nations, a realistic assessment of rates of demographic change and demographic dividend probabilities across African countries is essential to understanding the economic trajectory, and the associated ideal policies and investments. Moreover, amid hope for the potential to reap a demographic dividend, such an assessment reveals that most of Africa remains rich in youth—and, hence, ominously, in fact, 'demographic dividend poor' (Section 2).

The country with the continent's largest population, Nigeria, tells the story. Presently, Nigeria has a working-age population share of just over 50 per cent and a TFR of 5.5. This suggests that a demographic dividend working-age population share of some two-thirds, is not likely until 2070, at the earliest. Moreover, since such an age structure is common across most of SSA, an African "demographic bonus is still a distant prospect".[13] All factors constant, Niger can only hope for a demographic dividend around the year 2080.[14] However, 'demographic trailblazers' have also been identified: Botswana, Ethiopia, Ghana, Kenya, Morocco, Senegal, and Tunisia.[15] North, South, and East Africa more generally are further along a demographic transition curve than West or Central Africa. To realise per capita income gains from demographic change navigating how to incrementally realise economic development while accounting for labour-related and dependency-ratio-related changes over time is imperative. This approach, known as the economic demography transition approach to development, moreover, is equally relevant to all countries: whether economically rich or poor, and demographically young or old.[16] Section 4 of this chapter elaborates the economic demographic transition within Africa.

Before discussing the economic demography transition approach to development and associated policies, it is important to firstly explain the concept of the demographic dividend and how it can be utilised for a more rapid period of economic growth. This chapter reviews the most recent demographic data, revealing patterns of youth-richness in Africa demonstrating most countries are outside of even the pre-demographic dividend window, making the case for why these policy interventions are urgently needed.

"The specific issue of ending child marriage (as a sub-set of early marriage) as well as access to equitable education for girls and young women are critical for women's health and autonomy."

[8] Yaya, S., Odusina, E.K. & Bishwajit, G. (2019) Prevalence of child marriage and its impact on fertility outcomes in 34 sub-Saharan African countries. *BMC Int Health Hum Rights* **19,** 33 https://doi.org/10.1186/s12914-019-0219-1

[9] Johnston, Lauren A., (2020). "China's Economic Demography Transition Strategy: A Population Weighted Approach to the Economy and Policy," GLO Discussion Paper Series 593, Global Labor Organization (GLO).

[10] Lauren A. Johnston. (2015) *Boom to cusp: Prospecting the 'new normal' in China and Africa*, in Ross Garnaut, Ligang Song, Cai Fang and Lauren Johnston (editors), *China's Domestic Transformation in a Global Context*, ANU Press, Canberra, 383-408.

[11] Johnston, Lauren A (2019) *A Timely Economic Demography Lesson from China for the G20*. Institute for Global Dialogue Occasional Paper No. 75, South Africa. Available:http://www.igd.org.za/jdownloads/Occasional%20Papers/A%20Timely%20Economic%20Demography%20Lesson%20from%20China%20for%20the%20G20.pdf

[12] Johnston, Lauren A. (2019) *The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?*, Australian Economic Review, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325

[13] Alisa KaAlisa Kaps, Ann-Kathrin Schewe and Reiner Klingholz. *Africa's Demographic Trailblazers, How Falling Fertility Rates Are Accelerating Development*, Berlin Institut für bevölkerung und Entwicklung (Berlin 2019). Available: https://www.berlin-institut.org/en/publications/studies-in-english/africas-demographic-trailblazers.html

[14] Ibid: 10.

[15] Ibid

[16] See Johnston, Lauren A., (2020). "China's Economic Demography Transition Strategy: A Population Weighted Approach to the Economy and Policy," GLO Discussion Paper Series 593, Global Labor Organization (GLO) and Johnston, L. A. (2019). The Economic Demography Transition: Is China's 'Not Rich, First Old' Circumstance a Barrier to Growth?. *Australian Economic Review*, *52*(4), 406-426.

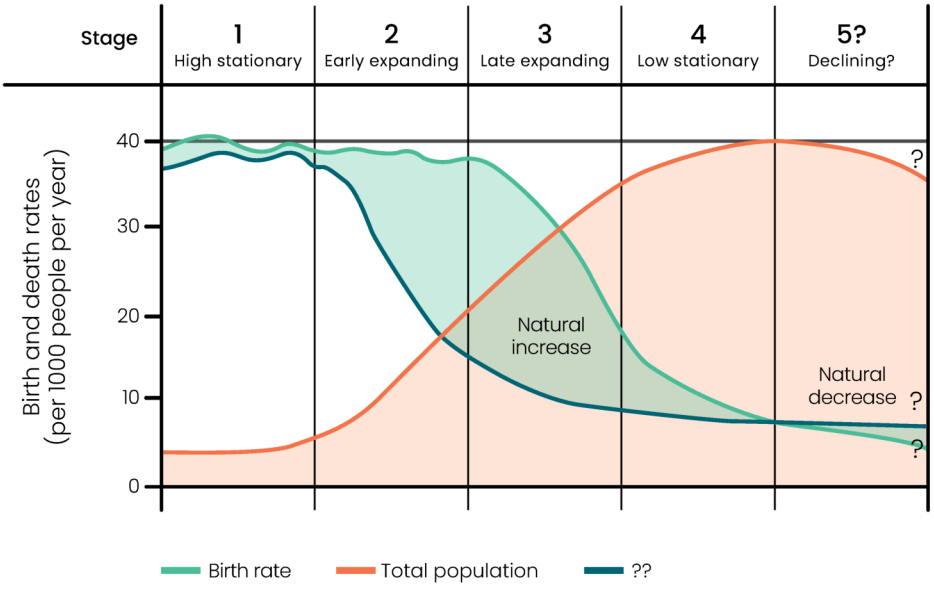
"Cultural changes also weaken the economic importance of children and produce a shift from 'quantity to quality' of children."

1. The Demographic Transition and Potential of a Demographic Dividend

The economic opportunity of demographic dividend is transitory: it arises via an underpinning process known as demographic transition. The demographic transition is the process via which societies shift from high fertility with high mortality to low fertility with low mortality (Figure 2). Factors helping to induce the demographic transition include the costs of having children increase with economic development. Cultural changes also weaken the economic importance of children and produce a shift from 'quantity to quality' of children.[17]

Consequences of demographic transition shift with the evolution of the transition itself. In the early stages of the transition, fertility rates and mortality rates begin to fall (Figure 2). The period during which a country can enjoy a "demographic bonus" is characterised by less than 30 per cent young persons (aged under 15) of the total population and less than 15 per cent of persons aged over 64.[18] This translates to at least 1.7 employment-aged persons for every dependent person. Figures 3 and 4 illustrate the difference of 'youth-filled' and 'working-age-rich' population structures.

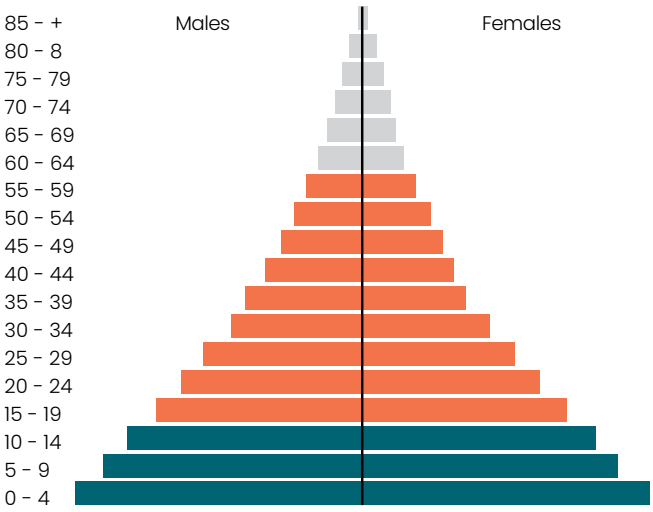
Figure 2: The Demographic Transition



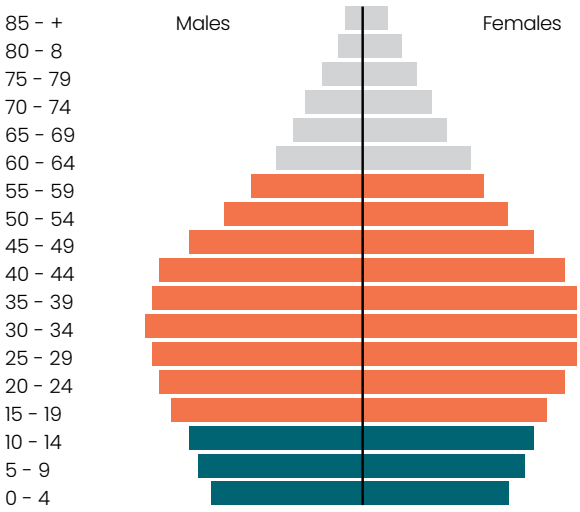
[17] See Gary Becker. An economic analysis of fertility. In *Demographic and economic change in developed countries*, 1960: 209-240 (Columbia University Press); and Oded Galor, The demographic transition: causes and consequences. Cliometrica, 6(1) 2012: 1-28.

[18] Alisa Kaps, Ann-Kathrin Schewe and Reiner Klingholz. *Africa's Demographic Trailblazers, How Falling Fertility Rates Are Accelerating Development*, Berlin Institut für bevölkerung und Entwicklung (Berlin 2019:10). Available: https://www.berlin-institut.org/en/publications/studies-in-english/africas-demographic-trailblazers.html

Figures 3 and 4: Population structure: Youth-filled and Demographic Dividend Structure



Low Mortality, High Fertility Stage



Low Mortality, Decreasing Fertility Stage

"Over a forty-year demographic dividend period, starting in the 1970s, the country managed a reform process, from around 1980, that underpinned a rise in per capita incomes from very low incomes to almost high per capita incomes."

This in turn means that household resources per child increase. Since birth rates were higher earlier, an elevated working-age population share soon arises. That in turn enables a 'transitory opportunity' for increased productivity via both the elevated population share of workers (assuming they find jobs or other means of being productive). Concurrently, it also 'frees up' resources or investment in economic development and household welfare, including health and education. All else being equal, over this period of the demographic transition incomes rise relatively rapidly thanks to the virtuous circle of a higher share of workers in the population being of working-age generating greater aggregate productivity. In Africa's case the continent on average is presently so youth-rich that there is "no (such) demographic bonus in sight".[19] That is, for some years to come, most African country population structures will reflect Figure 3 much more than Figure 4. However, where it arises and is successfully nurtured via appropriate policy settings for inclusive economic development, the demographic dividend offers a mutually re-enforcing and concurrent demographic and economic transition opportunity. For developing countries especially, it offers a unique window for more rapid development.[20] A prominent recent such case is that of China. Over a forty-year demographic dividend period, starting in the 1970s, the country managed a reform process, from around 1980, that underpinned a rise in per capita incomes from very low incomes to almost high per capita incomes. However, in China's case the demographic transition was officially imposed via family planning restrictions. The government appears also to have directly assumed a broad responsibility for capturing the ensuing demographic dividend for economic development.[21]

[19] Alisa Kaps, AnAlisa Kaps, Ann-Kathrin Schewe and Reiner Klingholz. *Africa's Demographic Trailblazers, How Falling Fertility Rates Are Accelerating Development*, Berlin Institut für bevölkerung und Entwicklung (Berlin 2019:10). Available: https://www.berlin-institut.org/en/publications/studies-in-english/africas-demographic-trailblazers.html

[20] See Arthur Lewis, (1954) *Economic development with unlimited supplies of labour. The Manchester School, 22*(2), 139-191.

[21] Lauren A. Johnston. (2019) The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?, *Australian Economic Review*, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325

In general, the scale of the dividend depends on how much is produced and consumed at each age by the respective population and its size. The length depends on the speed of demographic transition and is typically several decades long. In Western Europe this transition began in the eighteenth century and has been very gradual. In more recent decades, in East Asia especially, both the economic and demographic transitions happened more quickly.[22] It is unknown if African countries will continue this trend or evolve new ones. Economic capture of the dividend during demographic transition is, though, not automatic or at all guaranteed: it must be nurtured with the appropriate set of economic, educational, and social policies (Section 3). That the dividend is transitory also implies a new set of economic demography conditions in the later stage of demographic transition. Eventually, lower fertility and mortality rates have the reverse effect in terms of slowing the growth rate of the labour force, which at later phases of demographic transition begins to fall as a share of population. Instead, the old-age segment of the population grows rapidly, characterising a population as 'ageing'. Over this period, the sources of productivity growth of the earlier demographic dividend go into reverse.

A second demographic dividend is considered possible. In this later demographic transition phase case, the accumulated assets of the older cohort are invested at home and abroad in ways that generate additional income streams for the economy. This is especially true in that population ageing tends also to be associated with lower interest rates, putting stress on returns at home and encouraging riskier investments in 'younger' emerging markets. The dividends are sequential: the first dividend begins first and comes to an end, and the second dividend begins somewhat later and continues indefinitely.[23] The application of technology and labour-saving innovation is important in this phase also.[24]

It happens that the African continent was the single region to not have, in aggregate, enjoyed demographic dividend-related growth returns over the second half of the 20th century.[25] This speaks to Africa now being the world's youngest 'continent'—a structure it must domestically and internationally use to its advantage for economic and human development. Emerging demographic patterns give some indication as to whether this will be true of broadly 'youth-filled' Africa again, in the 21st century. The next section looks at selective related demographic trends.

[22] See David E. Bloom and John G. Williamson, *Demographic transitions and economic miracles in emerging Asia*. The World Bank Economic Review, 12(3), pp.419-455 (1998), and Andrew Mason and Tomoko Kinugasa. *East Asian economic development: two demographic dividends*. Journal of Asian economics, 19(5-6), 389-399, 2008.

[23] Ronald Lee and Anthony Mason. *What is the demographic dividend?* Finance and Development, Sept 2006 43(3). https://www.imf.org/external/pubs/ft/fandd/2006/09/basics.htm

[24] Serguei Kaniovski and Thomas Uri, (2019) *Macroeconomic Consequences of Ageing and Directed Technological Change*. Bertelsmann Stiftung, Germany. Available: https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/MacroeconomicConsequences_2019_FINAL2.pdf

[25] Ronald Lee and Anthony Mason. *What is the demographic dividend?* Finance and Development, Sept 2006 43(3). https://www.imf.org/external/pubs/ft/fandd/2006/09/basics.htm

"'Youth' in this context is defined as the share of population aged 0–14 years. 'Old', or 'elder', is defined as population share aged 65 years and over."

2. Survey of African Countries by Demographic Dividend Phase

2.1 Demographic Dividend Phase Empirical Thresholds

In demography a set of indicator thresholds, for example in terms of youth and elder population share, guide the understanding of demographic transition progress across countries and regions. 'Youth' in this context is defined as the share of population aged 0-14 years. 'Old', or 'elder', is defined as population share aged 65 years and over. The years between the two are 'working-age' years, though it is understood, of course, that working-age and propensity to retire before or after this retirement point varies across and even between countries.

Countries rich in working-age populations are broadly considered to be in their demographic dividend potential period—the period of elevated productivity potential around having a high population share of working-age people. Table 2 sets out three standard demographic dividend phase thresholds for each of youth and elder share, and the TFR.[26]

Taking from Table 2 and following Johnston (2020a and 2020b) in Table 3 a set of periods capturing phases of the demographic dividend across the demographic transition are framed. These periods are used throughout the rest of the analysis.

In recent years in SSA countries there has been a trend of declining morbidity, but this is not precisely matched by as rapid a decline in the total fertility rate. The consequence of this asymmetry is obvious which leads to a population pyramid shaped away from that of a working-age-rich demographic dividend era of growth potential and toward worsening youth and elderly dependency ratios. The following section explores these trends in more detail.

Table 2: Demographic Dividend Phase Threshold Indicators (2019 unless noted otherwise)

	TFR (children/woman, 2018)	Youth Share (% pop. aged <15yrs)	Elder Share (% pop. aged >65yrs)
Post-Dividend	≤ 1.55	≤ 16.0	≤ 19.29
Late-Dividend	1.74	18.94	11.18
Early-Dividend	2.49	28.57	5.97
Pre-Dividend	4.94	≥ 43.47	≥ 2.77

Source: World Development Indicators, World Bank (2020). Category names and threshold indicators taken directly from source, and are available online: http://datatopics.worldbank.org/world-development-indicators/

Table 3: Demographic Dividend Phases (indicator thresholds reflect 2019 unless noted otherwise).

	Total Fertility Rate* (no. children/woman)	Child Share (% pop.)	Elder Share (% pop.)
High Fertility Rate Society	> 5.0	> 43.5	< 2.8
Demographic Dividend Prospect	2.4 – 5.0	28.9 – 43.5	2.8 – 6.0
Demographic Dividend Era	1.7 – 2.4	19.0 – 28.9	6.0 – 10.7
Low Fertility Rate Society	< 1.7	< 19.3	> 10.7

*Reflects the year 2018. Source: World Development Indicators, World Bank (2020). The different years, 2018 and 2019, reflect data availability at the time of access. These thresholds are provided directly by the World Bank database referenced, and not the work of the author. See Johnston (2020) for classifications in brackets.

[26] World Bank, *World Development Indicators*, (2019). Available: http://datatopics.worldbank.org/world-development-indicators/

3.2 African Countries by Demographic Dividend Phase

3.2.1 African Country Demographic Dividend Phase by TFR Indicator

Data in Table 4 paints a humbling picture for those seeking to reap something of an 'African demographic dividend' any time soon. According to the data available, in 2018 only six African countries—Morocco, Seychelles, South Africa, Cabo Verde, Libya, and Tunisia—were home to an estimated TFR falling within the 'demographic dividend' category; that of the 'late demographic dividend' period.

In a demographic dividend-led development aspirations context, it is hopeful that the largest share of countries in 2018 were classified as pre-demographic dividend countries and not in the pre-dividend phase. Demographic trends in these countries over coming decades will determine which, if any, move into the demographic dividend phase and the broader development directions of the continent as a whole. Mauritius is alone as the only post-dividend, sustained low fertility society in Africa. Symptomatic of the traditional links between demographic transition and rising per capita income over time, Mauritius in 2019 also inaugurally entered the high-income per capita group according to the World Bank, defined as a gross national income of $12,536 or more.[27] Seychelles is the only other high per capita income country in Africa. Both countries entered the high-income group after 'getting old'—as measured by a 7 per cent or more share of population of persons aged 65 and over—a transition typically happening in the late demographic dividend era. To that end, most African countries hoping to enter the high-income group in future, might also expect to be 'old before getting rich', issues around which are discussed in Section Four.

On the level of scale, Nigeria as Africa's largest national populous, falls in the 'high fertility rate society' category is potentially ominous. However, the continent's next four most populous nations, Ethiopia, Egypt, Congo DRC, and Tanzania, present a more mixed picture. Egypt is home to almost 100 million persons and exhibited a TFR of 3.3 in 2018, down from 3.4 in 2017. Ethiopia is home to some 105 million and has experienced relatively rapid TFR declines in recent years. Ethiopia's TFR is now 4.3 according to latest available data—still well above replacement level of 2.1 let alone near the early demographic dividend TFR of 2.4 births/woman. Both Congo DRC and Tanzania fall into the 'high fertility society' and borderline 'high fertility society' groupings respectively. In other words, none of Africa's larger national populations are mid or near a demographic dividend phase of growth. As compared to looking at a single year data point, looking at the trend for the TFR for these countries over recent decades may or may not offer greater confidence that a 21st century demographic dividend period of development is probable.

Table 4: African countries by TFR demographic transition phase indicator, 2018.

Dividend phase	Countries
Low Fertility Rate Society	Mauritius (1.4)
Demographic Dividend Era	Tunisia (2.2); Libya (2.2); Cabo Verde (2.3); South Africa (2.4); Seychelles (2.4); Morocco (2.4).
Demographic Dividend Prospect	Djibouti (2.7); Botswana (2.9); eSwatini (3.0); Algeria (3.0); Lesotho (3.1); Egypt (3.3); Namibia (3.4); Kenya (3.5); Zimbabwe (3.6); Ghana (3.9); Gabon (4.0); Rwanda (4.0); Eritrea (4.1); Madagascar (4.1); Comoros (4.2); Malawi (4.2); Ethiopia (4.3); Sierra Leone (4.3); Togo (4.3); Liberia (4.4); Sao Tome & Principe (4.3); Sudan (4.4); Congo Rep. (4.4); Guinea-Bissau (4.5); Equatorial Guinea (4.5); Mauritania (4.6); Cameroon (4.6); Senegal (4.6); Cote d'Ivoire (4.7); Zambia (4.7); South Sudan (4.8); Guinea (4.7); Central African Rep. (4.7); Benin (4.8); Mozambique (4.8); Tanzania (4.9).
High Fertility Rate Society	Uganda (5.0); Burkina Faso (5.2); Gambia (5.2); Nigeria (5.4); Burundi (5.4); Angola (5.5); Chad (5.7); Mali (5.9.0); Congo DRC (5.9); Somalia (6.1); Niger (6.9).

Data source: *World Development Indicators,* World Bank (2019) (see Table 3 for demographic society definitions).

[27] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

3.2.2 African Country Demographic Dividend Phase by Child Population Share Indicator

By child-share of population, no African countries are post-dividend, low fertility rate societies (Table 5). Only three small island nations, Mauritius, Cabo Verde and Seychelles, alongside coastal North African countries, Libya, Morocco, and Tunisia in 2019 were in the late phase transition that is associated with a demographic dividend potential. To this end, it is less than surprising that countries like Morocco, proximate to European markets and with a relatively educated workforce, are emerging as possible frontier contenders with a greater role in global value-chains in the new era of the COVID-19 pandemic. For the island nations therein, it will be necessary to grasp the demographic dividend potential in the aftermath of the pandemic given the devastating impact on tourism, which is a critical industry for these economies. Otherwise, Africa's youngest countries by the child-share measure include Nigeria, Tanzania, and Congo DRC—three of Africa's larger national populations. This hints at demographic momentum for the future. What happens to the total fertility rate in these countries will have a significant impact on the future of the African, and hence the world, population.

In July 2020, Nigerian media reported the concern of Joseph Nnana, Deputy Governor of the Central Bank of Nigeria: "All things equal, we will have seen 2.8 and three per cent GDP growth for 2019. However, three per cent GDP growth rate for Nigeria is inadequate when our population growth rate is 3.2 per cent. So, the capital growth rate is slightly negative." The media source noted that the economy is not growing fast enough to create the needed jobs for its unemployed population. Also, that "This is a recipe for the kind of disaster envisaged by Thomas Malthus in his book, 'An Essay on the Principle of Population'".[28]

Table 5: African countries by demographic dividend phase (child population share, %, 2019)

Society	Countries
Low Fertility Rate	None.
Demographic Dividend Era	Mauritius (17.3); Seychelles (23.7); Tunisia (24.2); Morocco (27.0); Libya (28.1); Cabo Verde (28.4)
Demographic Dividend Prospect	South Africa (29.0); Djibouti (29.2); Algeria (30.6); Lesotho (32.5); Botswana (33.8); Egypt (33.8); Namibia (36.9); Equatorial Guinea (37.0); Gabon (37.1); Ghana (37.4); eSwatini (37.8); Kenya (39.2); Comoros (39.3); Rwanda (39.8); Mauritania (39.9); Sudan (40.2); Ethiopia (40.3); Madagascar (40.4); Sierra Leone (40.7); Liberia (40.7); Togo (41.0); Congo, Rep. (41.5); South Sudan (41.6); Cote d'Ivoire (41.7); Sao Tome and Principe (42.1); Guinea-Bissau (42.2); Zimbabwe (42.2); Benin (42.2); Cameroon (42.4); Senegal (42.8); Guinea (43.4)
High Fertility Rate Society	Malawi (43.5); Nigeria (43.7); Tanzania (43.8); Central African Republic (43.9); Gambia (44.1); Mozambique (44.4); Zambia (44.7); Burkina Faso (44.7); Burundi (45.4); Congo DRC (46.0); Somalia (46.4); Uganda (46.5); Angola (46.6); Chad (46.8); Mali 47.3); Niger (49.8).

*See Table 2 for societal (demographic) definitions. Data source: World Development Indicators, World Bank (2019).

[28] https://punchng.com/burden-of-nigerias-population-explosion/

3.2.3 African Country Demographic Dividend Phase by Old Population Share Indicator

Four countries in Africa are already in the 'population ageing' category whereby more than seven per cent of the population is aged 65+: Mauritius, Tunisia, Seychelles, and Morocco (Table 6). The country in Africa with the lowest population share of persons aged 65 and over is Uganda—the world's 'least-old' country by population share of people aged over 64.

In general, rising life expectancy amid low per capita rates of growth mean that many countries in Africa will 'get old' before they 'get rich'—unlike China. Johnston (2019) sheds light for policymakers on China's long-run approach to working with this economic demography structure over decades beginning in the 1980s when China nonetheless remained demographically very 'young'.[29] That a number of countries in Africa are moving in the direction of reaching the seven per cent of the population aged 65 and over threshold—becoming host to an ageing population—suggests it is time to plan for this population structure now in order to minimise 'old-age poverty'.

Table 6: African countries by demographic dividend phase (population >64yrs, %, 2018)

Society	Countries
Low Fertility Rate	Mauritius (12.0).
Demographic Dividend Era	Tunisia (8.6); Seychelles (7.8); Morocco (7.3); Algeria (6.6)
Demographic Dividend Prospect	South Africa (5.4); Egypt (5.3); Lesotho (4.9); Cabo Verde (4.7): Djibouti (4.6); Libya (4.5); Botswana (4.4); Eswanti (4.0); Sudan (3.6); Namibia (3.6); Gabon (3.5); Ethiopia (3.5); South Sudan (3.4); Liberia ((3.3); Benin (3.2); Mauritania (3.2); Senegal (3.1); Ghana (3.1); Comoros (3.1); Madagascar (3.0); Rwanda (3.0); Congo, DRC (3.0); Zimbabwe (3.0); Sao Tome & Principe (3.0); Sierra Leone (2.9); Guinea (2.9); Somalia (2.9); Togo (2.9); Mozambique (2.9); Cote d'Ivoire (2.9); Guinea-Bissau (2.9); Central African Republic (2.8).
High Fertility Rate Society	Nigeria (2.7); Cameroon (2.7); Congo Rep. (2.7); Malawi (2.6); Tanzania (2.6); Niger (2.6); Gambia (2.6); Mali (2.5); Chad (2.5); Equatorial Guinea (2.4); Kenya (2.4); Burkina Faso (2.4); Burundi (2.3); Angola (2.2); Zambia (2.1); Uganda (2.0).

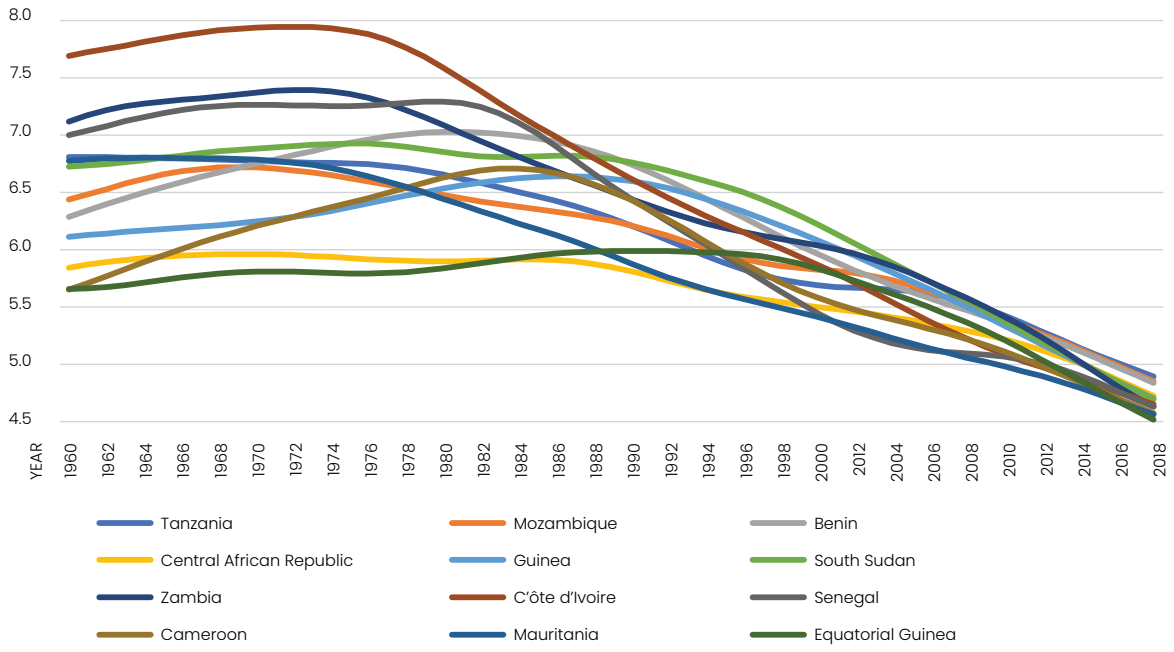
*See Table 2 for societal (demographic) definitions. Data source: *World Development Indicators*, World Bank (2020).

[29] Lauren A. Johnston, (2019) A Timely Economic Demography Lesson from China for the G20. *Institute for Global Dialogue Occasional Paper* No. 75, South Africa.

3.3 Sub-section Analysis and Discussion

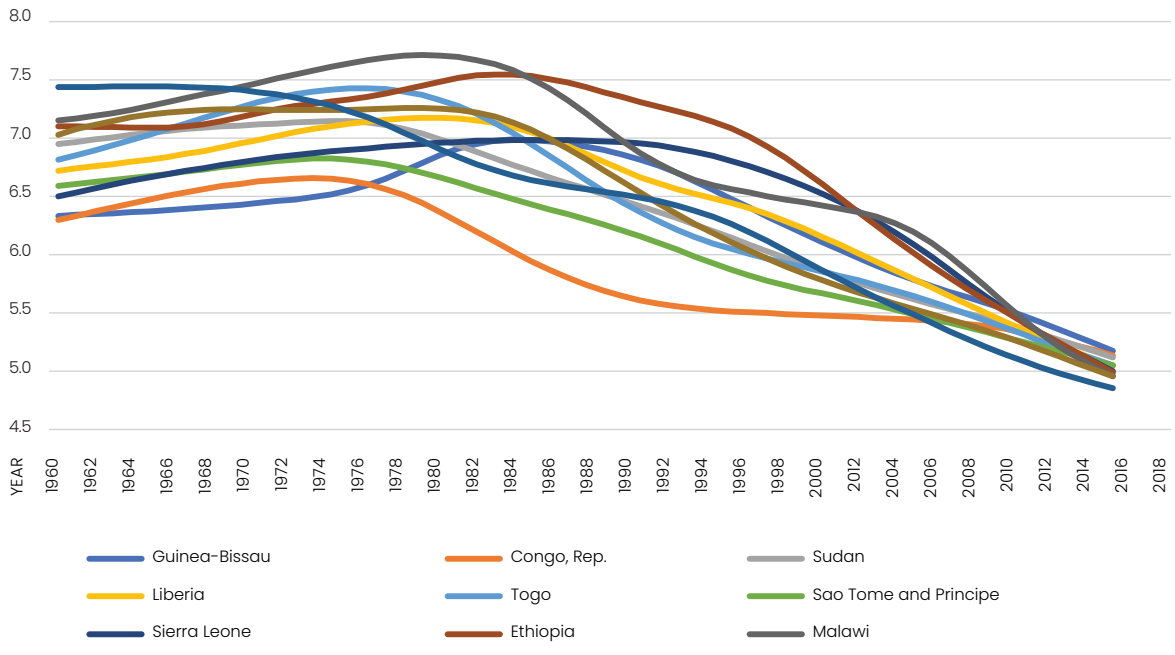
Tables 1-5 paint a picture of a mostly youth-rich SSA today—and most probably also tomorrow. One limitation of that latest-available-year data, is that it does not inform the direction of change. This type of in-depth analysis across African countries would exceed the word length of this chapter. Given the relevance of the TFR indicator, Figures 5, 6, and 7, offer an intertemporal lens of selective African TFR data over more than half a century. In particular, the figures chart change in the TFR rate of countries classified as 'demographic dividend prospect' in 2018 over years 1960-2018. These same countries (see Table 4 for list) are then separated in order of 2018 TFR into three further sub-groups of twelve for clearer figures. The resulting country batches are presented in Figures 6, 7, and 8, each with a specific TFR range on the y-axis.

Figure 5: Top twelve 'demographic dividend prospect' African countries by (2018) TFR indicator, 1960-2018.



Data source: World Bank, World Development Indicators (2020) (latest available data).

Figure 6: Mid twelve 'demographic dividend prospect' African countries by (2018) TFR indicator, 1960-2018.



Data source: World Bank, *World Development Indicators* (2020).

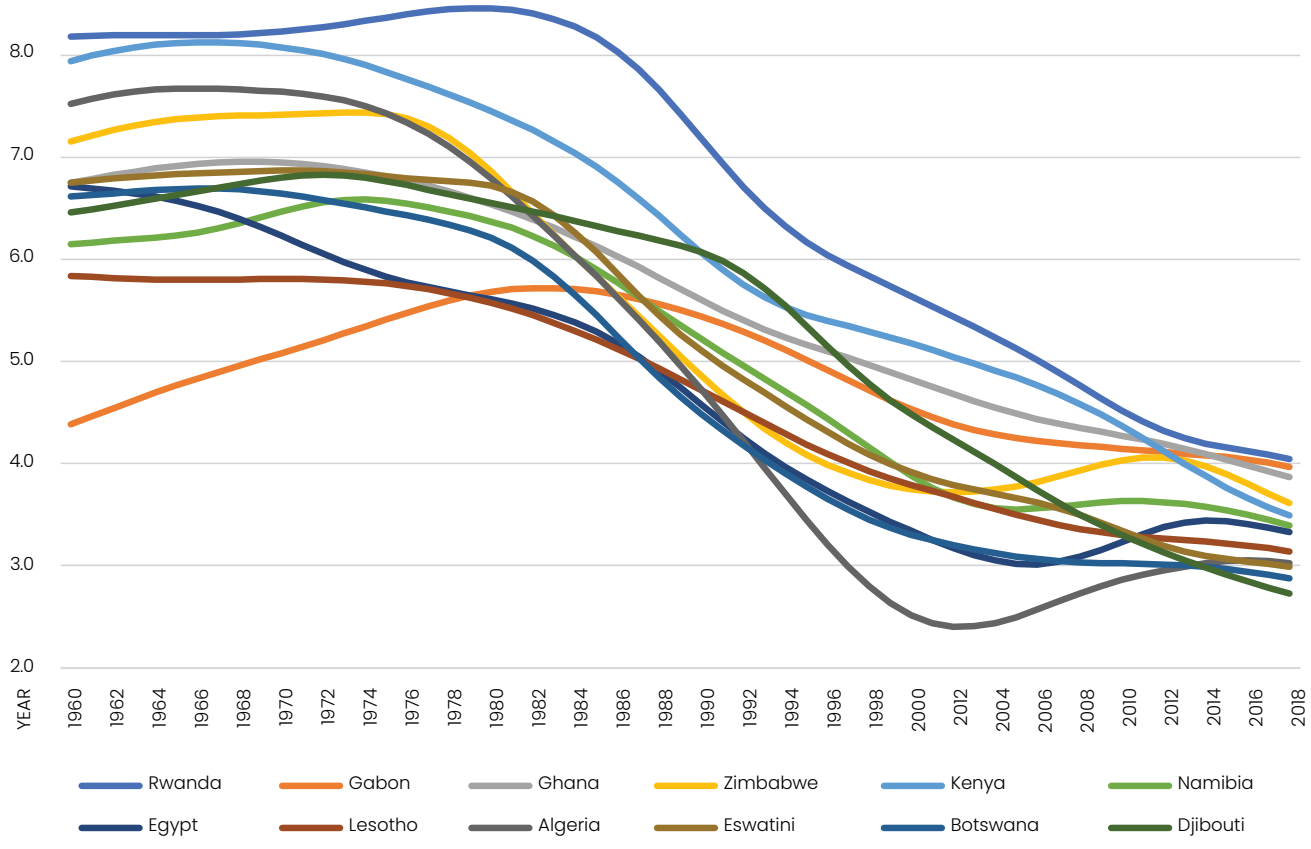
In sum, from highs and greater dispersion of TFR in the 1970s and 1980s, countries classed as 'demographic dividend potential' in 2018 over the recent half century have seen their TFRs almost halve. In doing so, they have converged in range toward a TFR of 4-5 on average, and to below three in the case of those countries with the lowest TFRs in the grouping in 2018 (Figure 7). Nonetheless, not only are such levels clearly outside of the demographic dividend window (1.7-2.4 in 2018 (Table 2)), but also well above replacement rate TFR of 2.1.

Into that general picture, Rwanda makes for an interesting case. Home to the highest TFR in Africa in the 1970s and 1980s, Rwanda's TFR had fallen to 4.04 per woman by 2018, placing it somewhere in the lower mid-point across African TFRs (Table 4). Ethiopia and Kenya are also countries that have experienced noticeable TFR decline. Whether or not fertility preferences follow those of other regions and also that of Mauritius to continue a downward trend to below replacement levels of the total fertility rate is yet to be seen. At current rates it will also be many years until this is known.

How soon each of these 'demographic dividend prospect' countries, and those outside the range, enter a period of greater economic development opportunity via a demographic dividend window (if at all) will depend on preferences, socioeconomic change, and related policy choices. Grasping the potential of a demographic dividend for improved development is far from automatic. China makes for a useful reference point, and not only for its relatively successful utilisation for development of a demographic dividend period. China has implemented a long-run strategy that saw advance and concurrent preparation for the consequential later period of population ageing—an economic demography transition strategy. Section 4 elaborates.

> **"China has implemented a long-run strategy that saw advance and concurrent preparation for the consequential later period of population ageing—an economic demography transition strategy."**

Figure 7: Bottom twelve 'demographic dividend prospect' African countries by (2018) TFR indicator, 1960-2018.



Data source: World Bank, *World Development Indicators* (2020).

Meantime, together with the fact that Mauritius is Africa's TFR decline frontier and is also since 2019 a high per capita income country, in general East African countries sit on the frontier of both SSA's demographic and economic transition. It is perhaps not a coincidence that they also sit at the frontier of Africa's recent higher growth levels: "In 2018, real GDP in East Africa grew by an estimated 5.7 per cent, slightly less than the 5.9 per cent in 2017 and the highest among African regions.[30] African economic growth were also projected to remain strong, at 5.9 per cent in 2019 and 6.1 per cent in 2020. The countries with the highest growth were in East Africa: Ethiopia, Rwanda, Tanzania, Kenya and Djibouti."[31] In July 2020 the African Development Bank published updated growth forecasts in the wake of the COVID-19 pandemic. Considering disruptions to fiscal expenditure plans, revenue mobilisation, supply chains, and international market demands, the region has taken a 'growth hit'. As a result, the region's 2020 growth was forecast to be 1.2 per cent, with a worst-case scenario of 0.2 per cent. However, this implies a negative per capita growth rate for the region in 2020.[32] Time will tell how well countries bounce back from COVID-19 and position themselves to grasp possibly enhanced opportunity to produce locally and regionally will determine the direction of these economies since the onset of COVID-19.

These growth rates levels remain well below those of East Asia when the region was benefitting from demographic dividend-related growth in the 1980s and 1990s (alongside the same across the OECD).[33] As most African nations are not yet in their demographic dividend growth potential phase, talk of a 'demographic dividend-led' development in Africa remains broadly optimistic, or at best prescient. However, a relatively comprehensive assessment of Africa's demography and related socio-demographic trends has identified 'demographic trail-blazers'.[34] These seven—in East Africa (Kenya and Ethiopia); in Southern Africa (Botswana); in West Africa (Ghana and Senegal); and in North Africa (Tunisia and Morocco)—were chosen for being countries that either already have a comparatively low fertility rate or are moving in this direction. These countries were selected based on a set of socio-economic parameters, including, inter alia, child mortality, education levels, and poverty rates—factors that when improved have been associated with an advancing demographic transition. Hence, those countries share commonalities in greater education levels and funding overall; a focus on the education of women and later average marriage age of women also; availability of the family planning options, among others.[35] Regardless of whether a country in Africa (or anywhere), is a 'demographic trailblazer' or otherwise, there are steps any country can take in account of its economic demography circumstance. A continuously cointegrated approach to economic and demographic change is known as the economic demography transition approach to the economy.[36] Section four explains this approach with special reference to China and to youth-filled countries, the majority of which are in Africa.

[30] African Development Bank. *East Africa Economic Outlook 2019*, Abidjan: ADB, 2019. Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2019AEO/REO_2019_-_East_Africa _.pdf. p.1

[31] Ibid.

[32] https://www.afdb.org/en/documents/east-africa-economic-outlook-2020-coping-covid-19-pandemic

[33] Eg. see David E. Bloom and John G. Williamson, *Demographic transitions and economic miracles in emerging Asia*. The World Bank Economic Review, 12(3), pp.419-455 (1998).

[34] Alisa Kaps, Ann-Kathrin Schewe and Reiner Klingholz. *Africa's Demographic Trailblazers, How Falling Fertility Rates Are Accelerating Development*, Berlin Institut für bevölkerung und Entwicklung (Berlin 2019:10). Available: https://www.berlin-institut.org/en/publications/studies-in-english/africas-demographic-trailblazers.html

[35] Alisa Kaps, Ann-Kathrin Schewe and Reiner Klingholz. *Africa's Demographic Trailblazers, How Falling Fertility Rates Are Accelerating Development*, Berlin Institut für bevölkerung und Entwicklung (Berlin 2019:10). Available: https://www.berlin-institut.org/en/publications/studies-in-english/africas-demographic-trailblazers.html. p.10

[36] See Lauren A. Johnston. The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth*? Australian Economic Review*, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325, and Johnston, L.A. (2018). Harvesting from "poor old" China to harness "Poor Young" Africa's Demographic Dividend. *Bridges Africa*, 7(5). International Centre for Trade and Sustainable Development, Geneva.

4. Adopting an Economic Demography Transition Approach to Development

4.1 What is the Economic Demography Transition?

The economic demography matrix illustrates four corner options for the different economic and demographic states of national development: poor-young; rich-young; poor-old; and rich-old (Table 7). All countries fall into one of these categories depending on the stage of demographic transition and economic development.

Each economic demography transition implies unique factor endowments and cross-country comparative advantage accordingly. For example, a rich-old country is likely to have expensive human capital, and so will be engaged in highly advanced capital-intensive sectors. In contrast, a poor-young country, depending on demographic transition phase, may be in the early- or mid-phase of a demographic dividend growth period.

An approach to managing the economy that factors these two respective rates of change over time, and their interaction, might be the most powerful long-run approach to development. China's contemporary economic development agenda makes a case in point. In China's case it was realised early in the contemporary reform and development process that China would be 'poor-old' before hope of ever being 'rich-old'. Where role model economies for China, like Japan, Taiwan, Hong Kong, and Singapore had all moved from 'poor-young' to 'rich-young' and then to 'rich-old', China understood it would need a long-run strategy to get to rich-old. Importantly, most African countries—like Seychelles and Mauritius—already will likely need to follow the same economic demography trajectory.

"In China's case it was realised early in the contemporary reform and development process that China would be 'poor-old' before hope of ever being 'rich-old'. Where role model economies for China, like Japan, Taiwan, Hong Kong, and Singapore had all moved from 'poor-young' to 'rich-young' and then to 'rich-old', China understood it would need a long-run strategy to get to rich-old."

Table 7: The Economic Demography Matrix

		Demographic Transition	
		Early	Late
Economic Transition	Low and Middle-Income	Poor and Young (PY)*	Poor and Old (PO)
	High-Income	Rich and Young (RY)	Rich and Old (RO)

Source: Johnston et al (2016), Johnston (2018 and 2019). *Most rich-young countries are established oil exporters. Otherwise, it is now more common that developing countries 'get old before getting rich'. Since around the mid-1990s they on average start as 'poor-young', next move to the 'poor-old' category of the economic demography matrix and finally, if successful economically over time, finally enter the 'rich-old' category.

4.2 China and the Economic Demography Transition

Demographic transition in China began in the 1960s, offering a demographic dividend period for some forty years from the early 1970s.[37] Imposition of a One Child Policy from the early 1980s encouraged policymakers to explore the full range of potential consequences thereof, and especially for China's economic development agenda.[38] Appreciating that China sat on the cusp of a potentially transformative low-wage demographic dividend era of growth and development, as outlined in the Nobel Prize-winning Lewis Model, from the 1980's Chinese policymakers offered foreign investor incentives for labour-intensive and export-oriented industries to settle into selected clusters along China's coast.[39] Fast forward to today, that demographic dividend era of growth is fading out, and thus a different model of growth is sought. Importantly, not only did China become the 'factory of the world', but in so doing, wages and incomes have incrementally increased over time. This has been invested in the next generation of workers. With China's workforce population share falling for almost a decade, wages are under pressure on two fronts: new entrants to the labour market are fewer than the number leaving; and new entrants to the labour market are on average far more educated than workers leaving the labour market.[40] And so, now investor incentives and pull factors centre upon capital, services and technology-intensive sectors, instead of low-wage labour-intensive sectors as in the 1980s and 1990s.

Hand-in-hand with a focus on explicitly capturing China's demographic dividend for a process of sustained economic development, was an eye on the period when China's demographic dividend would rapidly fade into history. Indeed, back in the 1980s, when researchers were exploring how China's One Child Policy might affect per capita growth and development, they realised that there was no feasible growth rate that would enable China to get rich before it got old.[41] China's demographic transition, in other words, would happen faster than its economic transition. Hence, there arose a fear that China was destined to get 'old before rich'.[42] It was believed that being a 'poor old' country would inhibit China's prospects for realising a full economic transition into a frontier high-income country. Drivers of that fear included not realising the elevated productivity per capita that would be required once the working-age population share began declining; loss of wage-related factor advantages before frontier human capital levels had been formed to compensate; and the necessary re-direction of human and financial resources away from national development and into caring and pensions once population ageing became increasingly intensive.[43] However, as a consequence of those fears, and that the government made itself directly responsible for China's relatively rapid demographic transition via the One Child Policy, China has been planning around the concurrent and interactive 'ebb and flow' of demography and the economy for several decades already.

Chinese national policy set out to seek a relatively high share of the next, younger cohort of workers who were vastly more educated than their parents' generation; and even the poorest would be able to enjoy a basic nine years of compulsory schooling. Theoretically this would enable them to be far more productive, and possibly therein also to maintain, or even elevate, productivity per capita despite a falling working-age share of population. Similarly, only modest pension promises have been made all through China's growth spurt, and in any case, these are also a function of what was mostly a low and later lower-middle income growth era.[44]

"Chinese national policy set out to seek a relatively high share of the next, younger cohort of workers who were vastly more educated than their parents' generation; and even the poorest would be able to enjoy a basic nine years of compulsory schooling. Theoretically this would enable them to be far more productive, and possibly therein also to maintain, or even elevate, productivity per capita despite a falling working-age share of population."

[37] Andrew Mason, Ronald Lee, Michael Abrigo and Sang-Hyop Lee, S. *Support Ratios and Demographic Dividends: Estimates for the World*, Population Division, United Nations, New York, New York. 2017.

[38] See Lauren A. Johnston. The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?, *Australian Economic Review*, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325;

[39] Arthur Lewis, *Economic development with unlimited supplies of labour. The Manchester School*, *22*(2), 139-191. 1954.

[40] See Ross Garnaut, Lauren A. Johnston and Ligang Song, Where is the Chinese Economy Going? A Forum on Contemporary Policy and Performance. *Australian Economic Review* 50, 4:441-449 (2017).

[41] Cangping Wu, The objective criterion to measure the adaptation of population development and economic development: The economic basis for advocating a couple to have only one child at the current stage in China, *Population Research*, vol. 1, 32–38 (1980); and Cangping Wu, Population Ageing Discussion, Liaoning People's Publishing House, Shenyang (both publications are in Chinese).

[42] Fang Cai, C and Meiyan Wang.. China's Process of Aging before Getting Rich. In *The China Population and Labor Yearbook, Volume 1* (pp. 49-63). Brill (2009); and Fang Cai. The coming demographic impact on China's growth: The age factor in the middle-income trap. *Asian Economic Papers*, *11*(1), 95-111 (2012).

[43] Lauren A. Johnston. The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?, *Australian Economic Review*, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325.

[44] See Lauren A. Johnston. The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?, Australian Economic Review, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325; Lauren A. Johnston, *A Timely Economic Demography Lesson from China for the G20. Institute for Global Dialogue Occasional Paper* No. 75, South Africa, 2019.

4.3 Africa and the Economic Demography Transition

Africa is on average youth-rich and still demographic dividend poor. While a handful of countries are enjoying a progressing demographic transition (Mauritius even has already passed its demographic dividend period, most countries remain either pre-demographic transition or something closer to Malthusian in having demographic patterns that dominate economic and productivity patterns. However, understanding the economic demography transition approach is likely to be useful in the medium- and long-term. Table 8 provides a summary of the approach countries might adopt if seeking to realise a demographic dividend-type growth era. Since most African countries are currently 'pre-dividend', Table 8 is essentially a long-run policy road map for these countries, should respective national household choices shift the nation in the direction of a demographic dividend. In China's case, the early dividend phase preparations were also implicitly being made for later economic demography transition requirements. In comparison, for today's already 'older' African countries, like Mauritius, Seychelles and Tunisia, late demographic dividend strategies are already the focus.

Some analysts fear that preparations for later more rapid ageing are insufficient. For example, by 2045 the share of South Africa's population that will be over 60 (the present age of qualifying for older-age social security) is expected to double, from 8 to 16 per cent (some 4.5-10.6 million people).[46] This means that South Africa's elderly population is growing at 2.9 per cent per annum, against 0.6 per cent for the overall population. It is important to ensure that sustainable systems are in place not only for those old, but for the active economy that must support them, and the economics of their own cohort also.

Table 8: Policy Priorities through Economic Demography Transition phases

Demographic Society	Policy Priorities
'Older' population countries (poor-old and rich-old countries)	
	Adapting to Ageing
Low Fertility Rate	Maintaining and improving welfare in the context of declining work-force population share and a growing old-age share. At this stage attitudes to the elderly and their productive engagement of the economy while also ensuring that the 'weight' of the old does not dampen the next generations' productivity is fundamental.
	Sustaining productivity growth
Demographic Dividend	Creating conditions necessary to reap the second demographic dividend and beginning to prepare for ageing. Countries typically need to begin re-shaping retirement policies and concurrently ensure that the smaller share of youth are not disadvantaged but in fact able to be extremely productive given the need to provide for the old. Incentives to direct the savings of the elderly into the most productive areas also need to be crafted.
'Younger' population countries (poor-young and rich-young)	
	Accelerate job creation
Demographic Dividend Prospect	Creating increasingly productive jobs for growing share of the population in working ages to reap the demographic dividend. This requires appropriate macro-fiscal and labour framework, including making it easier for parents to work formally.
High Fertility Rate	**Sparking the demographic transition (if sought by populous)**
	Improving human development (health and education) outcomes to accelerate the fertility decline and create a population age structure with fewer child dependents and a larger working-age share of the population.

*Rich-Young countries have a different set of challenges to the more classic poor-young countries in terms of reaping the potential of a demographic dividend. These countries for example typically encounter challenges in resource-rent management and distribution. With the exception of Equatorial Guinea, most such countries are in the Middle East and South East Asia, not Africa.[45] See Table 2 for empirical definitions of each demographic society type.

[45] See Lauren A. Johnston, Xing Liu, Maorui Yang and Xiang Zhang, *Getting Rich After Getting Old: China's Demographic and Economic Transition in dynamic international context*, in Garnaut, R., L. Song, C. Fang, and L. Johnston (editors), China's New Sources of Economic Growth Vol. 1: Reform, Resources and Climate Change. ANU Press, Canberra, 2016:215-246; Lauren A. Johnston. *The Economic Demography Transition: Is China's 'Not Rich, First Old 'Circumstance a Barrier to Growth?*, Australian Economic Review, Vol. 52(4): 406-426. https://doi.org/10.1111/1467-8462.12325; Ronald Lee and Anthony Mason. *What is the demographic dividend?* Finance and Development, Sept 2006 43(3). https://www.imf.org/external/pubs/ft/fandd/2006/09/basics.htm; and World Bank, Operational Tool for Pre-Dividend Countries (2019), available: http://documents.worldbank.org/curated/en/781891550815372274/pdf/Demographic-Dividend-Operational-Tool-for-Pre-Dividend-Countries.pdf

[46] Markle, A (2019). Ageing another barrier to South Africa's economic stability. Institute for Security Studies, South Africa (Nov. 19). Available: https://issafrica.org/iss-today/ageing-another-barrier-to-south-africas-economic-stability

4.4 A Global Economic Demography Transition Approach

From a global vantage, it is equivalently important for African policymakers and entrepreneurs to understand the demographic difference of their own prospective demographic dividend era and that of East Asia. East Asian countries were successful in their development largely via an export-oriented development strategy. The strategy worked by each country successively joining the region's global value chain and exporting to the high-income world, mainly Europe and North America thereafter. Over the second half of last century those high-income countries were also in a demographic dividend period. Hence, there was rapid productivity gains and a large working-age population offering demand for East Asia's lower-cost exported goods.

Circumstances for African exporters over the next several decades will be different. Instead of a demographic dividend, these high-income countries now are rapidly ageing, and hence the demand structure and broader economic structure will shift proportionately also. High-income coastal provinces in China may come on stream as consumers of international goods and services in offering international demand that was not earlier present. Since COVID-19, it is difficult to predict what new opportunities and threats may emerge in a medium-to-long-run context. It is important to highlight the need for any country to plan its contemporary economic context from a contemporary base, and not from a 'cut-and-paste' of yesterday's development success story.

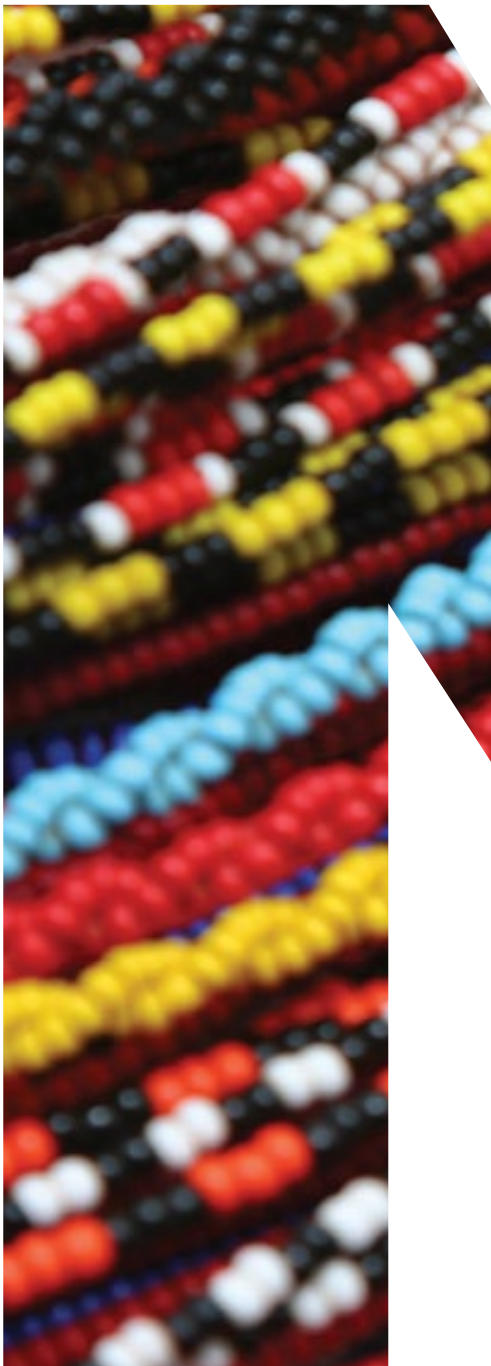
> **"Understanding the economic demography transition stages—how economics and demography interact over time, within and between countries, and which policies are optimal over time accordingly—may be the beginning of knowledge. For this knowledge to become "wisdom" and trigger effective policy interventions, countries will need to commit to unprecedented investment in education for boys and girls, particularly girls. Without this investment, quite simply, the youth will not become a dividend. With it, they can."**

CONCLUSION

This chapter has drawn attention to Africa's varying yet largely youth-rich demographic composition. That youth-richness should not be confused with a demographic dividend. However, it highlights that a demographic transition shift in that direction could lead to a demographic dividend growth opportunity. In Africa, Mauritius offers a reference for seeking this. China offers a bigger and more seminal such example. Change in China indeed is so significant globally that it is itself opening up new avenues for African development. Whether in a Malthusian or pre-demographic transition, or even a late demographic transition phase, all countries can learn from the economic demography approach to development. East Africa is ahead of that curve at this stage and many such countries therein share the Indian Ocean with Australia. This means also that they are members of the Indian Ocean Rim Association (IORA); a platform via which African countries, Australia, and other countries of the Indian Ocean region can work together toward common development, environmental sustainability, and prosperity over the coming decades.[47]

The last frontier of the demographic transition, that broader script, is to a large extent Africa's to write both at a continental level and a national level. Understanding the economic demography transition stages—how economics and demography interact over time, within and between countries, and which policies are optimal over time accordingly—may be the beginning of knowledge. For this knowledge to become "wisdom" and trigger effective policy interventions, countries will need to commit to unprecedented investment in education for boys and girls, particularly girls. Without this investment, quite simply, the youth will not become a dividend. With it, they can.

[47] Lauren A. Johnston. (2019) An Economic Demography Explanation for China's 'Maritime Silk Road' Interest in Indian Ocean countries. *Journal of the Indian Ocean Region*, 15:1, **97 112**, DOI: 10.1080/19480881.2019.1569326.



Murdoch University

Murdoch University Research and Innovation

commission@murdoch.edu.au

www.murdoch.edu.au/research/research-focus/the-murdoch-commission