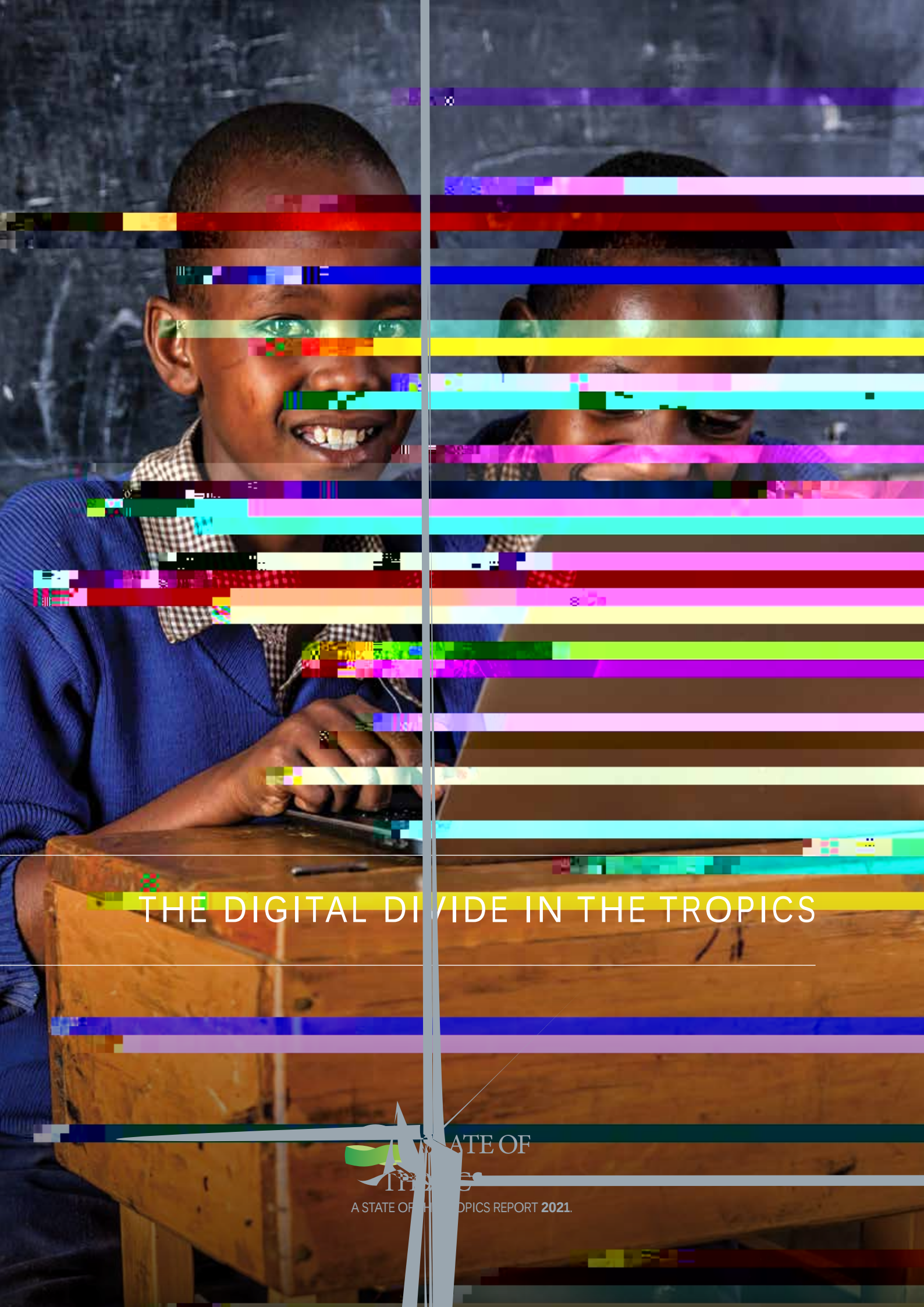


# THE DIGITAL DIVIDE IN THE TROPICS

ATE OF

A STATE OF THE TROPICS REPORT **2021**.

## CHAPTERS



## CASE STUDIES

# FOREWARD

There can be no doubt that the future is digital and to be on the wrong side of the digital divide is to be on the wrong side of history.

More than three billion people, almost half the world's population, are not online and most of those who are on the wrong side of the digital divide live in the tropical regions of the world.

The digital revolution has transformed lives. These new technologies have allowed people to connect with one another in a whole new way, overcoming distance and geography. A mobile phone means you can contact your family far away, receive money, avoid unnecessary and potentially dangerous travel and enjoy and share music and culture. As this technology develops, it will affect how we grow our food and receive health care and education, and makes possible a fairer and more equitable society.

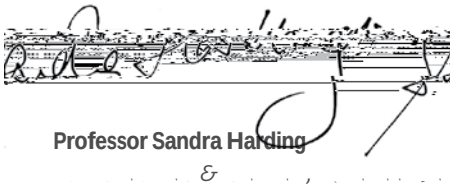
However, just like all instruments of development, the success of information and communication technology to alleviate poverty and drive sustainable development, depends on the social, cultural and environmental context in which it operates. Where inequality persists, the impact of introducing new technology remains unequal. While fourth and fifth generation (4 and 5G) mobile broadband or new satellite constellations can make the internet potentially available for everyone on Earth, true universal access still requires reliable electricity, the knowledge of how to use technology, and affordable devices and data.

The importance of digital technologies was growing inexorably when, in 2020, the COVID-19 pandemic put the role that this technology plays in our lives front and centre. Trade, employment, learning, communications and everyday life rapidly shifted into the digital realm.

In 2019, prior to the pandemic, representatives of the State of the Tropics leadership group met in Singapore to discuss the way forward for this project. At that time, the impact of digital technologies and the persistent digital divide was considered an important future focus for this project. The events of 2020 and 2021 have only served to highlight the critical nature of this particular axis of inequality as digital technology was put to work across the globe.

This report shines a spotlight on the extent and impact of the digital divide in the Tropics, in education, business and at home.

Spanning this digital divide, including understanding the innovative ways that people are using technology, holds in prospect a brighter future for the peoples of the Tropics.



**Professor Sandra Harding**

&

Convenor, State of the Tropics Project

# SUMMARY

People across the globe are more connected than ever. Digital technologies, mobile phones, the internet and other forms of digital information exchange have changed the way business and education are conducted and how knowledge is shared.

## LIST OF FIGURES AND TABLES

# 1

# INTRODUCTION

The growth of digital technologies, mobile communication and the internet is one of the major developments of the late twentieth and early twenty-first century. In September 2020, UN Secretary-General

In early 2011, a group of leading research institutions with a common interest in the future of the tropical world came together to examine the condition of life in the Tropics. Their goal was to examine the condition of life in the Tropics and answer the underlying question: is life in the Tropics getting better?

continued to bring together leading research institutions from across the tropical world to assess the state of the region and to examine the implications of the immense changes the region is experiencing. In doing so, it aims to build effective partnerships between tropical research institutions, build local research capacity and argue for the critical importance of the tropical zone in achieving a sustainable, prosperous and equitable global future.

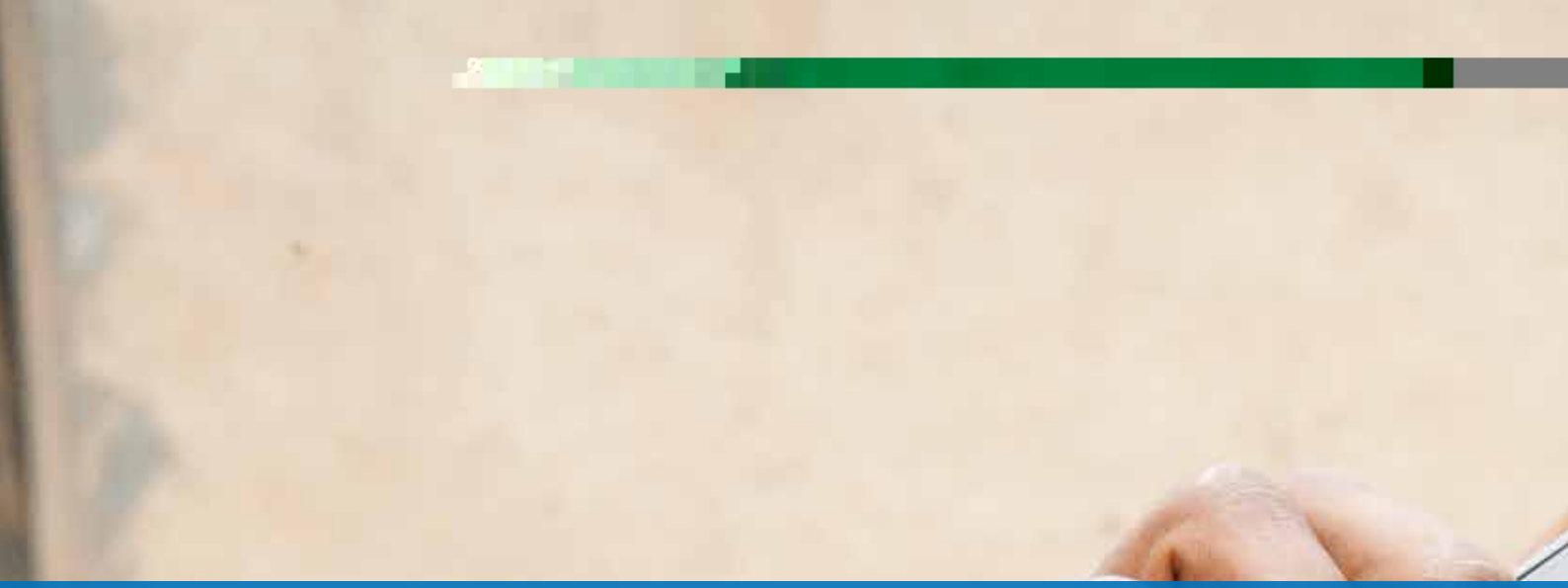
In 2016, the State of the Tropics Project welcomed the United Nation's decision to declare 29 June as the International Day of the Tropics. The initiative was spearheaded by the Australian Government in close collaboration with the institutions involved in the State of the Tropics Project. The International Day of the Tropics was designated to raise awareness of the specific challenges faced by tropical areas, the far-reaching implications of the issues affecting the world's tropical zone and the need, at all levels, to raise awareness and emphasise the vital role that countries in the Tropics will play in achieving the Sustainable Development Goals. The date was chosen, as it is the anniversary of the launch of the first State of the Tropics report by Nobel Laureate Daw Aung Sun Suu Kyi.

In 2017, a second major report was published focusing on sustainable infrastructure development in the Tropics. This report explored the tropical infrastructure gap and the challenges of meeting infrastructure needs while balancing environmental change and impacts on health and wellbeing.

Also in 2017, the State of the Tropics Project brought together a diverse group of distinguished researchers, private sector representatives, practitioners and policymakers through a Rockefeller Bellagio Center Workshop to help shape a strategic road map to strengthen the State of the Tropics consortium of universities and other institutions. The consortium agreed to work together to drive productivity through better educational outcomes, improved health, greater equity and more informed policy leading to sustainable development in the Tropics. It will do this by having an orientation to the future, a clear timeframe for success, creating connectivity between regions of the Tropics, and focusing on the youth of the Tropics grounded in targeted and reliable data.

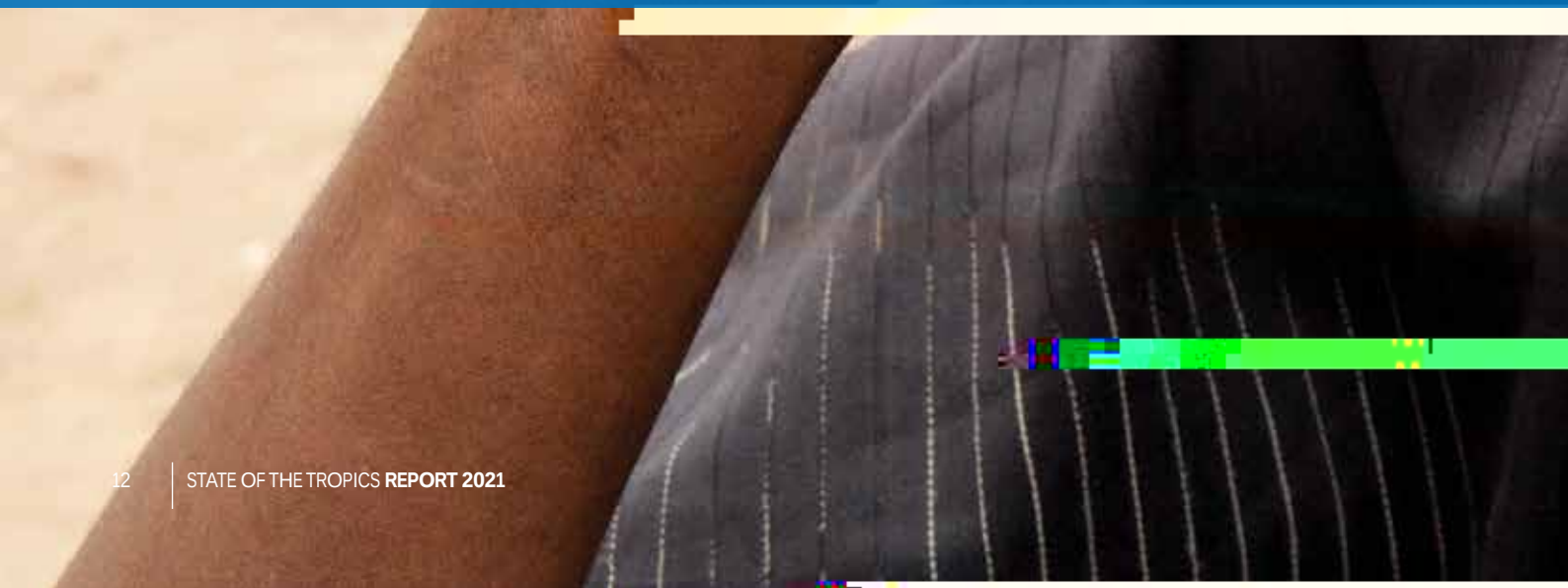
In 2019, a report on Health in the Tropics was published. This report took stock of the current and historical status of health and wellbeing across different regions of the Tropics. This report considered infectious disease, non-communicable disease, maternal and child health, mental Illness, substance abuse and accident and injury. It also explored the health workforce in the Tropics.

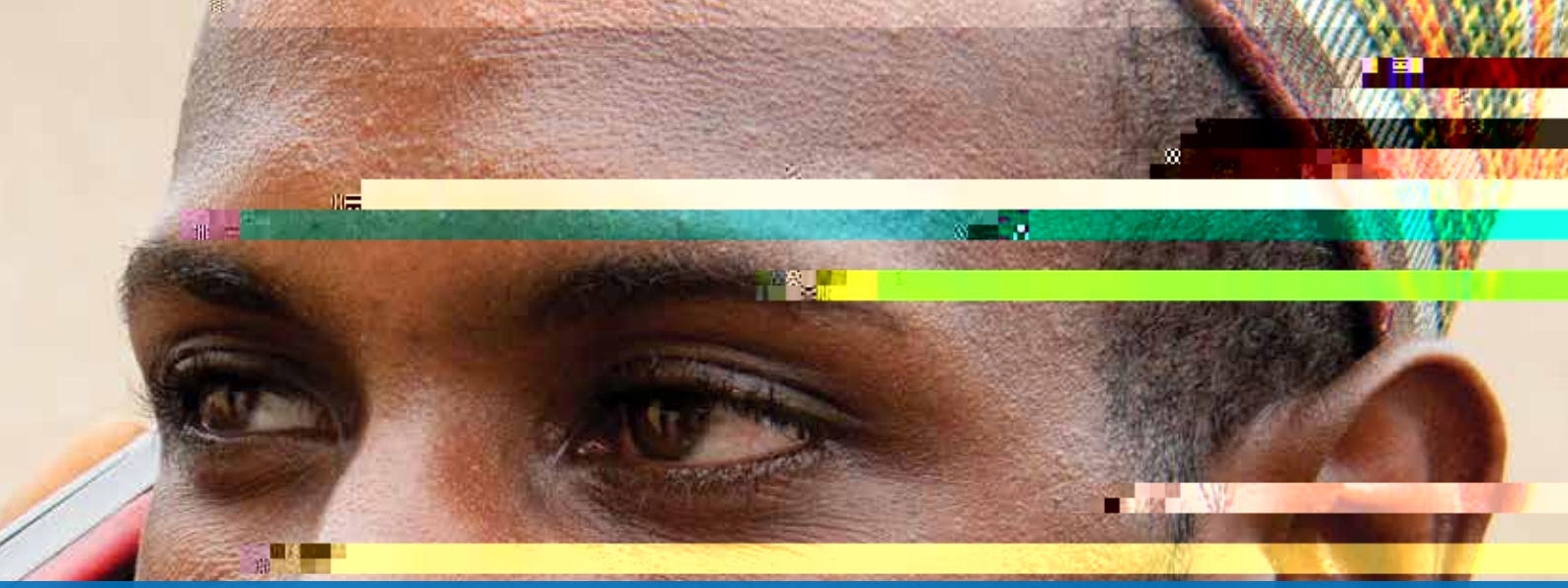
In 2020, another major report on the State of the Tropics was published. This report provided a timely update on the 2014 report and came at a critical time for the Tropics and its people. As the 0 (r)12 Tw n This rectious disease, nd historica5TJrAfutu other institutions. and my update oc (on ateTjp )200 scn/GS1 gs of universitijcu.y



# 2

# DIGITAL ACCESS IN THE TROPICS





## SUMMARY


The impact of the mobile phone across the world has been profound.

Globally, mobile phone ownership appears universal, with subscriptions out numbering people. In 2019, there were 108 mobile phone subscriptions for every 100 people globally. This equates to some 8.7 billion active mobile cellular subscriptions.

In the Tropics, access to mobile phones has increased dramatically since the turn of the century but still trails behind the rest of the world. In 2000, there were fewer than five mobile phones per 100 people in the Tropics. By 2019, this number had grown to more than 97 per 100.

According to the latest available estimates from the ITU, in 2019, 53.5% of people worldwide used the internet in 2019—an increase from just 17% in 2005.

In 2019, estimates suggest just 37.1% of people used the internet in the Tropics—indicating that the gap between the Tropics and the rest of the world has actually widened since previous State of the Tropics reports.

Recent advances in mobile technology have allowed more people to access the internet through the use of internet-enabled mobile devices, particularly smartphones. This has allowed far more people access to the internet without ever having to be connected by a fixed line. However, access to the internet through mobile broadband remains low in many parts of the Tropics.

Low Earth Orbit (LEO) satellite constellations could be transformative for expanding high-speed internet to underserved regions. However, the costs, both monetary and environmental, are potentially high.

The groups of people who have access to and use the internet vary between regions, gender and age. People living in urban areas are more likely to use the internet, men are more likely than women, and young people are more likely than the elderly.

There is no doubt that access to mobile phones and the internet has changed and continues to change how we communicate, work, do business, learn and interact with culture and art. During the various stages of lockdown imposed across the world in 2020, these forms of communication became more important than ever.

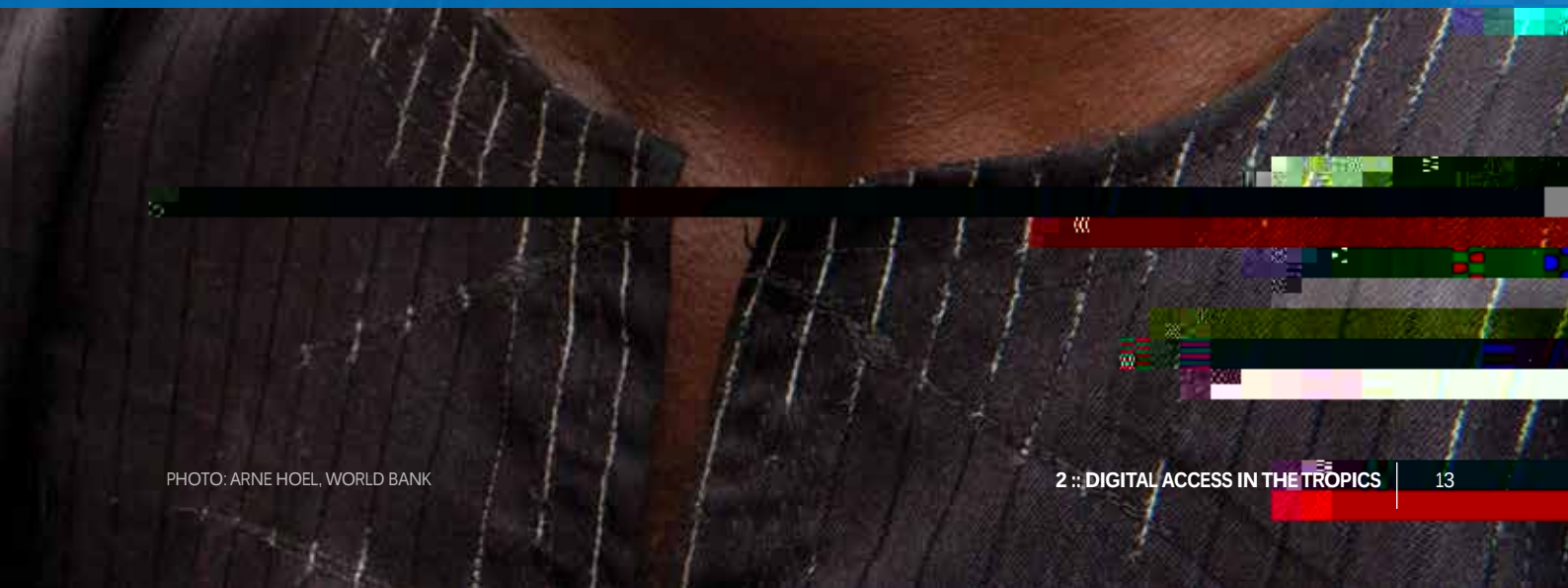



PHOTO: ARNE HOEL, WORLD BANK

People across the globe are more connected than ever. Digital technologies, mobile phones, the internet and other forms of digital information exchange have changed the way business and education are conducted and how knowledge is shared. ICT refers to any technology that enables the communication and electronic capture, processing and transmission of information. This includes older technologies such as radio, television and fixed-line telephony, as well as more recent innovations such as personal computers, mobile phones, broadband networks and the internet. The potential of these new technologies lies in their capacity to instantaneously connect vast networks of individuals, organisations and governments, across all corners of the world. ICT can provide many opportunities for education, entrepreneurship and new modes of finance and banking and play a role in reducing corruption.

Tropical nations have experienced rapid but uneven growth in ICT

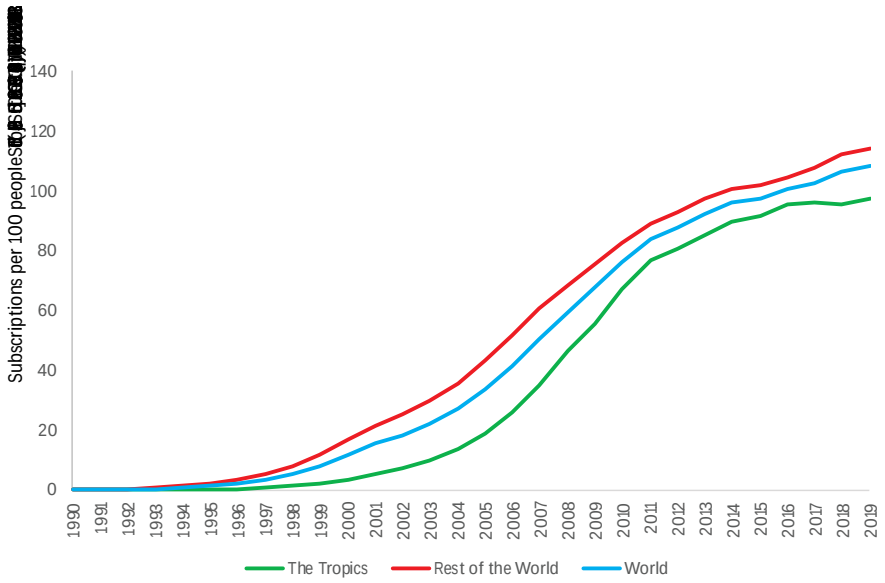



**Figure 2.1** Mobile Phone Subscriptions per 100 people in the Tropics, globally and the rest of the world.

International Telecommunications Union, 2020

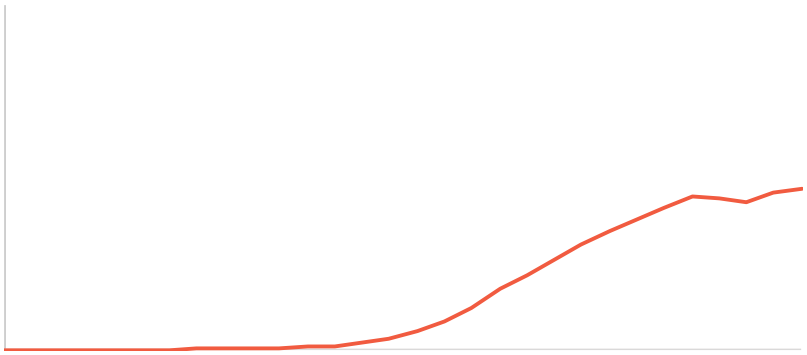


**Figure 2.2** Mobile cellular subscriptions per 100 people across the tropical regions.

International Telecommunications Union, 2020

### Internet users

The World Wide Web has existed for just over 30 years; however, recent data estimates 21.7 billion devices are now connected—a number that continues to grow (ITU and UNESCO, 2019). Internet users are individuals who have used the internet from any location in the past three months of being surveyed. These data do not represent subscriptions; they are based on household surveys.

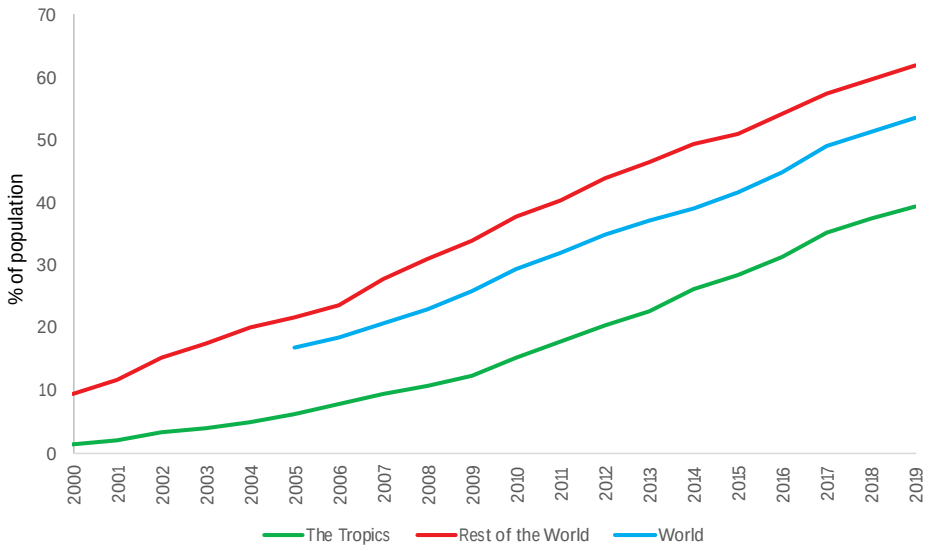



**Figure 2.3** Internet users (% of population) in the Tropics, the rest of the world and globally.

International Telecommunications Union, 2020

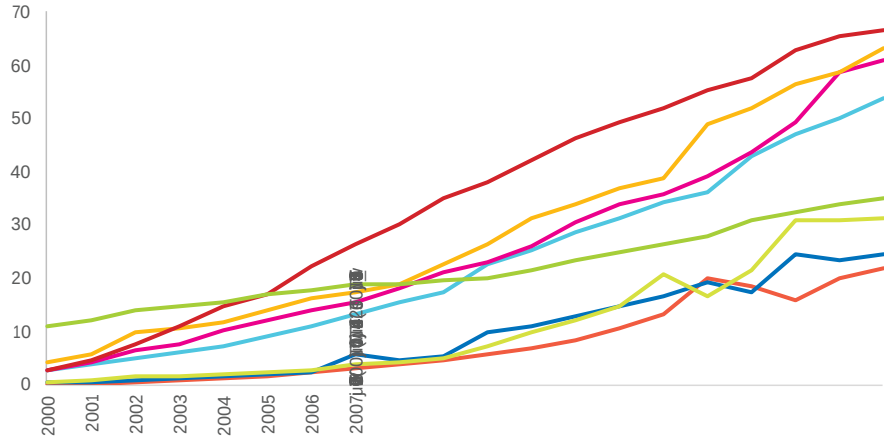



**Figure 2.4** Internet users (% of population) across the tropical regions.

International Telecommunications Union, 2020

**Affordability of ICT**

Affordability of a mobile phone and internet data are an essential part of the conversation around the digital divide. There is evidence to suggest that affordability, or the ability of individuals or households to pay for telecom services relative to their disposable income, is one of the main barriers to the use of mobile phones and the internet. Affordability depends not only on both price and income but also on other competing spending choices.

The cost of data varies substantially across the world (see Figure 2.7). Although price does not translate directly as an indicator of affordability, there are some assumptions we can make based on our knowledge of income, poverty rate and development of various countries. By far, the most expensive places to access the internet in the world are small remote islands: Sao Tome and Principe (US$28.26/GB); Bermuda (US$28.75/GB); and Nauru (US$30.47/GB). Islands are less likely to have extensive fibre infrastructure; thus, more expensive solutions such as satellite uplink are often used (Cable.co.uk, 2020). Conversely, the cheapest data in the world can be purchased in India, Israel, Kyrgyzstan, Italy and Ukraine. All these countries also have excellent fibre infrastructure. Generally, sub-Saharan Africa is the most expensive region in the world due to underdeveloped infrastructure and low access rates, although there are some exceptions. Sudan has some of the cheapest data in the world due to almost sole reliance on mobile data (Cable.co.uk, 2020).

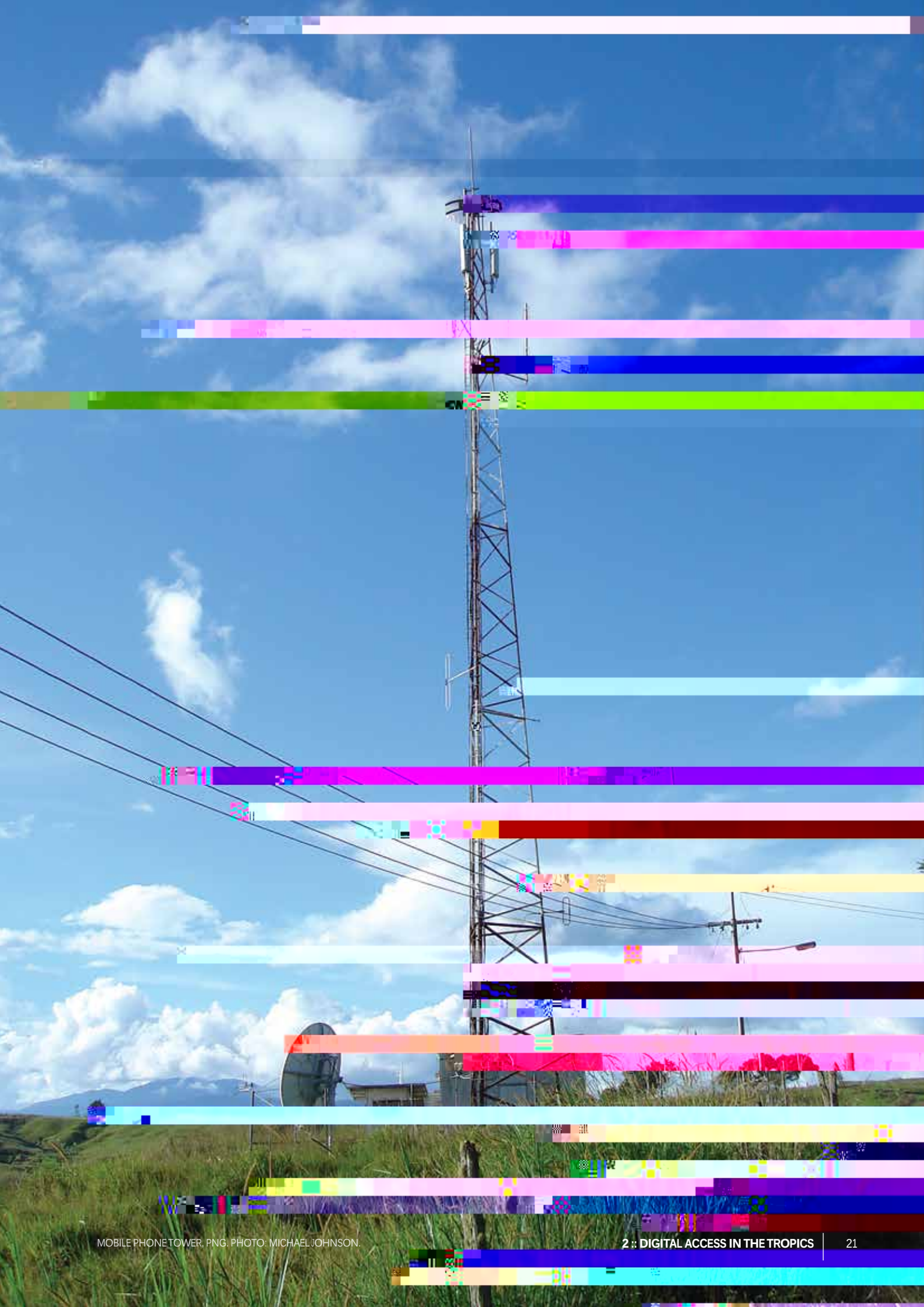
South Asia and South-East Asia have some of the cheapest data in the world due to a large, connected population and the rise of smartphone ownership. Generally, countries with cheap data are either wealthy countries with excellent infrastructure or those with less advanced networks but are heavily reliant on mobile data; thus, the market forces the prices lower.

There is no doubt that access to mobile phones and the internet has changed and continues to change how we communicate, work, do business, learn and interact with culture and art. During the various stages of lockdown imposed across the world in 2020, these forms of communication became more important than ever.

Human Rights Council of the General Assembly of the United Nations passed Resolution A/HRC/32/L.20, which covers the promotion, protection and enjoyment of human rights on the internet (United Nations, 2016). This resolution explicitly 'condemns unequivocally measures to intentionally prevent or disrupt access to or dissemination of information online in violation of international human rights law and calls on all States to refrain and cease such measures' (United Nations, 2016, p. 4).

Despite this, in 2020 alone, Bangladesh, the DRC, Egypt, India, Indonesia, Iran, Iraq, Sudan, Myanmar and Zimbabwe shut down the internet in all or some parts of their countries (Roth, 2020). In early 2021, following a coup d'état, the military-controlled government of Myanmar imposed several internet blackouts across the country. Governments use internet shutdowns during elections, anti-government protests or armed conflict. While some prolonged internet shutdowns are measures taken to tackle insurgency and political opposition, they have also been used for causes as small as preventing examination cheating (Kathuria et al., 2018). An internet shutdown has been defined by online digital rights organisations Access Now as: 'an intentional disruption of internet or electronic communications, rendering them inaccessible or effectively unusable, for a specific population or within a location, often to exert control over the information' (Taye, 2019, p. 2).

Internet shutdowns can have far-reaching consequences, even for countries with already low internet use rates. According to an analysis by the Brookings Institute, internet shutdowns have created significant negative economic impacts across the world (West, 2015). Looking at just the impact of shutdowns on GDP, the analysis estimates that in 2015, India lost $US 968 million; Saudi Arabia $US 465 million; Brazil $US 116 million; and the Republic of ConGoof internet



MOBILE PHONE TOWER, PNG. PHOTO: MICHAEL JOHNSON.

dimensions of extreme poverty, such as having to walk to visit family or contact people during emergencies, but often people will sacrifice food, sanitation and other needs to pay for the


# INFORMATION AND COMMUNICATIONS TECHNOLOGY IN THE PACIFIC

provide more business opportunities but also connectivity that previously had been denied due to culture and distance. The diversity of the pacific islands has also supported a diverse group of ways that people use and interact with technology.

In Papua New Guinea, as mobile phones spread further, it became commonplace for people, during cheap call times, to randomly dial numbers hoping to connect with new people. This phenomenon, known as 'phone friends' in Papua New Guinea, has grown to the point where particularly young people can have many phone friends whom they never actually meet in person (Wardlow,

## REFERENCES


BURKITT-GRAY, A. 2020. DigiCel lenders agree to cut debt by $16bn and interest by $125m a year. [Online]. Available: https://www.capacitymedia.com/articles/3825793/digicel-lenders-agree-to-cut-debt-by-16bn-and-interest-by-125m-a-year [Accessed 10 May 2021].

FINAU, K. 2019. Satellite communications in Pacific Island countries. *A* - . Bangkok, Thailand.

FOSTER, R. J. & HORST, H. A. 2018. Introduction. In: HORST, R. J. F. A. H. A. (ed.) . Canberra, Australia: Australian National University Press.

GALLOWAY, A. 2021. Australia may finance buyer for Pacific mobile network Digicel to block China. .

GSMA 2015. The mobile economy: Pacific Islands 2015. London, UK: GSMA Intelligence.

GSMA 2019. The mobile economy—Pacific Islands. London, UK: GSMA Intelligence.

HOBBIS, S. K. & HOBBIS, G. 2020. Non-/human infrastructures and digital gifts: The cables, waves and brokers of Solomon Island's internet. , 1–23.

INTERNATIONAL TELECOMMUNICATIONS UNION 2020. World telecommunications/ICT indicators database. Geneva, Switzerland: International Telecommunications Union.

JOGENSEN, D. 2018. Toby and 'the mobile system': Apocalypse and salvation in Papua New Guinea's wireless network. In: FOSTER, R. J. & HORST, H. A. (eds.) . Canberra, Australia: Australian National University Press.

KRAEMER, D. 2018. 'Working the mobile': Giving and spending phone credit in Port Vila, Vanuatu. In: FOSTER, R. J. & HORST, H. A. (eds) . Canberra, Australia: Australian National University Press.

NEWENS, C. 2021. Papua New Guinea calling. [Online]. Available: https://restofworld.org/2021/papua-new-guinea-calling/ [Accessed 23 April 2021].

WARDLOW, H. 2018. HIV, phone friends and affective technology. In: FOSTER, R. J. & HORST, H. A. (eds.) . Canberra, Australia: Australian National University Press.

The enormous growth of digital technologies in the twenty-first century has provided evidence that these technologies have the potential to improve health care provision and promotion and overcome geographical and socioeconomic barriers (Lupton, 2014). Although there is some debate around whether digital services can be safely used to replace face-to-face consultations and treatment, there is certainly evidence they provide benefits and have enormous potential. These benefits are seen particularly where mobile and digital communications have a greater reach into populations than existing health services.

There are numerous ways in which digital technologies are used or could be used. According to a review by Lupton (2014), there are many examples, including:

- telemedicine and telehealth—medical consultations, clinical diagnosis and health care delivery, offered remotely via digital technologies
-

## IMPROVED MANAGEMENT OF CHRONIC CONDITIONS

people or witnesses is received directly from reports sent through different communication channels, such as social media or established alert systems, and information channels, such as news, public health networks, and non-governmental organisations (O'Shea, 2017). These systems can complement existing monitoring programs and are often inexpensive, transparent and flexible, particularly as digital technology continues to penetrate rural and remote human populations (O'Shea, 2017).

A key tropical example of digital disease detection is the surveillance and outbreak management response system (SORMAS), a collaboration between the Helmholtz Center for Infectious Research, Robert Koch-Institute, Bernhard-Nocht Institute and the Nigeria Field Epidemiology & Laboratory Training Program (Denecke, 2017). It was initiated in 2014 when there was a high potential for Ebola outbreaks in Nigeria due to the ongoing epidemic in West Africa. SORMAS was developed specifically to provide demographic data of any Ebola infections to the National Nigerian Ebola Emergency Operation Centre; support the detection of suspected cases and contacts; and manage surveillance of close contacts (Denecke, 2017). Through a smartphone and tablet app, SORMAS allowed real-time, bi-directional information exchange between field workers and the Emergency Operations Centre and included contact follow-up, automated status reports and GPS tracking with all data stored on a secure cloud-based system (Denecke, 2017). SORMAS has more recently been adapted for use for other infectious diseases, including COVID-19, cholera, congenital rubella, dengue fever, guinea worm, human rabies, influenza, Lassa virus, malaria, measles, meningitis (CSM), monkeypox, plague, poliomyelitis and yellow fever (SORMAS, 2020).

As well as disease detection, technology is also used to monitor symptoms and aid treatment. Leishmaniasis is a neglected tropical disease caused by a protozoan parasite transmitted by sandfly bite. It is common in Brazil, which accounts for 97% of all infections in Latin America. It is largely a disease of poverty, more readily contracted in situations of poor housing and sanitary conditions (WHO, 2020). A smartphone application called Leishcare was developed through a collaboration between medical researchers and software engineers to assist health professionals in diagnosing and managing the condition in rural and remote settings (da Silva et al., 2020). The application provides treatment suggestions and allows users to store patient information to track their progress and share de-identified information with colleagues for advice. The application used the data entered to provide information on how serious the infection was and what treatment options were available (da Silva et al., 2020). Trials of the applications were considered highly successful, and variations of the app have been developed in other parts of the Tropics, such as Africa, with locally relevant information (da Silva et al., 2020).

Other forms of emerging technology are being used in the Tropics to monitor and treat other neglected tropical diseases such as schistosomiasis. For example, the Geshiyaro Project, based in Ethiopia, uses biometric fingerprint technology to identify and track participants in a project evaluating the feasibility of treatments for schistosomiasis in Ethiopia (Mekete et al., 2019).

## LIMITATIONS OF DIGITAL HEALTH

Given the infancy of digital and mobile health programs in the Tropics, it is perhaps too soon for measurable positive outcomes to be reflected in key health indicators such as life expectancy and maternal mortality. However, in terms of effectiveness, digital technologies, particularly mobile phones, have been shown to provide access to medical services for remote populations, enhance communication flows and coordination among medical organisations, improved education and training of health care workers, allow timely data collection (Chib, 2013).

However, all interactions with mobile and digital health are not necessarily positive and, in some cases, could have unintended negative consequences. Digital technology is far from perfect, and many devices and applications can be erratic, frightening

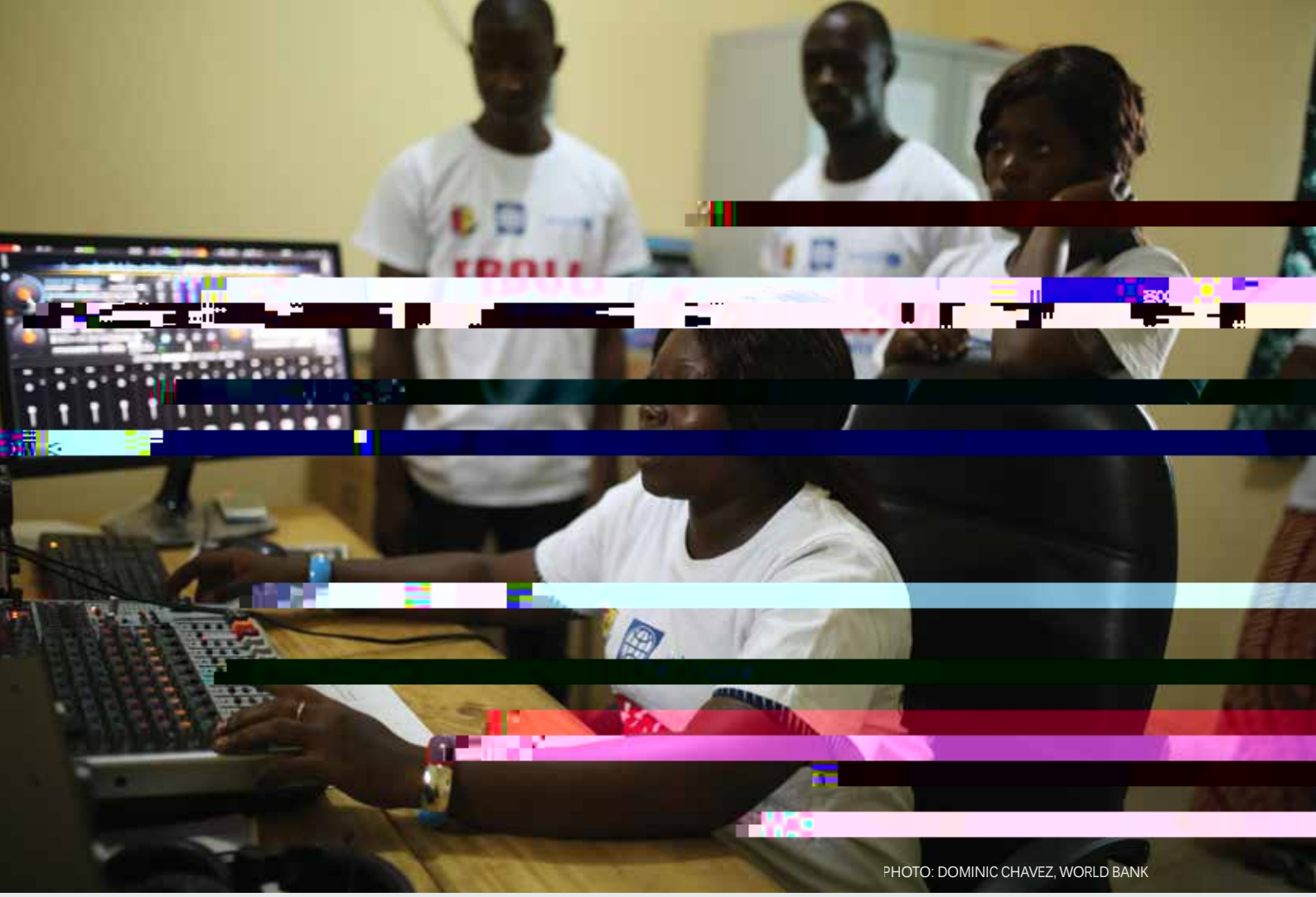


PHOTO: DOMINIC CHAVEZ, WORLD BANK

complex processes such as data entry or health care information. Even among health professionals, there is sometimes reluctance to rely on digital technologies since they do not replace local and contextualised knowledge developed over time through their work (Lupton, 2014).

Additionally, there are privacy concerns. The proliferation of m-health and e-health applications has led to a large amount of sensitive data being generated (Benjumea et al., 2020). Concerns around privacy are often a barrier facing the adoption of digital health technologies, particularly among older users and those for whom digital literacy is low (Fox and Connolly, 2018). More broadly, however, concerns around the privacy of m-health are justified because many health apps on the market lack appropriate security to protect the integrity of the data they collect and display (Galvin and DeMuro, 2020). Different countries have different legal requirements for privacy, and there is no universal system to score the privacy rating of health applications.

Physical security is also an issue (Galvin and DeMuro, 2020). Mobile phone usage practices of device sharing make the dissemination of sensitive medical information difficult for groups such as women who might be reliant on male partners or village leaders for access to technology (Chib, 2013). Additionally, more than a third of smartphone users do not apply security measures to prevent access, and thus misplacement, theft or loss of mobile devices can lead to privacy breaches (Galvin and DeMuro, 2020).

## CONCLUSION

It is clear that digital technologies have the potential to continue to transform how health care is delivered in the Tropics and potentially have far-reaching positive health outcomes. However, it is a tool, not a panacea, and its value will always be influenced by the personal, cultural, social and environmental context in which it is used. Digital health technologies are not likely to be able to replace face-to-face interactions between patients, health care workers, nurses and physicians, but they can add value.

AMANKWAA, I., BOATENG, D., QUANSAH, D. Y., AKUOKO, C. P. & EVANS, C. 2018. Effectiveness of short message services and voice call interventions for antiretroviral therapy adherence and other outcomes: A systematic review and meta-analysis. , 13, e0204091–e0204091.

BENJUMEA, J., ROPERO, J., RIVERA-ROMERO, O., DORRONZORO-ZUBIETE, E. & CARRASCO, A. 2020. Privacy assessment in mobile health apps: Scoping review. , 8, e18868.

BROWNSTEIN, J. S., FREIFELD, C. C. & MADOFF, L. C. 2009. Digital disease detection—Harnessing the web for public health surveillance. , 360, 2153–2157.

CHIB, A. 2013. The promise and peril of mHealth in developing countries. & , 1, 69–75.

DA SILVA, P. E. F., DOS SANTOS FONSECA JUNIOR, G., AMBROZIO, R. B., TIBURCIO, M. G. S., MACHADO, G. B., DE CARVALHO, S. F. G., DE OLIVEIRA, E. J., DE ALMEIDA SILVA TEIXEIRA, L. & JORGE, D. C. 2020. Development of a software for mobile devices designed to help with the management of individuals with neglected tropical diseases. , 36, 527–537.

DANIEL, T. M. 2006. The history of tuberculosis. , 100, 1862–1870.

DASUKI, S. I. & ZAMANI, E. D. 2019. Assessing mobile phone use by pregnant women in Nigeria: A capability perspective. The Electronic , 85, e12092.

DENECKE, K. 2017. An ethical assessment model for digital disease detection technologies. , , 13 (1): 1-11.

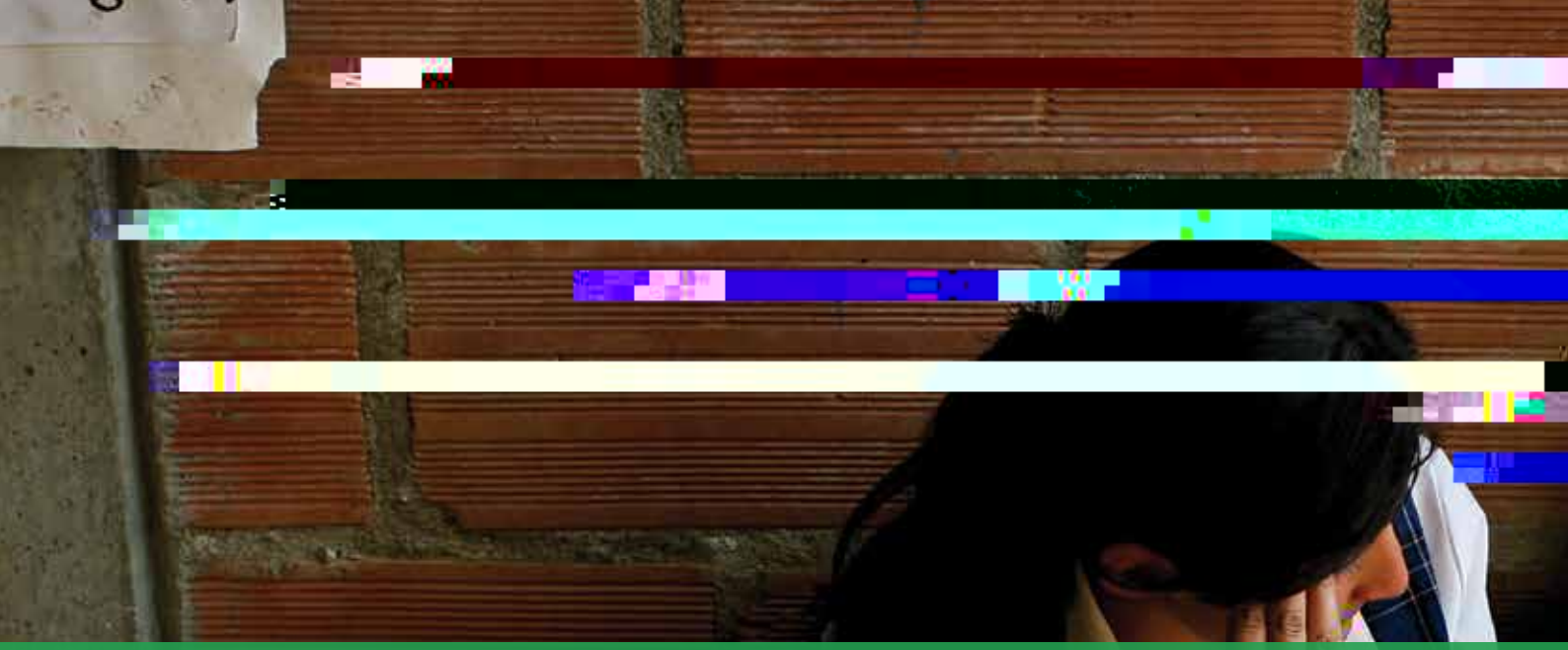
FOX, G. & CONNOLLY, R. 2018. Mobile health technology adoption across generations: Narrowing the digital divide. , 28, 995–1019.

GALVIN, H. K. & DEMURO, P. R. 2020. Developments in privacy and data ownership in mobile health technologies, 2016–2019. , 29, 32–43.

GASHU, K. D., GELAYE, K. A., MEKONNEN, Z. A., LESTER, R. & TILAHUN, B. 2020. Does phone messaging improves tuberculosis treatment success? A systematic review and meta-analysis. , 20, 42–42.

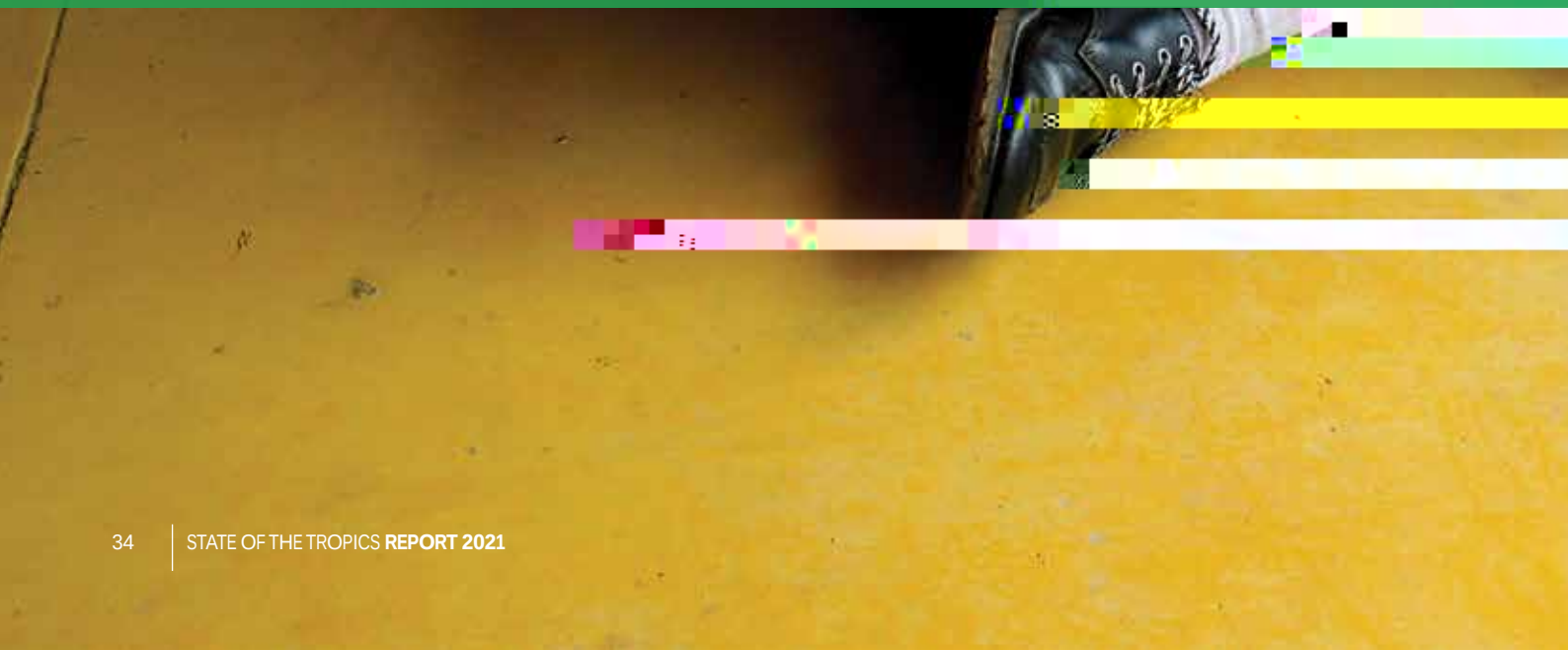
HALL, A. K., COLE-LEWIS, H. & BERNHARDT, J. M. 2015. Mobile text messaging for health: A systematic review of reviews. *A* , 36, 393–415.

KIM, S. S., PATEL, M. & HINMAN, A. 2017. Use of m-health in polio



# 3

# EDUCATION AND DIGITAL LITERACY



## SUMMARY


Lack of access to ICT at school and at home limits the ability of students to learn digital skills that would allow them to participate in the global digital economy, which many see as essential for ongoing sustainable development.

There is huge variation in schools with internet access, from less than 3% in Madagascar and Burkina Faso to 100% in Brunei, Maldives and a number of Caribbean states. Access tends to remain very low across Central and Southern Africa and in some parts of South Asia, South-East Asia and Central America. Data are not available for any countries in Oceania.

Africa and South Asia have particularly low levels of internet access at home. The youngest group, school-aged children, had the lowest access levels in these regions, with slightly higher access in East Asia and the Pacific.

In the context of the global pandemic with many schools operating remotely, this low level of access in many tropical countries meant that when schools were closed, the only means of students continuing schooling was through take-home packages—this has resulted simply in many students not accessing schooling at all with potentially huge social and economic costs to the countries that can bear it the least.

Generally, ICT is far less likely to be included in primary school curriculums, particularly in Africa and the Middle East. However, by upper secondary, most countries reporting included ICT in the curriculum. Programs in Brazil, Malaysia and Thailand have increased the number of schools with the capacity to teach ICT skills in those countries.

Far fewer youth and adults have basic digital skills in the Tropics than in the rest of the world. However, there are some exceptions. Saudi Arabia, Malaysia and Singapore have relatively high digital literacy rates, with rates comparable to most countries reporting from the non-Tropics and higher than some countries.

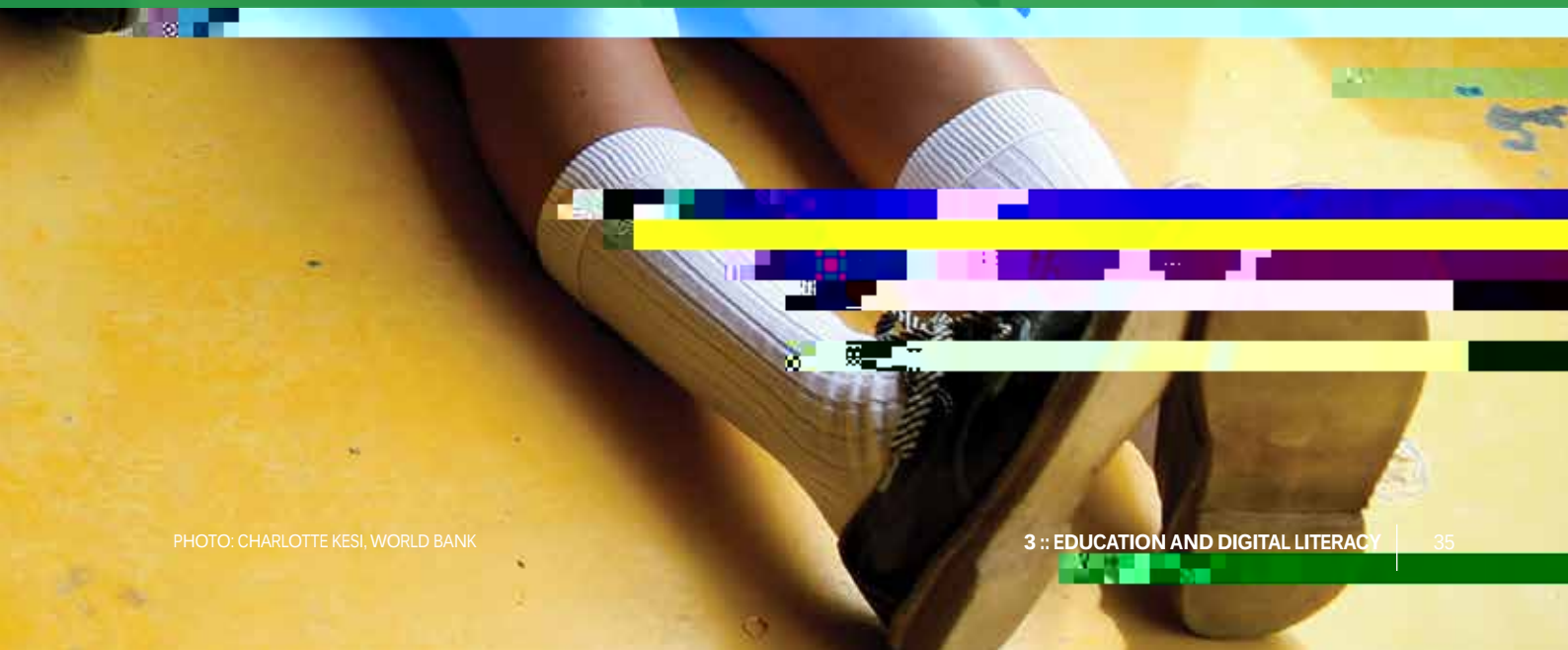



PHOTO: CHARLOTTE KESI, WORLD BANK

Education underpins all aspects of human rights and sustainable development. Well educated people tend to live longer, make better-informed health choices and have higher incomes. Access to quality education for all people is central to achieving the 2030 Agenda for Sustainable Development.

Lack of access to ICT at school and at home limits the ability of students to learn digital skills that would allow them to participate in the global digital economy, which many see as essential for ongoing sustainable development. Access to ICT, and the knowledge to use it, is increasingly important for employability and will only increase in importance as the use of digital technology continues to grow and penetrate across the Tropics. A key indicator of the Sustainable Development Goal Education for all is the proportion of youth and adults with ICT skills, by type of skill.

In 2020, according to UNESCO, 191 countries closed their schools for varying lengths of time due to the COVID-19 pandemic (UNESCO, 2020a). More than 1.5 billion students, from pre-primary to tertiary level, were disrupted by these closures, with classroom-based teaching disrupted (Montoya, 2020). The State of the Tropics project has clearly demonstrated that even prior to the pandemic of 2020, rates of children out of school were much higher in the Tropics than in the rest of the world (State of the Tropics, 2020). Before the pandemic, children from the poorest households were already almost five times more likely to be out of primary school than their wealthier counterparts.

Thus, without adequate ICT devices, internet access, appropriate resources for distance learning and teacher training, millions of

## ICT access at home

Learning has never been confined to school only; children and young people continue to learn outside formal schooling, through parents and other relatives, life experiences and, increasingly, online through the internet (Daoud et al., 2020). During the height of the COVID-19 crisis in 2020, 90% of governments around the world closed schools and implemented remote learning practices (UNICEF, 2020b). At their peak, school closures affected 1.5 billion school students from pre-primary to upper secondary (UNICEF).

Given that two-thirds of all children and young people do not have an internet connection at home (UNICEF, 2020b), remote learning poses a range of challenges. During 2020, schools and governments

## Digital skills

An important output measure of ICT education is whether young

Table 3.1

The digital divide is more than just access to technology, the internet or even a smartphone. The ability to learn remotely, to use technology for work or to run a business represents the second and third levels of the divide.

In the context of education, the digital divide between the Tropics and the rest of the world has been shrinking slowly but unevenly. It remains significant. The COVID-19 pandemic has highlighted this divide and potentially, at least for the short term, increased it. It is clear that better infrastructure development is necessary, but not sufficient, to help bridge this divide. It is not just the technology but how it is used.

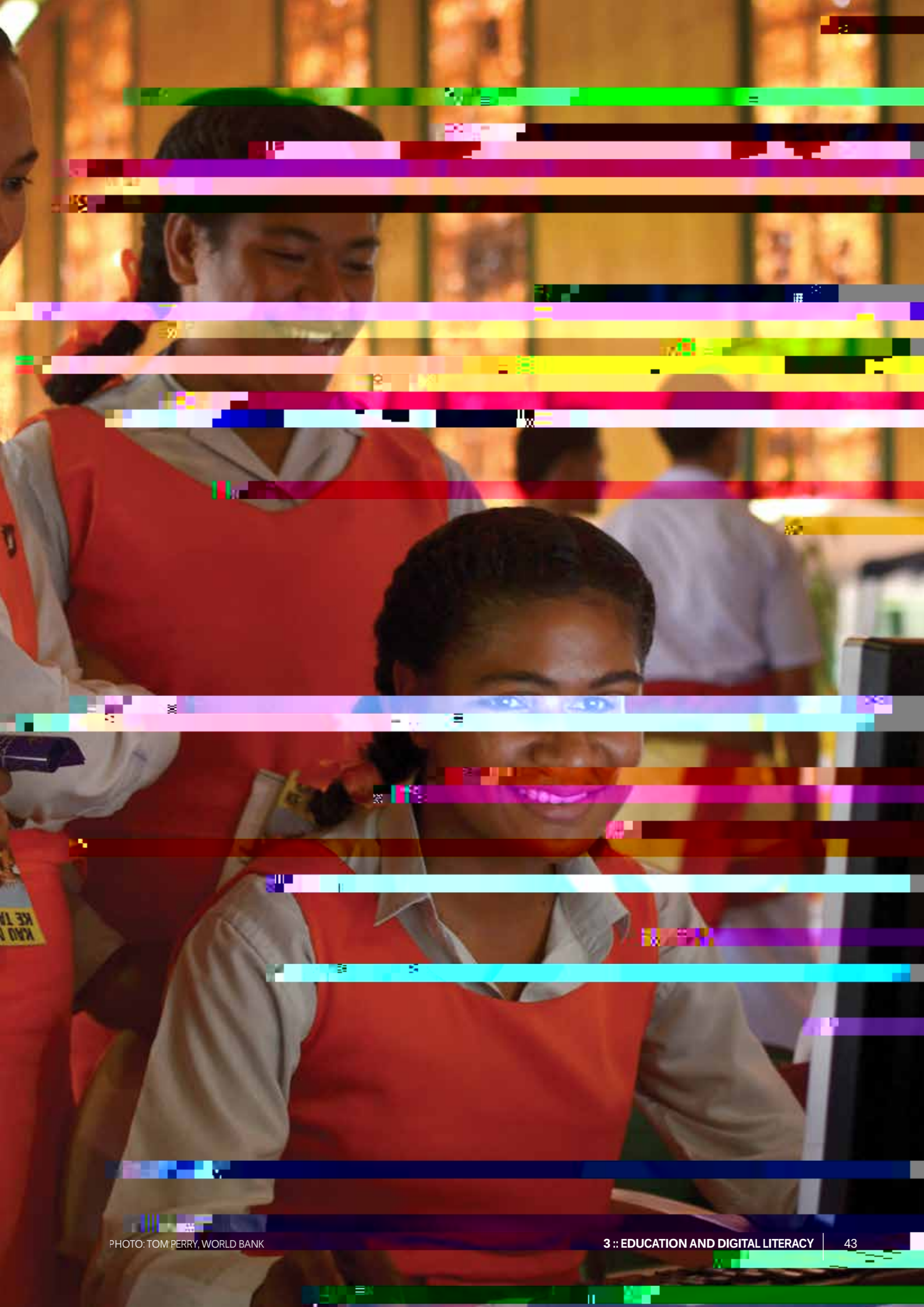


PHOTO: TOM PERRY, WORLD BANK

## REFERENCES


AGARWAL, R. & MALHOTRA, G. 2016. Women and access to ICT: A case study of India. *A* , 10, 288–297.

ANTONISIS, M. & MONTOYA, S. 2018. A global framework to measure digital literacy. Available from: http://uis.unesco.org/en/blog/global-framework-measure-digital-literacy.

ANWAR, T., JIMENEZ, A., BIN NAJEEB, A., UPADHYAYA, B. & MCGILL, M. M. 2020. Exploring the enacted computing curriculum in K–12 schools in South Asia: Bangladesh, Nepal, Pakistan, and Sri Lanka. *2020 A* 79–90.

CETIC BR 2019. ICT in education 2018—Survey on the use of information and communication technologies in Brazilian schools. Sao Paulo: CETIC BR.

DAOUD, R., STARKEY, L., EPPEL, E., VO, T. D. & SYLVESTER, A. 2020. The educational value of internet use in the home for school children: A systematic review of literature. , 1–22.

EBERHARD, D. M., SIMONS, G. F. & FENNIG, C. D. 2020. Ethnologue: Languages of the world. Twenty-fourth edition. Dallas, Texas: SIL International.

KRÖNKE, M. 2020. Africa's digital divide and the promise of e-learning. *A* . Acrra, Ghana: Afrobarometer.

MBODILA, ,34d]TJ/TtqES(of Busines-1.063 -19, (, 1NgiP2[ws0.01i64m6hIr)(cnes-1.3J0 Ia [er)12 3nwE1dJ1.063 -1.25 Td[Itme (Africa')53 - R25 Td(BR.)ue (t)]TJt3eedin 0 -42Td[(A)-2

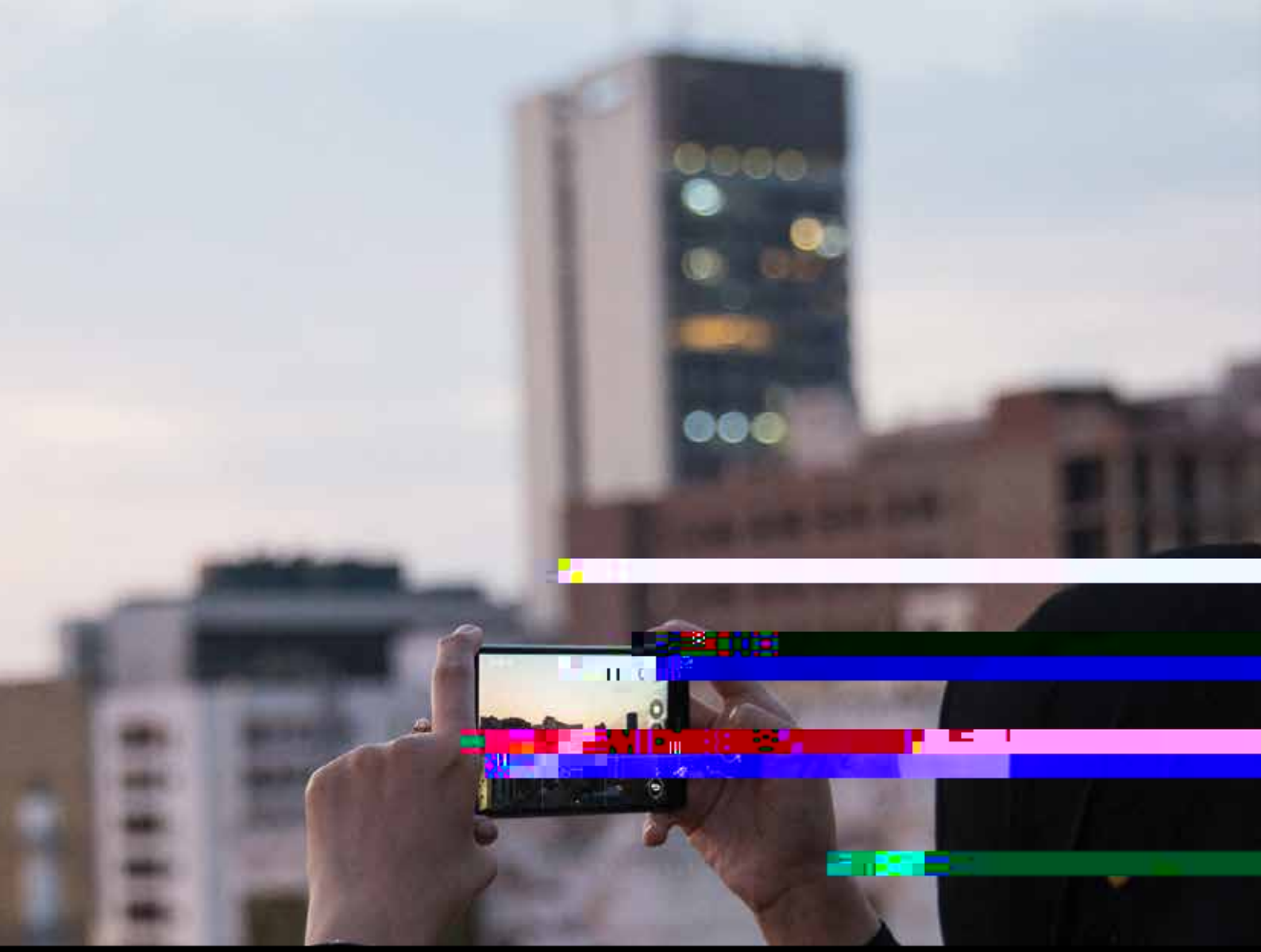


PHOTO BY MARK ZIEMBICKI


# MOBILE MONEY AND THE STORY OF M-PESA

Although it has only been available for just over a decade, mobile money has transformed how people access financial services, particularly in the Tropics. With just a basic mobile phone, mobile money allows people to safely store, send and transact money via text messages. This extends financial services to unbanked people at a very low cost (Logan, 2017; Suri and Jack, 2016). Unlike more modern payment apps such as Venmo or WeChat pay, it does not require a smartphone, bank account, credit card or internet connection (Kusimba, 2021). Mobile money is a money transfer system that uses mobile phones and a network of human agents who cash in and cash out for customers, exchanging e-money as text messages for hard currency (Kusimba, 2021). First introduced in South Africa and the Philippines in the mid-2000s, by 2018, the mobile money industry had reached 866 million people across some 90 countries by 2018 (GSMA, 2018). Mobile money accounts allow people to pay for things without having to use cash and thus can provide a gateway to life-enhancing services such as health care, education, employment and social protections (GSMA, 2018).

In 2007, Safaricom, the largest mobile network operator in Kenya, launched a phone-based money transfer service known as M-Pesa. Pesa is the Swahili term for money. It has now spread to the DRC, Egypt, Ghana, Kenya, Lesotho, Mozambique and Tanzania. It is used in 96% of Kenyan households and is considered Africa's most successful mobile money service and the region's largest fintech platform (Suri and Jack, 2016; Vodafone, 2020). According to Safaricom's parent company Vodafone, in 2019, M-Pesa had 41.5 million active customers who carried out more than 12 billion transactions (Vodafone, 2020).

M-Pesa turns small businesses and other people into ATMs. When it was launched, the average distance from an individual to a bank was 9.2 kilometres (Logan, 2017). By 2015, the average distance to an M-Pesa agent was just 1.4 kilometres meaning far more people were in reach of one (Logan, 2017). The rapid uptake of M-Pesa is attributed to the fact its rollout coincided with growing mobile phone use, its simplicity of use and on the ground marketing by Safaricom (Suri and Jack, 2016). Importantly, M-Pesa has allowed a dramatic increase in internal remittances, particularly from urban areas to rural areas. Although urbanising rapidly, most of Kenya's population remains rural. M-Pesa has allowed remittances to flow from large towns and cities to rural areas quickly and safely.

Generally, M-Pesa is perceived to have had a positive impact on poverty alleviation and economic development in Kenya. Some estimates suggest that M-Pesa alone has lifted as many as 194,000 households out of poverty and has been effective in improving the economic lives of poor women and members of female-led households (Suri and Jack, 2016). It has reportedly done this through more efficient allocation of labour, savings and better risk management (Suri and Jack, 2016).

However, as with questions around the impact of microfinance in other parts of the Tropics (Duvendack and Palmer-Jones, 2012), the

profit for international stakeholders. Evidence suggests that M-Pesa has been more successful and has more customers in wealthy urban areas than in poorer areas and slums (Bateman et al., 2019).

One of the key criticisms of mobile money in general and M-Pesa in particular is that due to its popularity, it has become very profitable, but these profits are not passed on to customers. M-Pesa is owned by Kenyan registered company Safaricom, which is now 40% owned by UK-based multinational Vodafone. Safaricom is Kenya's largest company and in 2019, posted a US$620 million profit, thus providing considerable dividends for shareholders, most of which are in the UK (Bateman et al., 2019). Thus, the perception could be that wealthy shareholders are profiting from the transactions of some of the poorest people in

## REFERENCES

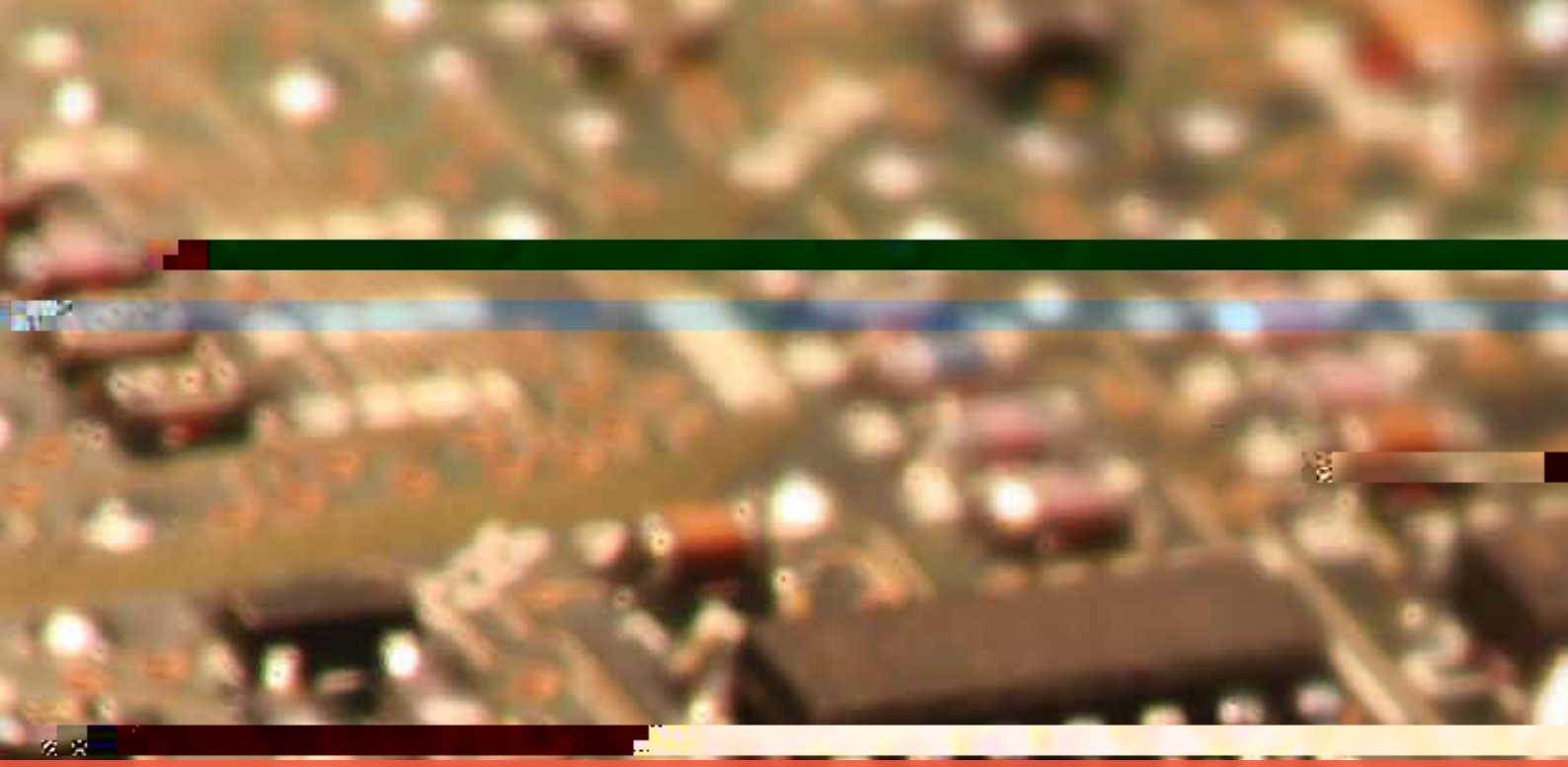

ALUSHULA, P. 2019. Alarm as easy digital loans yoke more Kenyans to debt. [Online]. Available: https://www.businessdailyafrica.com/datahub/Alarm-as-easy-digital-loans-yoke-more-Kenyans-to-debt/3815418-5063014-en2bp7z/index.html [Accessed 05 May 2021].

BATEMAN, M., DUVENDACK, M. & LOUBERE, N. 2019. Is fin-tech the new panacea for poverty alleviation and local development? Contesting Suri and Jack's M-Pesa findings published in Science. *A* , 46, 480–495.

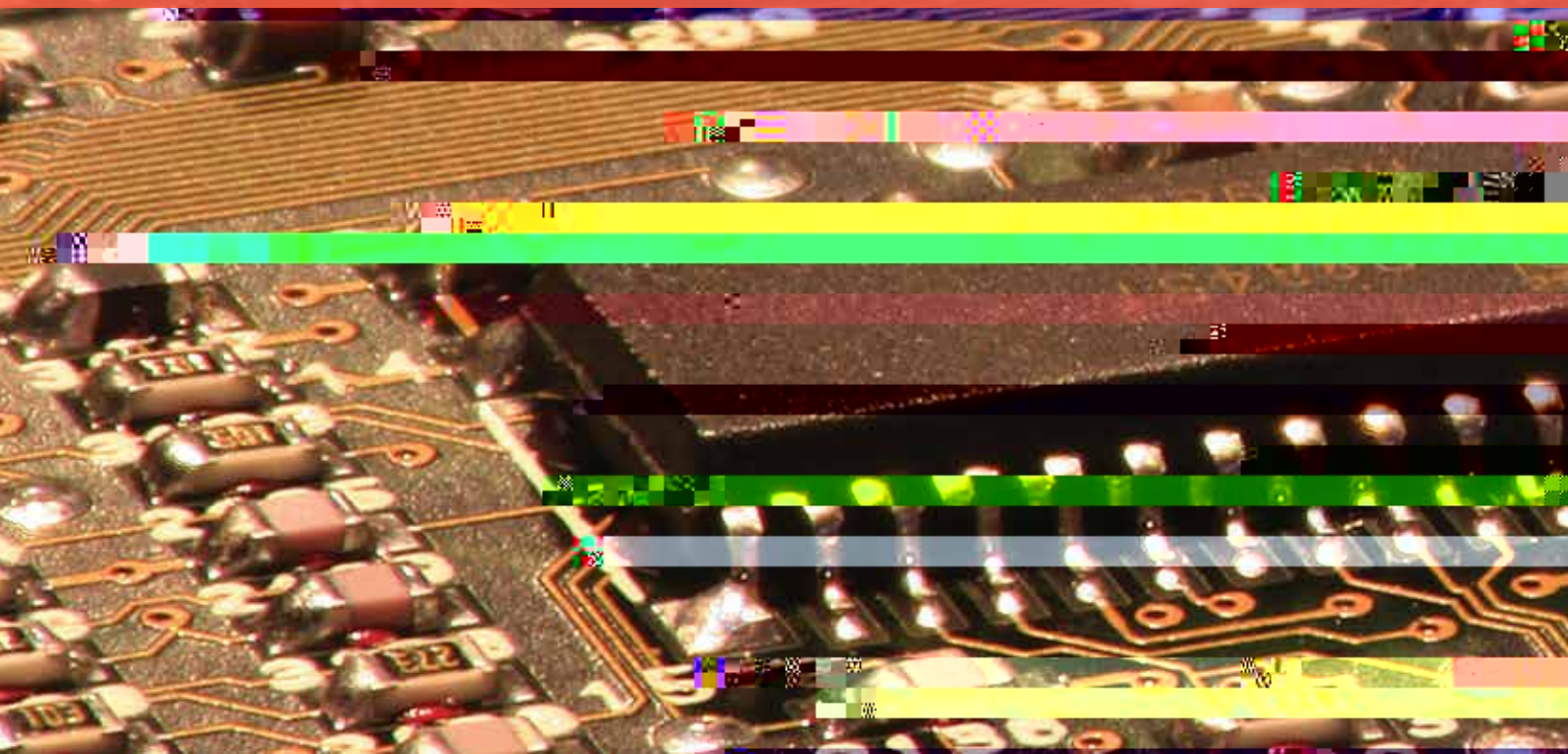
DUVENDACK, M. & PALMER-JONES, R. 2012. High noon for microfinance impact evaluations: Re-investigating the evidence from Bangladesh. , 48, 1864–1880.

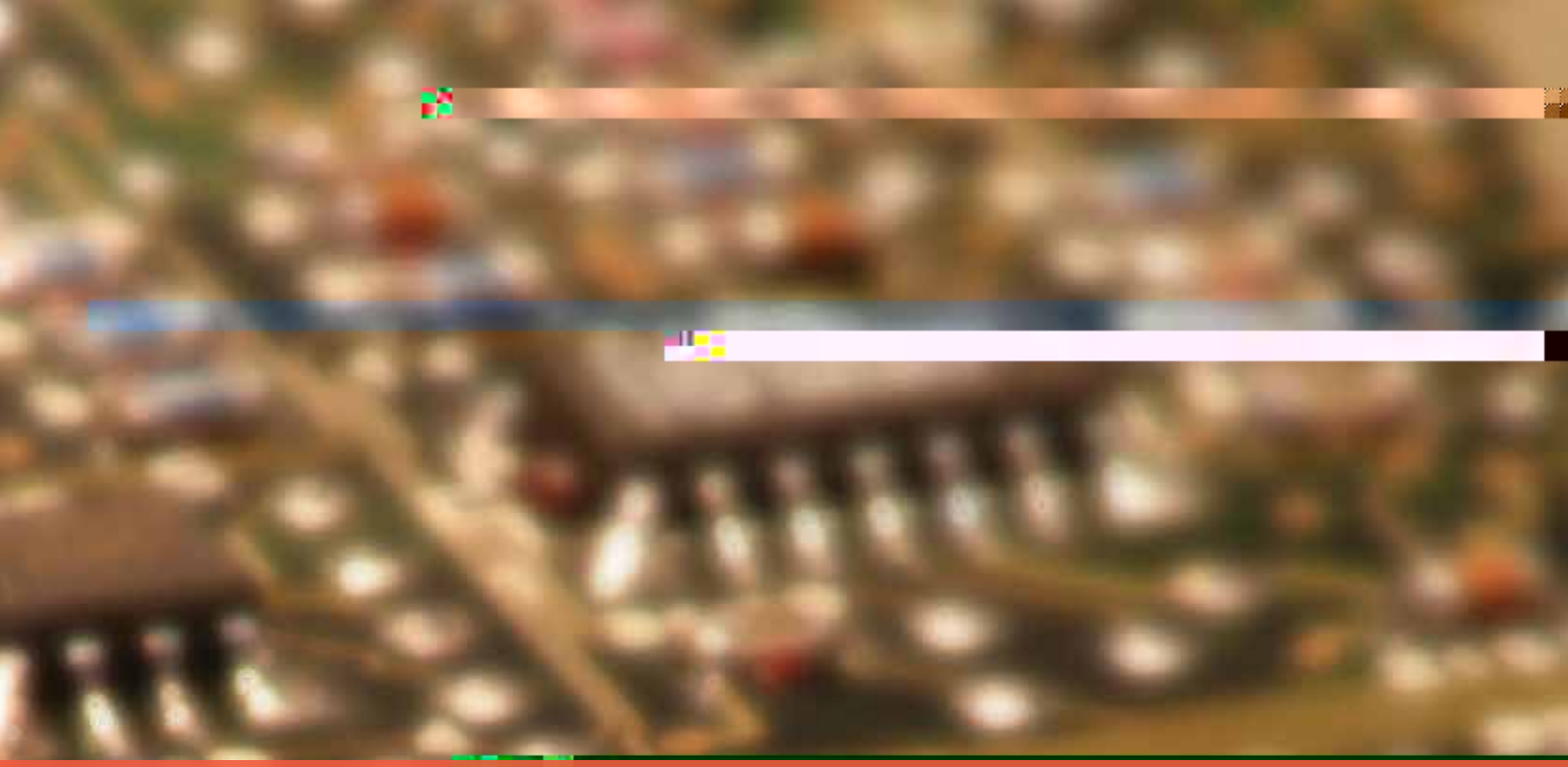
GSMA 2018. State of the industry report on mobile money. London, UK: GSMA.

KUSIMBA, S. 2021. : , Stanford, CA, Stanford University Press.



# PRODUCTION, TRADE, USE AND DISPOSAL OF ICT IN THE TROPICS





## SUMMARY

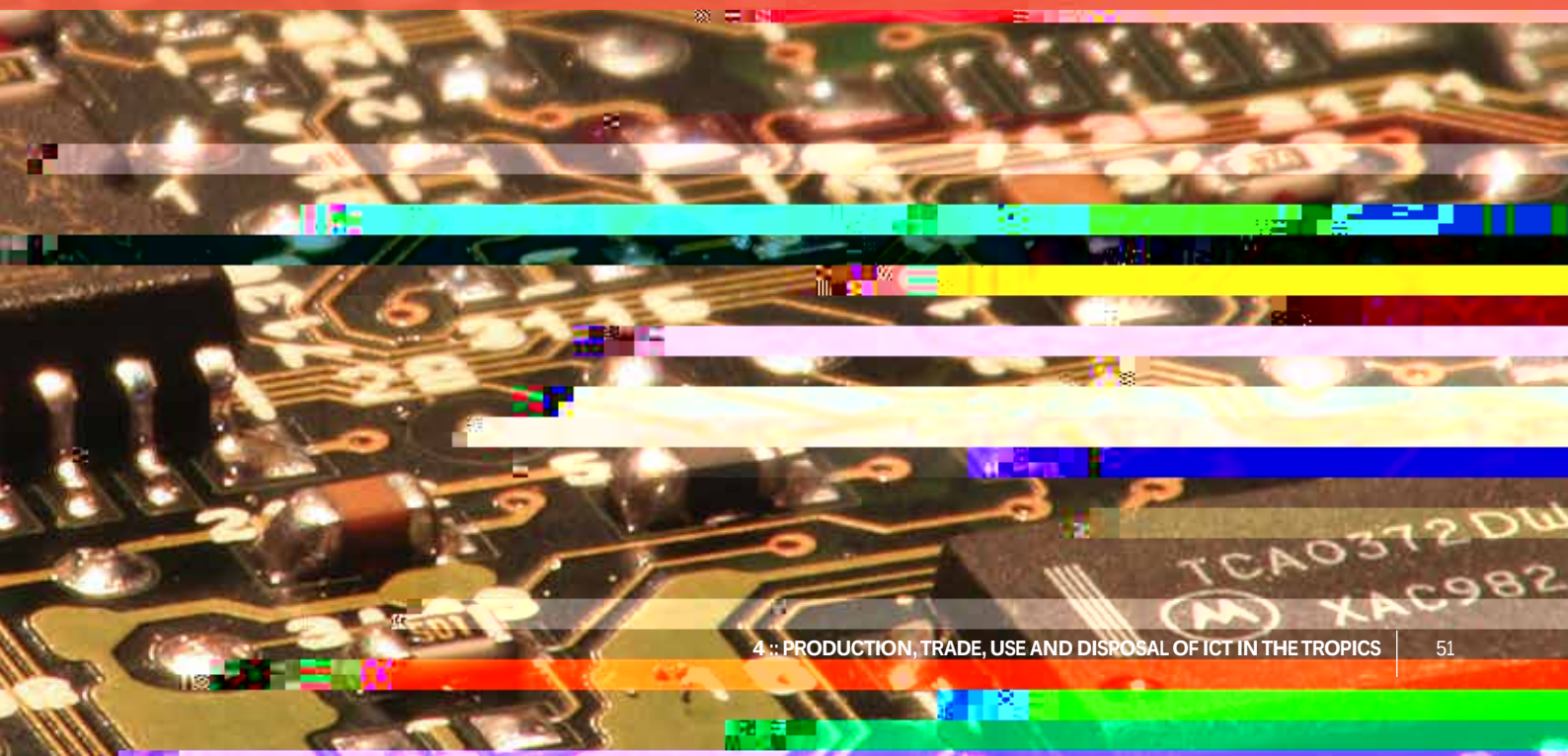

Around 40% of all ICT goods are exported from tropical regions. These exports are dominated by South-East Asia and Central America. In other regions of the Tropics, the share of the global trade in ICT goods remains small.

South-East Asia is the only region in the Tropics that is a net exporter of ICT goods. All other regions in the Tropics import more technology than they produce and export.

Globally almost one-quarter of all people used the internet to make a purchase in 2019; however, this was concentrated in wealthy countries in North America, Europe and East Asia. Far fewer people use the internet for purchasing throughout the Tropics, with some exceptions such as Saudi Arabia, Malaysia and Singapore. The largest growth markets in the Tropics have been Hong Kong and India.

The rapid expansion of electrical and electronic equipment manufacturing across the world due to industrialisation, economic expansion, technological development and growing wealth has led to complementary growth in electronic waste or e-waste.

On a per-capita basis, tropical countries, with the exception of tropical Australia and the USA (Hawaii), produce far less e-waste than nations in North America and Europe. E-waste from North America and Europe is often exported to China, Brazil, Nigeria, Ghana and India.

Elsewhere in the Tropics, Mexico and Costa Rica are also important suppliers of electrical components, with ICT goods comprising 9% of all exports from the Tropics. Costa Rica has been an important manufacturing base for multinational companies for many years. By 2012, around 40 firms were operating exclusively in the electronics and electrical industries in Costa Rica (Frederick and Gereffi, 2013). Firms cited political stability and safety, competitive labour and operating costs, availability of qualified, skilled labour and proximity to large markets in the USA and Latin America as reasons for selecting Costa Rica (Frederick and Gereffi, 2013).

Mexico, with a large skilled population, is one of the largest exporters of ICT goods in the world, comparable to Thailand and the Philippines. Economic integration with the USA has been an important driver of ICT production in Mexico; however, it is likely that some ICT goods manufacturing and exports are underestimated due to the production occurring within large multinational, USA-based firms (Schatan and Enríquez, 2016).

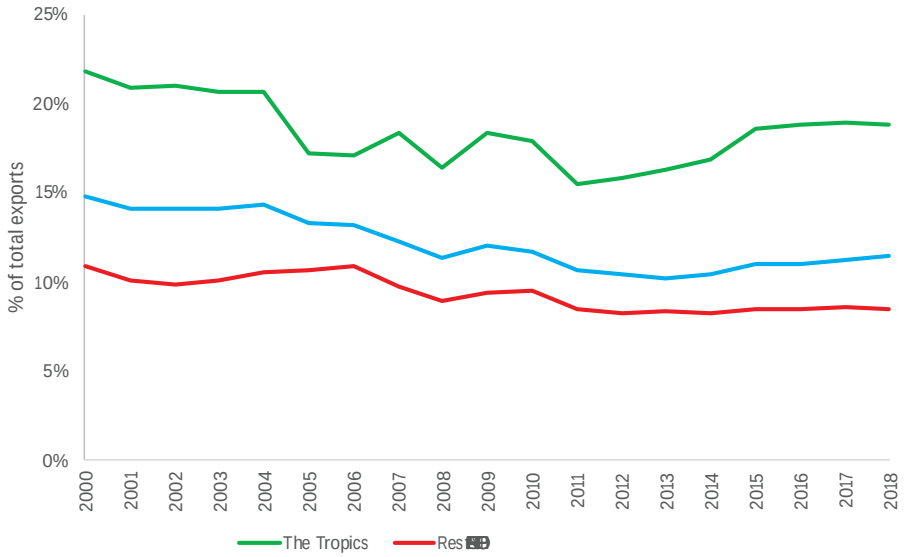



**Figure 4.1** ICT goods exported as a percentage of total exports globally, in the Tropics and in the Rest of the world.

Source: World Bank, 2020a

Nations and regions that export ICT goods also tend to be the largest importers of technology as well. Given different parts of the digital manufacturing cycle require different components, it makes sense that countries with digital manufacturing would be both high importers and exporters.

South-East Asia is the only region in the Tropics that is a net exporter of ICT goods. All other regions in the Tropics import more technology than they produce and export (see Figure 4.5).

Evidence suggests that increasing ICT imports, particularly for lower income countries, will have a positive impact on economic growth (Yoon, 2019). ICT goods are used to further develop ICT access and diffusion and drive innovation (Yoon, 2019). ICT goods imports also improve both the efficiency of ICT accumulation and the efficiency of the domestic production process due to the technological progress embodied in these imported goods (Yoon, 2019). Thus, growing ICT imports are expected to have a positive impact on tropical countries. Growth in South Asia is particularly notable. This is driven by India, the fastest growing technology market on the planet, as its young population becomes increasingly educated and connected.

## E-commerce

According to the World Trade Organization (WTO, 2013 p1),

Globally, almost one-quarter of all people used the internet to make a purchase in 2019; however, this was concentrated in wealthy countries in North America, Europe and East Asia (World Bank, 2019; see Figure 4.5). Far fewer people use the internet for purchasing throughout the Tropics, with some exceptions such as Saudi Arabia, Malaysia and Singapore (see Figure 4.5). The largest growth markets in the Tropics have been Hong Kong and India (UNESCAP, 2018). Some estimates suggest that the e-commerce market in India is expected to grow from US$33 billion in 2017 to US$200 billion by 2026. There are no data available for tropical island nations of the Pacific but given internet access remains low in that region, it is likely e-commerce is rare outside of urban areas.

Using ICTs and e-commerce can lower transaction costs for small- and medium-sized enterprises and has been shown to support rural development. It is a crucial way for businesses to expand into new and bigger markets. However, given the unequal access to

On average, the total weight (excluding photovoltaic panels) of global electrical and electronic equipment increases annually by 2.5 million metric tonnes. In 2019, the world generated 53.6 million tonnes of e-waste, an average of 7.3 kg per capita (Forti et al., 2020).

On a per-capita basis, tropical countries, except for tropical Australia and the USA (Hawaii), produce far less e-waste than nations in North America and Europe (see Figure 4.6). The lowest per capita e-waste production occurs in Central and Southern Africa, followed by Northern Africa and the Middle East and South Asia. Other tropical regions are comparable to global per-capita rates. Although time series data are not available, all research and trends available suggest that e-waste is the fastest growing form of waste globally.

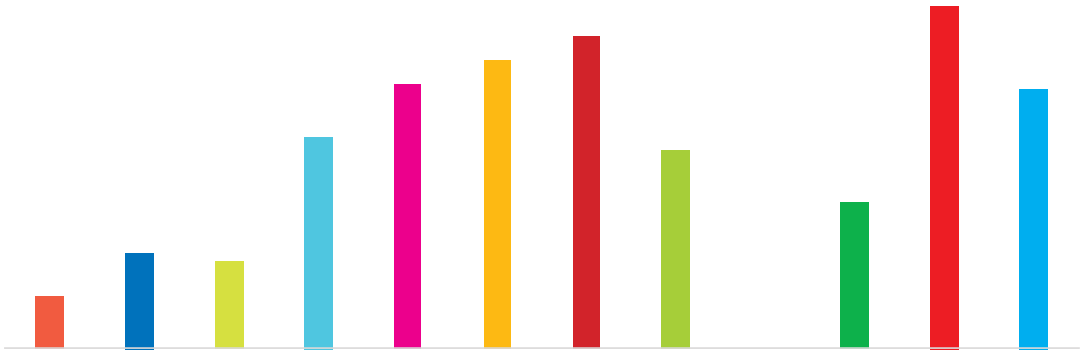


**Figure 4.6** Kilograms (kg) of e-waste generated per capita across the tropical regions and globally in 2019.

Source: ewaste.org (2021)

**Figure 4.7** E-waste (kg per capita) produced globally. Arrows show major flows of e-waste from producing countries.

Source: ewaste.org and Rautela et al., 2021.

Currently, an estimated 82.6% of e-waste generated globally is informally recycled and rarely in its country of origin (Forti et al.,

From an economic and trade perspective, the extraction, production, trade, use and recycling of ICT products provide many opportunities for countries in the Tropics. There are challenges associated with safety, exploitation and inequality, but with better governance and empowerment, ICT and its components will be an essential part of the tropical economy going forward.

## REFERENCES


ASIBEY, M. O., KING, R. S., LYKKE, A. M. & INKOOM, D. K. B. 2021. Urban planning trends on e-waste management in Ghanaian cities. , 108, 102943.

CIRIANI, S. & PERIN, P. 2017. Trends in Global ICT Trade. & , 107: pp 17-201.

FORTI, V., BALDÉ, C. P., KUEHR, R. & BEL, G. 2020. The global e-waste monitor 2020. Quantities, flows and the circular economy potential. Bonn/Geneva/Rotterdam.

FREDERICK, S. & GEREFFI, G. 2013. . North Carolina: CGGC.

FU, J., ZHANG, H., ZHANG, A. & JIANG, G. 2018. E-waste recycling in China: A challenging field. & , 52, 6727–6728.

HENRY-NICKIE, M., FRIMPONG, K. & SUN, H. 2019. . Washington DC.

ISIMEKHAI, K. A., GARELICK, H., WATT, J. & PURCHASE, D. 2017. Heavy metals distribution and risk assessment in soil from an informal e-waste recycling site in Lagos State, Nigeria. , 24, 17206–17219.

KITUYI, M. 2020. The intricacies, impact and opportunities of e-commerce for trade and development. Available from: https://unctad.org/news/intricacies-impact-and-opportunities-e-commerce-trade-and-development [Accessed 22 June 2020].

LI, W. & ACHAL, V. 2020. Environmental and health impacts due to e-waste disposal in China—A review. , 737, 139745.

MUJEZINOVIC, D. 2019. Electronic waste in Guiyu: A city under change? , Summer.

OECD & WTO 2017. Aid for trade at a glance 2017: Promoting trade, inclusiveness and connectivity for sustainable development. Geneva: Organisation for Economic Cooperation and Development.

RAUTELA, R., ARYA, S., VISHWAKARMA, S., LEE, J., KIM, K.-H. & KUMAR, S. 2021. E-waste management and its effects on the environment and human health. , 773, 145623.

SCHATAN, C. & ENRÍQUEZ, L. 2016. Mexico: Industrial policies and the production of information and communication technology goods and services. 117 pp 147-163.

STEP 2014. One global definition of e-waste—Solving the e-waste problem (step). White Paper. Tokyo: STEP.

UNESCAP 2018. Embracing the e-commerce revolution in Asia and the Pacific. Bangkok, Thailand: UNESCAP.

VU, K. M. 2017. ICT diffusion and production in ASEAN countries: Patterns, performance, and policy directions. Policy, 41, 962–977.

WORLD BANK 2019. Global Findex Database. Washington DC.: World Bank.

WORLD BANK 2020a. World development indicators.

WORLD BANK 2020b. World development report 2020—Trading for development in the age of global value chains. Washington DC.

WTO 2013. E-commerce in developing countries. Opportunities for small and medium enterprises. Geneva, Switzerland:WTO.

YOON, S.-C. 2019. The Impact of ICT Goods Imports on Economic Growth: Evidence from Asia-Pacific Countries. , 23, 1–12.

crop growth (Zaborowska et al., 2016). According to the World Bank, cobalt mining, particularly artisanal mining, through the dumping of waste, tailings and effluences, contributes to river damage in alluvial areas, heavy metal pollution, land degradation and soil erosion, and the loss of biodiversity (World Bank, 2007).

However, the most significant negative impacts of cobalt mining, particularly in the DRC, are on human health and wellbeing. Research has found that both miners and nearby residents (even those not associated with mining) are heavily contaminated with cobalt (Banza Lubaba Nkulu et al., 2018). It is inhaled in dust and ingested through contaminated water and food (Sovacool, 2019). High doses and long-term exposure may affect the heart, lungs, blood and thyroid (Paustenbach et al., 2013). In Zambia, silicosis and tuberculosis were high among miners working in copper/cobalt mines (Mwaanga et al., 2019), and there is evidence of exposure-related oxidative DNA damage in highly exposed children in the DRC, which will likely lead to an increased risk of cancer later in life (Banza Lubaba Nkulu et al., 2018). Also, although preliminary, there is evidence of increased rates of birth defects associated with paternal mining exposure in the DRC copper belt (Van Brusselen et al., 2020).

The industry is also responsible for the exploitation of some of the most vulnerable people in the Tropics. The incredible rise in demand for cobalt from large international companies has driven efforts to formalise the artisanal mining sector to guarantee a steady supply of cobalt and assuage international concern about artisanal mining, particularly child labour (Calvão et al., 2021). Although sound in theory, it has led to large-scale mining corporations integrating artisanal miners into an essentially wage-less workforce paid by production output without a base salary or other social protections (Calvão et al., 2021). There are also few incentives for workers to become part of a cooperative described above and mine legally. There are costs and tax disadvantages for the miners of being a member and holding an official mining card (Krummel and Siegfried, 2021). Additionally, the government has been unable to monitor or enforce this formalisation process (Krummel and Siegfried, 2021).

One of the most controversial aspects of artisanal mining for cobalt in the DRC is the use of child labour. Although children are rarely used in the mines, they are active in collecting minerals from tailings or working in streams and lakes to wash and sort the stones (Amnesty International, 2016). Any form of child labour 'which by its nature or the circumstances in which it is carried out is likely the harm the health safety or morals of children' is considered by the International Labour Organisation (1999 p.2) as the 'worst forms of child labour'.

A common task carried out by children around the mines requires them to carry heavy sacks of mineral ore that can weigh between 20 and 40 kg, resulting in injuries and long-term damage such as joint and bone deformities (Amnesty International, 2016). Those that worked in the open, often worked in high temperatures or in the rain with little or no protective equipment such as masks or gloves (Amnesty International, 2016). Thus, they are directly exposed to cobalt dust and other pollutants, causing ongoing health concerns as mentioned above. Many children worked 12–14 hours per day, and even those who went to school, often worked after school and on weekends (Banza Lubaba Nkulu et al., 2018).

Cobalt mining in the Congo is precarious. The demand for cobalt continues to rise, and as electric vehicles become more ubiquitous, it will continue for some time. This remains a significant opportunity for the DRC. Artisanal mining operations are vital to the livelihoods of hundreds of thousands of families. Still, they are essentially dangerous holes in the ground, often operated without tools and protection, putting children at risk (Sovacool, 2019). The vast wealth created by the digital revolution and manufacture of lithium-ion batteries does not flow down to those who extract the core mineral components.

The cobalt mining industry remains a huge opportunity for tropical countries, particularly the DRC, to profit from the digital and energy revolution. Many companies are making a great deal of money from Congolese cobalt. However, the booming international market does not always benefit those who provide the source material.

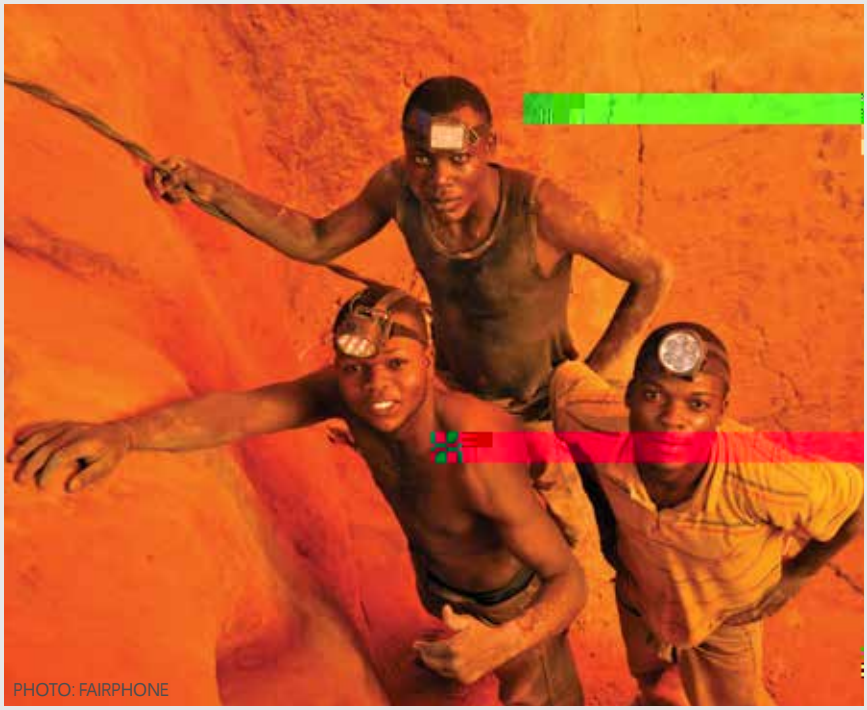


PHOTO: FAIRPHONE

## REFERENCES


AMNESTY INTERNATIONAL 2016. *'*
, Amnesty International.

BANZA LUBABA NKULU, C., CASAS, L., HAUFROID, V., DE PUTTER, T., SAENEN, N. D., KAYEMBE-KITENGE, T., MUSA OBADIA, P., KYANIKA WA MUKOMA, D., LUNDA ILUNGA, J.-M., NAWROT, T. S., LUBOYA NUMBI, O., SMOLDERS, E. & NEMERY, B. 2018. Sustainability of artisanal mining of cobalt in DR Congo. , 1, 495–504.

BAZILIAN, M. D. 2018. The mineral foundation of the energy transition. , 5, 93–97.

CALVÃO, F., MCDONALD, C. E. A. & BOLAY, M. 2021. Cobalt mining and the corporate outsourcing of responsibility in the Democratic Republic of Congo. . In Press.

DIAZ RIZO, O., COTO HERNÁNDEZ, I., LÓPEZ, J., DÍAZ ARADO, O., PINO, N. & RODRIGUEZ, K. 2011. Chromium, cobalt and nickel contents 8 (ullet[ )6 (gJ0.0E(Y)48mAhnTviainabionmen-0.02 Tal1.25 Td[(N. Td621 (ongo. )]TJ/T12 w)-4 -0.02 TaJ1he ener-4211 T)3ibiMess.BAZILIAN, M. D. 016.

# APPENDIX A

| REGION/Nation | Population 2020 (millions) | % of Population in the Tropics | % of Regional population in the Tropics |
|---|---|---|---|
| **CENTRAL AND SOUTHERN AFRICA** | | | |
| Angola | 32.87 | 100.0% | 3.6% |
| Benin | 12.12 | 100.0% | 1.3% |
| Botswana | 2.35 | 51.5% | 0.3% |
| Burkina Faso | 20.90 | 100.0% | 2.3% |
| Burundi | 11.89 | 100.0% | 1.3% |
| Cameroon | 26.55 | 100.0% | 2.9% |
| Cape Verde | 0.56 | 100.0% | 0.1% |
| Central African Republic | 4.83 | 100.0% | 0.5% |
| Comoros | 0.87 | 100.0% | 0.1% |
| Democratic Republic of the Congo | 89.56 | 100.0% | 9.8% |
| Congo | 5.52 | 100.0% | 0.6% |
| Cote d'Ivoire | 26.38 | 100.0% | 2.9% |
| Equatorial Guinea | 1.40 | 100.0% | 0.2% |
| Ethiopia | 114.96 | 100.0% | 12.5% |
| Gabon | 2.23 | 100.0% | 0.2% |
| Gambia | 2.42 | 100.0% | 0.3% |
| Ghana | 31.07 | 100.0% | 3.4% |
| Guinea | 13.13 | 100.0% | 1.4% |
| Guinea-Bissau | 1.97 | 100.0% | 0.2% |
| Kenya | 53.77 | 100.0% | 5.9% |
| Liberia | 5.06 | 100.0% | 0.6% |
| Madagascar | 27.69 | 91.8% | 3.0% |
| Malawi | 19.13 | 100.0% | 2.1% |
| Mauritius | 1.27 | 100.0% | 0.1% |
| Mozambique | 31.26 | 80.3% | 3.4% |
| Namibia | 2.54 | 80.3% | 0.3% |
| Nigeria | 206.14 | 100.0% | 22.5% |
| Rwanda | 12.95 | 100.0% | 1.4% |
| Sao Tome and Principe | 0.22 | 100.0% | 0.0% |
| Seychelles | 0.10 | 100.0% | 0.0% |
| Sierra Leone | 7.98 | 100.0% | 0.9% |
| Tanzania | 59.73 | 100.0% | 6.5% |
| Togo | 8.28 | 100.0% | 0.9% |
| Uganda | 45.74 | 100.0% | 5.0% |
| Zambia | 18.38 | 100.0% | 2.0% |
| Zimbabwe | 14.86 | 100.0% | 1.6% |
| **NORTHERN AFRICAL AND MIDDLE EAST** | | | |
| Djibouti | 0.99 | 100.0% | 0.5% |
| Chad | 16.43 | 100.0% | 8.1% |
| Eritrea | 3.55 | 100.0% | 1.8% |
| Mali | 20.25 | 99.9% | 10.0% |
| Mauritania | 4.65 | 99.3% | 2.3% |
| Niger | 24.21 | 100.0% | 12.0% |
| Saudi Arabia* | 14.28 | 41.3% | 7.1% |
| Senegal | 16.74 | 100.0% | 8.3% |
| Somalia | 15.89 | 100.0% | 7.9% |

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

PHOTO: MARK ZIEMBICKI

# APPENDIX B

## SUB-NATIONAL REGIONS/STATES/PROVINCES USED FOR LARGE NATIONS THAT STRADDLE THE TROPICS