#ICT4SDG

Fast-forward progress

Leveraging tech to achieve the global goals

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Acknowledgements

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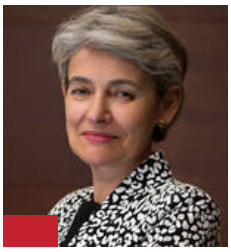

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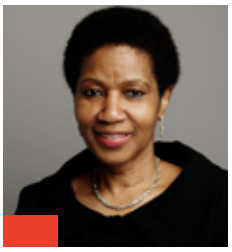

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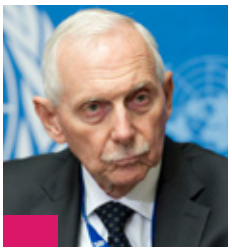

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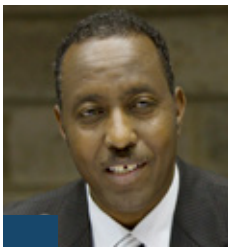

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Foreword to "Fast-forward progress: Leveraging tech to achieve the Global Goals"

By António Guterres, Secretary-General, United Nations

Our networked society is changing the way we live. The impact and implications of the digital revolution are becoming more evident with each passing hour.

The 2030 Agenda for Sustainable Development recognizes the great potential of global connectivity to spur human progress. It challenges us to ensure universal and affordable Internet access for all.

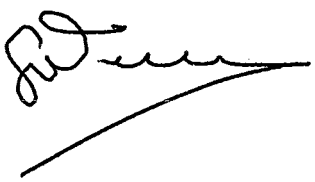
This report offers insights into the risks and opportunities in using Information and Communication Technologies (ICTs) to achieve the Sustainable Development Goals.

It outlines how the future is crystallizing before us in the use of big data to improve the design of policy and decision-making, the use of satellite mapping to track animal migrations and our changing environment, and the use of population mapping to ensure that no one is left behind.

It details the difference a mobile phone can make in the lives of humans across the globe. We see how farmers can monitor prices, refugees can let their families know they are safe, and health workers can check a patient's status or respond to emergencies.

This report also presents evidence of how UN agencies are adopting – and adapting – ICTs to maximize their impact and help communities and people in need. We see concerted efforts to extend telecommunication networks and ICTs into remote areas; train and equip workers with new digital skills; and ensure that schools, hospitals, clinics and whole cities are smarter, more energy-efficient and safer.

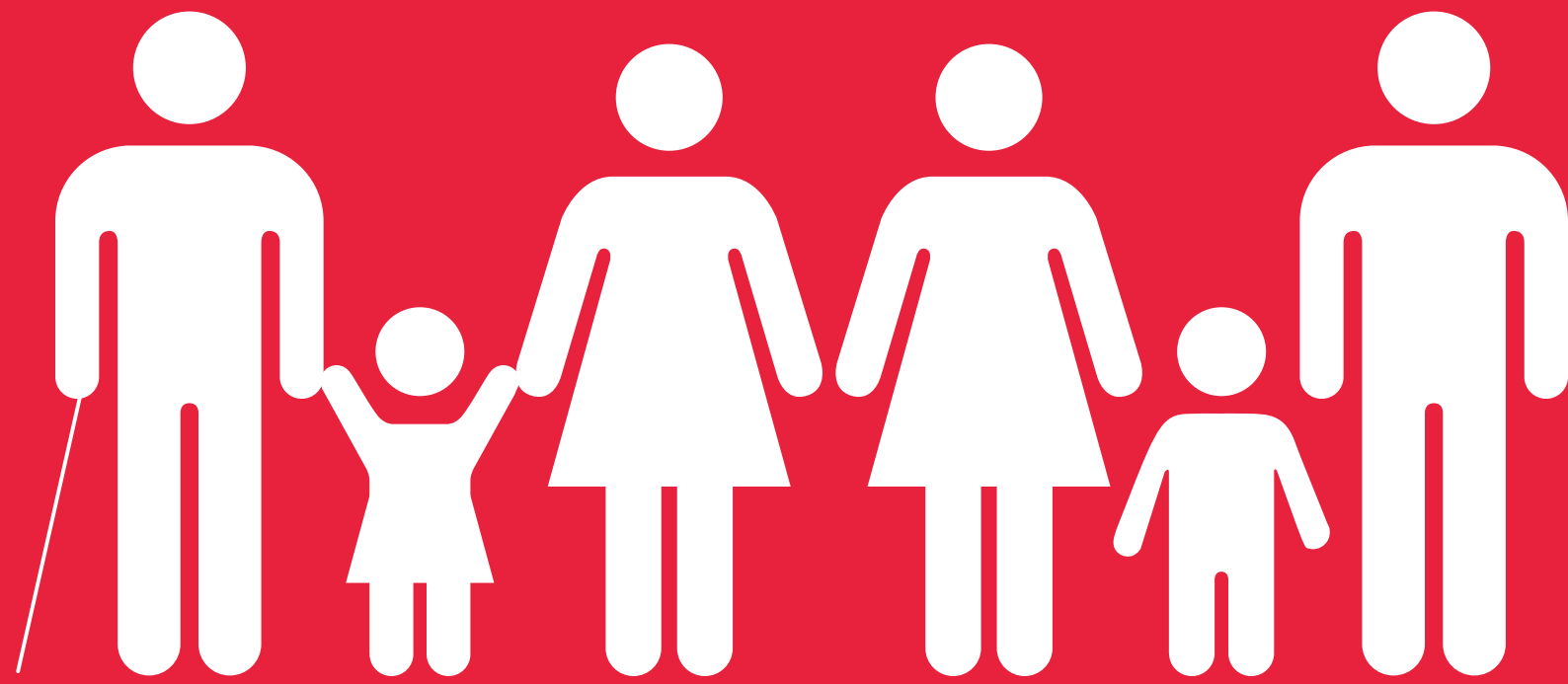
The United Nations is making the most of cutting-edge technologies and new opportunities to improve our service delivery. I thank the UN officials and other experts who contributed to this report, and commend it to all those interested using ICTs to advance sustainable development.



António Guterres
Secretary-General of the United Nations

Insights

End Poverty



Ending Poverty in all its forms, everywhere

By Tegegnework Gettu, Associate Administrator, United Nations Development Programme (UNDP)

The Sustainable Development Goals (SDGs) are a compact to apply the world's unprecedented know-how, ingenuity, technology and wealth to end the unacceptable human suffering and deprivation endured by many millions of women and men. They provide a framework for transforming development to ensure it is both more socially equitable and environmentally sustainable, operating within planetary boundaries.

1. Harnessing ICTs for poverty eradication

SDG 1 sets out to eradicate extreme poverty and cut in half the numbers of people living in all dimensions of poverty, according to national definitions. It seeks to ensure that all people have equal rights to economic resources and are covered by social protection schemes. Successes in advancing the MDGs demonstrate that these aims are within reach. From 1990 to 2015, more than 1 billion people were lifted out of extreme poverty. Achieving SDG 1, however, will nonetheless not be easy. Over 700 million people continue to battle extreme poverty, living on less than $1.90 per day. The world population continues to grow. Poverty eradication efforts will demand we reach communities alienated within current development pathways because they lack productive capacities, live in remote areas without access to services or face discrimination.

The SDGs recognize that poverty is the manifestation of multiple, compounding deprivations which prevent people from fulfilling their full potential. Many people who escape income poverty may remain relatively poor in their local context or face deprivations in health, education and shelter. Others remain highly vulnerable to setbacks that threaten to send them back into poverty including the impacts of natural disasters. Information and communications technologies (ICTs) have the potential to enable new poverty solutions and amplify the positive results of existing efforts.

UNDP's 2001 Human Development Report[1] and, more recently, the World Bank's 2016 World Development Report[2] evaluated the potential of ICTs to accelerate human development. They show conclusively that ICTs have penetrated almost every corner of the planet, transforming for the better the way people live, work, and relate to governments and with each other. ICTs are contributing to sustainable development - powering economies, facilitating green growth, improving disaster preparedness, advancing health and education, and strengthening civic participation and accountability. Mobile phones and Internet services are enabling people, from all segments of society, to benefit from development. The reports also argue, however, that technologies can widen disparities between rich and poor, women and men, and disadvantaged communities and everyone else. There is evidence of both trends.

The people with the most to gain from ICTs are also those most likely to be locked out of the benefits. One billion people worldwide lack the digital literacy and skills necessary to fully enjoy the benefits of ICTs[3]. Less than half the world's population use the Internet: just 25% of people in sub-Saharan Africa, and 42 percent in Asia and the Pacific and the Arab States. In contrast, two-thirds of people in North and South America are online. Globally, there are 200 million fewer women online than men; and the gender digital gap is the largest in Least Developed Countries (LDCs)[4]. For many the price is prohibitive. The cost of Internet access is higher in developing countries and highest in least developed countriesLDCs, holding back poor communities[5]. Estimates suggest that equalizing Iinternet access between developing and developed countries could generate around USD $2.2 trillion in GDP and 140 million new jobs, including 44 million in Africa.[6]

The potential of ICTs will only be maximized when all women and men have equitable, reliable and affordable access to the technologies available. Access alone, however, is not enough. Policies and interventions must also ensure that those furthest behind are empowered to benefit from ICTs.

2. How ICTs are enabling poverty reduction

Against this backdrop, UNDP is committed to working with its partners to harness the power of ICTs to achieve SDG 1 and sustainable development. Based on experience, we see four areas in which ICTs play a particularly significant role: 1) making needs visible and actionable, 2) expanding voice and empowerment, 3) underpinning inclusive, sustainable growth, and 4) accelerating and sustaining progress.

Making needs visible and actionable: The SDGs make equity an explicit, cross-cutting objective, with a clear commitment to "leave no one behind." However, many of the disparities that divide people remain hidden due to a lack of data. That, in turn, complicates efforts to target those at risk of being left behind. Household surveys and censuses offer a picture of poverty but only at five and ten year intervals. Poor and marginalized people and communities are among the most likely to be missed by official statistics. Alongside improving official statistics, therefore, policy-makers are turning increasingly to ICTs to facilitate "big data" solutions. Big data solutions are important to reach the furthest behind and understand who and why people are left behind from the benefits of social and economic progress. New data mined from social media and geospatial data sensors can plug SDG data gaps and deliver timelier, targeted and more effective poverty-reduction interventions. In Uganda, the UN Global Pulse found that mobile phone credit purchases (i.e. SIM cards) correspond closely to household consumption data. In the Sudan, UNDP, UN Global Pulse and the National Statistics Office are mining mobile phone data in an effort to monitor socioeconomic behaviour as a proxy for poverty[7].

Big data solutions can also enable countries to take aim at gender gaps in health, education, and labour markets. Improving the well-being and prospects of women is a proven driver of poverty reduction across income, health and other areas. In Uganda, people frequently raise concerns and express their perspectives through talk shows on community radio stations. Global Pulse is using voice recognition software to analyze trends, better understand gender biases and ultimately inform policy measures to address poverty.

Expanding voice and empowerment: ICTs can strengthen the core capacities of governments to extend and improve public services and information in hard-to-reach, poor and marginalized communities. Guatemala, for example, has used mobile phones to train more than 300 aspiring nurses via distance education, helping to reduce a critical lack of skills. Telemedicine is increasingly making medical advice and treatment options available to people irrespective of their geographical location. Health platforms powered by mobile phones, for example, are used by frontline health workers to diagnose and treat pneumonia and pre-eclampsia, with the latter being the second-leading cause of maternal deaths.

ICTs are more powerful where there are investments in people's capacities to use and understand data and information, and where governments make data freely accessible. For example, Nigeria's SMDG Information System, launched in 2015, uses geo-referenced data from mobile phones to provide location-specific information about government services, environmental challenges, water access points etc. The online system builds evidence of what works, and enables civil society to see results and hold government accountable.

Economic empowerment and inclusive growth: ICTs are transforming economies at every level, overcoming infrastructure bottlenecks, lifting productivity and enabling innovation that boosts incomes. In Ethiopia farmers are using mobile phones to check coffee prices. In Saudi Arabia farmers rely on wireless technology to distribute scarce irrigated water for wheat cultivation. In Bangladesh, more and more women are starting productive phone service businesses, earning a living while expanding access to phones. At the same time, it is clear that people without official identification struggle to access financial services, land and other productive assets and social protection systems. The most affected are poor and marginalized societal groups, such as women and children, indigenous people and ethnic, linguistic or sexual minorities. Digital identity management systems, enabled by ICTs, are allowing countries to close these gaps. For example, in Pakistan, biometric technology ensures that women receive cash transfers directly, as a result, empowering them to decide how the money should be spent.

UNDP is a partner in the Better Than Cash Alliance, which supports countries to include more people in their economies by transitioning from cash to digital payments. Other efforts directly engage the private sector, such as in Rwanda, where UNDP, businesses and the Government sponsor the YouthConnekt. Programme, which facilitates access to capital and jobs for young ICT entrepreneurs. Across sub-Saharan Africa, UNDP helps farmers and small and medium enterprises use ICTs for training, expert advice and agricultural inputs. The aim is to help raise agricultural productivity and enable small producers build agricultural value chains and meet quality standards.

Accelerating and sustaining progress: ICTs can help overcome bottlenecks to progress, so as to catalyze and sustain development gains. ICTs are increasingly facilitating efforts to prevent and recover from setbacks that disproportionally affect marginalized and poor populations. During disease outbreaks, for example, big data from mobile phones can help track the movement of people, helping to prevent, predict and prepare for the spread of deadly diseases, as was the case in the Ebola crisis in West Africa. Mobile phones were also vital to ensure timely, accurate payments to those who provided health and other critical services on the frontlines of the Ebola response, enabling them to meet their own needs and provide continuous care[8].

More generally, mobile phones have the potential to enable real-time tracking and guide recovery measures in crisis-affected countries, to ensure crisis-response interventions are more effective. After Typhoon Haiyan in the Philippines, UNDP partnered with private telecom companies to implement emergency cash for work schemes for debris management in poor communities. Participants paid through mobile phones have continued to benefit from mobile banking although the scheme has ended.

3. Going forward: Maximizing ICTs for poverty eradication

To harness ICTs for poverty eradication, all members of society—from government to business to community groups – have a role to play. Governments, civil society and the private sector will need to work together to create an enabling environment and invest in ICTs to expand the infrastructure that enables access. Setting locally ambitious and feasible SDG targets to improve digital connectivity are an important means to build momentum. The experience of Myanmar suggests that where this is done progress can be rapid and transformative. Internet usage in Myanmar jumped from 1.2% in 2013 to 15% in 2015 due to the 2013 Telecommunications Law. This created a competitive market which triggered a reduction in the cost of SIM cards from approximately USD$150 in 2013 to just USD$1.50 in 2015. The Government mandated operators to ensure that 10 million of the new subscribers were women, and developed a Universal Service Fund to support services and infrastructure within underserved rural areas.[9] Access to ICTs, however, does not automatically result in access to information, services, or opportunities. Government at all levels, local communities, the ICT industry, and development organizations must work together to develop and fund strategies that harness the potential of ICTs to eradicate poverty.

Connectivity enables the producers of goods and services to pursue niche demands and operate through peer-to peer networks. Across the developing world, growing numbers of educated young people are seeking new technology solutions to solve problems. ICTs are enabling them to start new businesses and link to global value chains. With increased public and private investment in ICT skills, young people can help their communities and countries leapfrog into higher value-added industries. To generate inclusive growth and achieve SDG 1, initiatives that work in practice need to be scaled up. The iHub in Nairobi, Kenya, for example, employs young entrepreneurs to invent ICT solutions to local problems, such as to expand access to health care and education, and better link marginalized groups to these critical services.

Governments can foster the use of digital payments and mobile money in ways that expand financial services to poor and marginalized populations, helping them build assets and weather financial shocks. In Africa, 12 percent of adults now have mobile bank accounts, compared with just 2 percent globally, in large part due to the innovation of M-Pesa in Kenya[10]. In China, digital payments through social networks and e-commerce platforms are bringing financial services to millions, helping low-income populations invest, save and build credit scores. As of September 2016, China's Alipay platform had provided financing to over 4.11 million small and microenterprises and entrepreneurs.[11]

Globally, decision-makers should work together to identify technologies vital to SDG achievement and take steps to remove obstacles to their adoption. More work is needed, including in research and development, to unleash the potential of big data. Acceptable standards and agreed privacy safeguards are needed to overcome the reluctance to share data and fully tap the vast potential to improve policies, get results, and build the capacity of stakeholders to use and apply data and information to poverty-related interventions.

The SDGs will not be met without significantly expanding access to the benefits of ICTs and overcoming a digital divide that sends the already deprived further behind, within and across countries. To this end, the UN Development System must take full advantage of ICTs to strengthen partnerships and connect the networks and groups with the greatest potential for impact where it is needed. The stakes are high. Without action, the digital divide will continue to drive the inequalities that separate people, groups and countries, drawing new forms of exclusion, defined by varying access to broadband, computers and smartphones. UNDP looks forward to working with its partners to seize the opportunity ICTs present to empower and enable all people to participate fully in their economies, societies and political systems, eradicate poverty, in all its dimensions, and achieve SDGs that leave no one behind.

Zero Hunger

Ending Hunger, Achieving Food Security, Improving Nutrition and Promoting Sustainable Agriculture

By Gilbert Houngbo, President, International Fund for Agricultural Development (IFAD)

The *2030 Agenda for Sustainable Development* has given us a framework to eliminate poverty and achieve sustainable food security. A significant part of the efforts to meet those commitments should be focused in the rural areas of the developing world where 70% of the world's extremely poor people live, including most of the hungry. Improving rural people's livelihoods and smallholders' capacities is a central element in ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture.

There is ample empirical evidence showing that the use of ICTs for Development (ICT4D) can produce better results in the area of agricultural development. For example, an article published in 2014 in the Journal of Development & Agricultural Economics[12] states that "ICTs play a significant role in a country's development and the strategic application of ICTs to the agricultural sector … offers the best opportunity for economic growth and poverty alleviation".

ICTs play an important role in fostering local, national and global food security and inclusive rural development by enhancing production and productivity, lowering operating costs, facilitating access to markets, information, credit, and capacity-building, among other things. In fact, over recent decades, we've seen the socioeconomic benefits of, for example, mobile telephony in improving the lives of many poor rural people. We've seen how, thanks to mobile phones, people who previously were both socially and economically excluded are now actively participating in the economy. By accessing timely and reliable information, farmers can go from being dependent on the information provided by middlemen to being independent negotiators and deal-makers.

In Tanzania, for example, an IFAD-supported project provided rural women and men with information via mobile phones, the Internet and email while giving them access to other key people in the market chain, including processors, traders and consumers. After just one agricultural season, they agreed there had been considerable impact on their access to markets, their production, and their incomes. For an initial investment of USD 200,000, the project's activities contributed to a gross increase in income of participants of more than USD 1.8 million. Some smallholder farmers doubled or even quadrupled their market volume, demonstrating how responsive they can be when assured of a market and a fair price[13].

At the same time, ICTs can play a key role in opening new and more challenging opportunities for rural people, especially young people. In Sub-Saharan Africa alone, 17 million young women and men enter the job market every year. Most live in rural areas. They will work with their mobile phones, computers and/or Ipads, but they will not pick up the hoe or the machete of their fathers and mothers. They need and they want technology.

Finally, ICTs can also help governments and development organizations working to enhance food security and agricultural development in the world to improve their work by accessing better information as well. IFAD's experience using Geographic Information Systems (GIS) and earth observation to get a clearer picture of land use and environmental degradation, scaled down to the project area, is only one example. Mapping spatial data at the project design stage, and collecting it during implementation, have already led to better beneficiary targeting, and enhanced the capacity of Ministries and universities to utilize such data in their own development strategies and projects.

Looking forward

Extending the use of ICTs to poorer people requires investment in the rural areas where the poor and hungry people live – not just in ICTs, but in basic infrastructure, in social services and in policies that support inclusive rural communities and sustainable agriculture. Without this investment, young people with no hope at home will continue to migrate from villages to overcrowded cities and urban centres, and beyond.

Extending access to ICTs also requires partnerships as no single government, development institution, rural organization, or ICT company can ensure the sustainable, reliable and inclusive provision and use of ICTs in rural areas by itself. ICTs offer opportunities for private, public and social institutions to work on sustainable, productive, profitable and inclusive partnerships to expand the services and to make them accessible and affordable for those who need it.

Farming, at whatever scale, is a business. To ensure rural people and smallholders continue to play a critical role in global food and nutrition security, they need access to technology and to information, which are key to their success. They have demonstrated that, with the support of ICTs, rural people can become reliable and interesting business partners that can comply with market requirements for their specialty products.

ICT for Development in IFAD

IFAD recognizes the centrality of ICTs in general for promoting sustainable and inclusive rural transformation in developing countries, and has included ICTs in its Strategic Framework 2016-2025 by underlining, inter alia, that "expanding the uptake of new ICTs will be a priority. IFAD will leverage the surge in cellular phone ownership to facilitate access to better market information and financial services and products such as credit, savings and insurance, as well as weather information to ensure better capacity to predict rainfall and better preparedness for extreme weather events".

At the country level, IFAD has been working on ICT programmes for several years. For example, in Zambia, an information service open to smallholder producers and traders was designed in cooperation with the Zambia National Farmers Union (ZNFU) to provide accurate and up-to-date agricultural and market information covering the entire value chain. This allows smallholder producers to make informed decisions about what to grow, volumes required, storage, processing, marketing and investment opportunities. Sending SMS messages to smallholder producers and traders can help them find the best prices on offer for a commodity in the selected area, and contact the buyer who responds to their need. This service can improve the bargaining power of smallholder producers, by giving them better access to markets and allowing them to deal with traders on an equal footing. Farmers have managed to reduce their transaction costs, and are now producing higher value produces and targeting different markets. Thanks to their weekly updates, farmers are no longer overproducing, thus eliminating storage challenges. Also, policy-makers are using the information service to have up-to-date information to identify price fluctuations and to flag emerging food security challenges.

In Cambodia, a global strategic partnership between IFAD and Intel Corporation supports smallholders through mobile and IT farm extension services. Smallholder farmers have been provided a step-by-step software program to analyze soil, determine fertiliser requirements, give advice on best seeds and deal with pests and diseases. Local people have been trained to use the software to sell their services to farmers via mobile, enabling the farmers to improve their practices. Prompted by the software, farmers analyze conditions on their farms and the program gives advice on what to do. The locations of nearby suppliers are also provided. This software, launched in 500 locations across Cambodia, has helped farmers who were overdosing their rice fields with fertilizers to cut their costs in half. Similar software is being used in India, where it has helped small farmers increase their production by around 300%.

In Yemen, IFAD is investing in forecast problem tree analysis and climate change vulnerability mapping, combining GIS modelling, satellite observations and social vulnerability assessments. IFAD has been able to identify target areas and communities according to their vulnerability to climate change, and to set out the plan for building retaining walls, water catchment ponds, dry wall terraces and other key infrastructure according to local risk levels and the needs of the rural population. This approach reduces biases in project design, and sets a remarkable milestone in the development of monitoring and evaluation systems to assess project achievements. GIS modelling approaches can and are being extended to other hazards (such as dust storms or the threats and opportunities in coastal zones).

These initiatives and services highlight how ICTs play a critical role in fostering food security and promoting rural and agricultural development. They also provide evidence that poor rural people are willing to spend part of their income on ICT services. Investments in ICTs need to reach rural areas, and governments, private companies, and development and farmers' organizations need to embed and mainstream ICTs in rural development projects and programmes, so we can have many more successful cases such as these. IFAD will work with governments, the private sector, and farmers' organizations to ensure that ICTs are integrated into development projects and to mobilize much-needed infrastructure for ICTs in rural areas.

While ICTs provide unprecedented opportunities for rural people to access services and information needed for their development, we should always remember that people – not technologies – should remain at the centre of our attention. The better ICTs respond to the demands of people, groups, and communities, and the better their design (according to local circumstances and conditions), the bigger the contribution of ICTs to the achievement of the SDGs.

The FAO Vision to Combat Poverty, Hunger & Malnutrition using Digital Services in Food & Agriculture

By José Graziano da Silva, Director-General, Food and Agriculture Organization (FAO)

From ending poverty and hunger to responding to climate change and sustaining our natural resources, food and agriculture lie at the heart of the 2030 Agenda for Sustainable Development and the SDGs[14]. Over the coming years, the FAO will focus its efforts in assisting all countries and relevant actors in implementing and monitoring the SDGs. FAO's Strategic Framework draws five main strategic objectives[15] to support the SDG implementation and help farmers, fishers, collectors, pastoralists, women, youth and traditional communities to be more productive, sustainable and resilient.

Today, nearly 800 million people are extremely poor and chronically undernourished, while another 1.9 billion are overweight, of which 600 million are obese. In rural areas, the reality is most dramatic, considering that 80% of the world's hungry and poor live there. FAO believes that food security can be the common thread that links the different challenges the world faces in building a sustainable future.

The use of ICTs can support many activities of rural development, food security and climate change. FAO hopes to make terabytes of global data and information accessible, useful and understandable to farmers, fishers, collectors and pastoralists. Unfortunately, lack of access, caused by the absence of telecommunication infrastructure, is a reality in many countries that hinders access to these technologies. Within the same territory, there may be huge differences in terms of literacy and cost of access to services. Without properly addressing issues such as low incomes and affordability, user literacy and infrastructure, barriers to the adoption of new technologies will remain[16].

Bridging the Digital Divide

Applying innovative ways to use ICTs in the rural domain, with a primary focus on agriculture (including farming, fisheries, livestock, forestry, etc.), can boost agricultural and rural development. Improving access to valuable information and knowledge can help agricultural stakeholders make informed decisions and use the resources available in the most productive and sustainable way. In a sector that is becoming increasingly knowledge-intensive, having access to timely information, in the right format and through the right channels, makes a crucial difference in the livelihoods of people involved in agriculture and related fields.

FAO is developing and deploying new ways of packaging and delivering digital value-added services to combat hunger and all forms of malnutrition, reduce poverty, promote food security, increase incomes, improve resilience and mitigate the effects of climate change. These proposed innovative solutions seek to maximize economic, social and environmental impact by finding scalable and sustainable models for the process and networks that bring existing or new agricultural products, processes and practices into social and economic use, connecting promising ideas and impact investment funders[17].

In its Digital Strategy guidelines, FAO states that digital technologies are creating opportunities to improve how we produce, distribute and manage food and feed people, creating a major driver for economic growth and an accelerator for innovation and change. Digital technologies can be useful tools to address the multifaceted nature of nutrition by enhancing agricultural systems, improving access to healthy diets, improving knowledge for food choices, increasing resilience of food systems to economic, climatic and human-made shocks, and responding to food-borne threats to consumers.

FAO in Action

Further to offering support to governments and policy-makers, by exchanging ICT tools, systems and data, FAO has started to work on the development of ICT solutions to support directly the work and well-being of farmers, fishers, collectors, rural populations and traditional communities. From this perspective, FAO's Digital Strategy to achieve the SDGs focuses its conceptual approach on:

1. ***Promoting ICTs*** for enhancing small-scale agriculture, family farming and rural development. These country-based rural development strategies aim at delivering private and public goods through policies and partnerships.
2. ***Improving the livelihoods*** of small and family farmers worldwide through appropriate usage of ICTs across the whole value chain of food systems, promoting social business models and social entrepreneurship in rural areas.
3. ***Building the capacity of rural advisory local systems*** to provide timely and effective services and agricultural policies through ICTs – with particular reference to their ability to:
    a. Integrate and make available different data sources from the public and private sector to make sense of changes occurring in the state of agriculture;
    b. Collect real-time data on rural population, land, water, animals, food and climate from a crowdsourcing approach, thereby improving national capacities for the collection, dissemination, and analysis of basic food and agricultural data; and
    c. Incorporating stakeholders' feedback into information systems, so as to include users in policy-making and monitoring.
4. Creating development and innovation networks with governments, civil society, and private companies to enhance the adoption of appropriate frameworks and ICTs for family farmers and rural development, using tools to promote e-learning courses and serious games to engage girls and boys.

Based on this strategy, FAO has developed and implemented several double-faceted initiatives for both farmers and governments, which have since resulted in the provision of mobile or web-based tools, for example:

Direct support to farmers

- **FAO Digital Services Portfolio** – FAO is developing mobile applications to offer information, transactional and advisory services to farmers in the field. The first Portfolio initiative has been ongoing since November 2016 in Rwanda and Senegal for the development of four mobile applications to small farmers on themes such as nutrition, market and prices, animal health and meteorological forecasts.

- **Climate Services** – early warning agrometeorological and agro-climatological applications. The development of improved climate services can benefit from FAO's work related to the Global Information and Early Warning System on Food & Agriculture (e.g. GIEWS), Desert Locust Information Services (DLIS), water productivity, Climate Change Impact Assessment in Agriculture and actions for building resilient livelihoods. FAO is developing Early Warning and Early Action, and Weather and Climate Services for Agriculture and Food Security through mobile applications to build up climate change resilient capacities.

- **FAO Integrated Digital Platform** – FAO is proposing the development of an FAO Integrated Digital Platform (IDP) based on a human-centred design. It will provide services and information for the diversity of stakeholders in value chains, facilitating capacity building and empowering extension workers to provide better services to small holders in the field. Digital services should evolve to become more advanced in reach and impact, transforming from information services to advisory services, using the mobile technologies and telecom infrastructures available.

Direct Support to Governments and Rural Advisory System:

- **EMPRES** – The Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases uses satellite imagery to monitor desert locust swarms migration and warn rural populations in Africa, Near East and South-west Asia to avoid upsurges of these insects. The Event Mobile Application (EMA-i) provides timely animal disease field reporting to enhance surveillance and early warning of animal disease outbreaks, including zoonotic diseases posing a potential public health threat, and enables national authorities to advise at-risk populations.

- **Agricultural Market Information System (AMIS)** is an inter-agency platform designed to enhance food market transparency and policy response for food security. Bringing together the principal trading countries of agricultural commodities, AMIS assesses global food supplies (focusing on wheat, maize, rice and soybeans) and provides a platform to coordinate policy action in times of uncertainty. By enhancing transparency and policy coordination in food markets, AMIS helps prevent unexpected price hikes and strengthen global food security.

    - **Satellite imagery** – a strategic partnership between FAO and Google enables access to Google Earth Engine, a planetary-scale platform at hand for Earth science data and analysis. More and more projects in FAO are now using satellite imagery to calculate land use and water resources, disease risk maps, agricultural drought, water scarcity, productivity, potential yields and more.

» **E-Agriculture Strategy Guide** – Aligned to regulatory bodies of local governments in the Asia-Pacific region, FAO and the ITU have designed an e-agriculture guide to help rationalize financial and human resources, respond to ICT opportunities and challenges for the agricultural sector more efficiently, generate new revenue streams and improve livelihoods in rural communities, while ensuring that the goals of the national agricultural Master Plan are achieved. In 2017, the plan[18] will be extended to Africa.

» **ICT for Sustainable Agricultural Production Innovation Lab** – the G20 Ministries of Agriculture are proposing an ICT innovation lab that can develop capacity for state-of-the-art ICT applications to promote transformative agricultural development. Its activities will aim at developing state-of-the-art applications that generate ideas, create prototypes, test and scale solutions that can be adopted in different locations within a multi-stakeholder context.

Partnerships and Collaboration

FAO is not alone in using ICTs to achieve the SDGs. Governments, UN agencies, civil society and private stakeholders are also key partners, as they hold local information about agriculture, food security, nutrition, climate, existing policies and funding initiatives. National and local governments are being invited to contribute resources to this effort. Regulatory policies and national plans to promote access to the Internet and increase the penetration of digital networks in rural areas will also contribute relevant inputs to the initiatives. ICT companies, software, telecom and device manufacturers are strategic partners to help build digital solutions. The "Partnerships for SDGs" online platform[19] presents over 160 projects, programmes and initiatives that use ICTs to achieve the 17 SDGs. Almost one third involve at least one area of FAO's mandate. Finding relations between these partnerships and putting them to work together is a vital task to be implemented by UN agencies.

The digital economy empowers rural communities, and global solutions networks play a key role in organizing overarching partnerships between governments, business, civil society and citizens. Digital inclusion has become pivotal for sustainable rural development. In the Business Call to Action[20], private companies were challenged by the Global Solution Networks to develop inclusive business models with mutual benefits for the poor and for private companies. These concepts are equally valid for urban and rural areas.

Inclusive business models can help achieve both commercial success and development impact. They unleash the potential of the poor by driving innovations, creating new markets and improving existing value chains. More and more investment agencies and donors request reporting on economic, social and environmental impact. Novel ways of establishing truly inclusive digital business models and empowering rural poor, women and youth, are capable of delivering on these demands.

Good Health & Wellbeing

Ensure Healthy Lives and Promote Wellbeing for All at All Ages

By Dr. Margaret Chan, Director-General, World Health Organization (WHO)

In the year 2000, the UN Millennium Development Goals (MDGs) introduced the concept of ICTs as a force for development with the Millennium Declaration resolving to "ensure that the benefits of new technologies, especially information and communication technologies, are available to all"[21]. By incorporating ICTs into the goals and targets of the MDGs, the UN captured the attention of both the public and private sectors, which were encouraged to find new ways to work together. WHO was immediately engaged, establishing innovative projects in every region to test the potential of ICTs for health, even in some of the most challenging settings.

At that time, WHO led the development of what has become one of its most successful public-private partnerships, a landmark initiative that continues today. The Health InterNetwork Access to Research Initiative (HINARI)[22] began by making the equivalent of a major medical school library, in electronic form, available for free or nearly free to health researchers and workers in 113 low- and low-middle income countries. Today, the partnership, now known as Research4Life[23], includes UN agencies, academia and 185 publishing partners contributing essential knowledge resources on health, agriculture, environment, science and technology.

And that was just the start. In 2005, WHO's governing body, the World Health Assembly, recognized that eHealth was transforming health services and systems around the world and urged Member States to plan for appropriate eHealth services in their countries[24]. At that time, the digital economy was already a reality and its continued growth has opened up new opportunities for health. More significantly, on the broader development agenda, eHealth is now seen as a driver – not just a beneficiary – of development, innovation and economic vitality.

The shift from the MDGs to the SDGs is expected to further expand the role of ICTs in health as countries prepare to tackle SDG3: Ensure healthy lives and promote wellbeing for all at all ages (Figure 1). Some of the many ways this can be done are already reflected in country eHealth policies and plans. Drawing on results from the WHO's Global Observatory for eHealth global survey in 2015[25], this report provides an overview of how ICTs are already contributing to realizing SDG 3 and describes some of the opportunities and challenges ahead.

Figure 1: Health in the SDG Era

Source: WHO, 2016.

eHealth in health services and systems

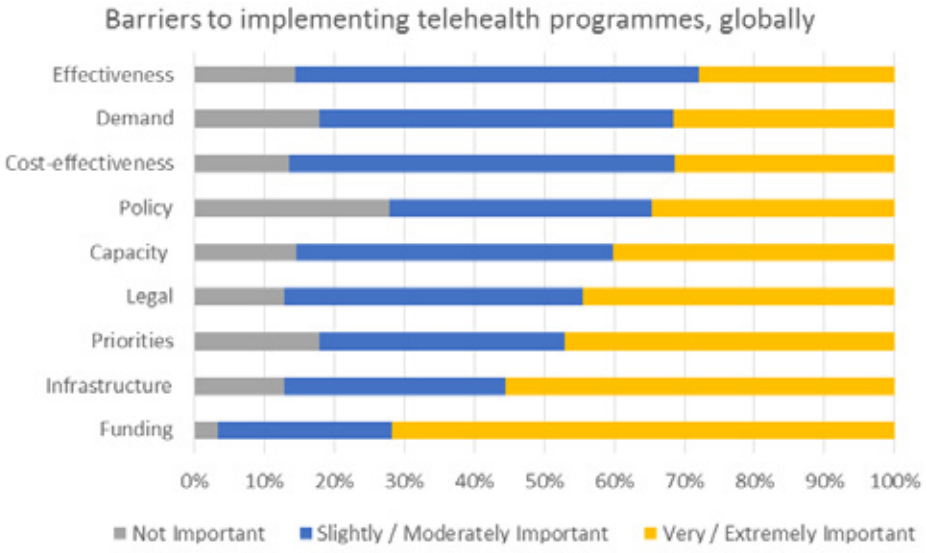
Today, eHealth is making an impact in every country and changing how healthcare is delivered and how health systems are run. ICTs support functions that will be critical to achieving SDG 3 and its many sub-targets. One fundamental way ICTs will do so is by improving the ability to gather, analyze, manage and exchange information in all areas of health, from research on molecular genetics to large-scale humanitarian interventions. In health systems, ICTs are being used to improve the timeliness and accuracy of public health reporting and to facilitate disease monitoring and surveillance. They are also fundamental in distance learning, and in enabling rapid response in emergencies. The strategic use of eHealth can support sector-wide planning, as well as coordinating decentralized district health systems, and improving the ability to plan, budget and deliver services that underpin the delivery of integrated, people-centred health services and universal health coverage (UHC).

Since the first global survey on eHealth in 2005, WHO's Global Observatory for eHealth has documented the development of and trends in eHealth worldwide. The adoption of eHealth has grown, as stakeholders such as governments, industry, academia and others increasingly depend on ICTs to conduct the daily business of health. More recently, the rapid global uptake of mobile technologies has opened up important opportunities in public health and clinical practice to reach patients, health professionals and the public, when and where needed. As health systems face stringent economic challenges, greater demands for efficiencies and higher expectations from citizens, there is a need to provide more care and better care to more people, especially those most in need. The use of eHealth is now understood as central to this effort.

Improving access to care and reaching people with the information and knowledge they need to lead healthier lives and engage in their own health is a key part of SDG 3. To this end, the impressive adoption of national policies (over 120 countries in 2015, according to GOE) including objectives on how ICTs, eHealth or telehealth can support UHC. In addition, countries at all income levels are gearing up to make the best use of ICT resources by ensuring eHealth training opportunities for health sciences students and professionals. eHealth is well-positioned as a tool to reach the public with health messages and support, as well as encouraging patients and their families to take an active role in their health and wellbeing. Re-directing health care interventions from expensive hospital settings and into people's homes through telemedicine, remote care and mobile health has the potential to transform health services and systems. Examples include the provision of services such as home monitoring and regular communication with elderly patients; enabling patients' access to information and ability to manage their chronic conditions; and ensuring that the general public has access to timely, expert advice by phone in health emergencies.

However, social, economic and other barriers affect a country's ability to take advantage of digital opportunities. Public policy-makers often need a much better understanding of the main components of eHealth and how to plan for its adoption and oversight. To make eHealth a reality, countries must address a number of challenges (Figure 2), including: planning for, funding and building infrastructure; deploying appropriate services and applications; developing a capable health workforce; ensuring a sound legal and regulatory environment; and improving governance, policy, standardization and interoperability. The days of pilot projects are waning as governments move towards strategic, integrated planning and sustainable financing mechanisms to enable solid foundations for investment.

Figure 2: Barriers to implementing telehealth programmes in support of UHC, by level of importance



Source: WHO Global Observatory for eHealth, 2016.

WHO has long recognized the need for a systematic, practical approach that aligns the many stakeholders in eHealth around a national vision and strategy. Sustained commitment, investment and political will are as important as ever. Legal and ethical issues must be addressed to ensure that new policy frameworks protect privacy and security, as privacy protection is essential if trust in eHealth is to be maintained. Leadership and stakeholder engagement are critical to developing the potential of eHealth in the context of a country's economy and health priorities. Governments need to assess and adopt innovations that create value for patients and society, while keeping in mind that this may not match the short time horizons for return on investment that now characterize our approaches. And beyond the technical challenges of implementing eHealth at the national level, it will also be critical over the coming years to ensure that cross-border, regional and international efforts in eHealth work in harmony and that all governments build mechanisms to collaborate in this area.

The case for adopting ICTs has been evident for over a decade and there has been considerable progress and growth in eHealth. Today, at the start of the SDG era, many countries are poised to take the next step of moving eHealth to the centre of strategic health planning. Here is where we will build the foundations of future health systems, by delivering on national eHealth strategies, building capacity, engaging in collaborations and striving to ensure public ownership, trust and confidence in eHealth over the years to come.

Using ICTs to Implement the SDGs

By the International Atomic Energy Agency (IAEA)

The IAEA plays an active part in helping Member States to achieve the SDGs. The IAEA helps countries to use nuclear and isotopic techniques, thereby contributing directly to attaining many of the goals in the areas of poverty, hunger, human health, clean water, affordable and clean energy, industry and innovation, and climate change, to name just a few. The IAEA's work extend, among others, into the education and training of health professionals in nuclear medicine techniques (SDGs 3 and 4).

Virtual University for Cancer Control (VUCCnet)

The IAEA has also established the Virtual University for Cancer Control (VUCCnet) as a pilot e-learning initiative in Ghana, Tanzania, Uganda, and Zambia (Egypt and South Africa are mentor countries) to support these countries in addressing the extreme shortage of healthcare professionals and to build human resource capacity in comprehensive cancer control. The achievements of the pilot phase have created further demand for scaling up with additional courses in more countries. In response, the IAEA is rolling out the initiative to 33 countries in SubSaharan Africa, in multiple languages, customized to each country's national needs.

VUCCnet looks to build the workforce and help current healthcare professionals gain skills to help patients receive the care they need from early detection to treatment and palliative care. It strengthens health systems by enhancing human resource capacities at the national level through relevant elearning training, thus avoiding "Brain Drain". VUCCnet offers countries customized, accessible, high-quality elearning training programmes across all stages of the cancer care continuum, with courses designed to upgrade skills of working professionals, as well as Masters courses. Although VUCCnet's goal is to give healthcare professionals access to uniquely customized and contextualized courses to address the most pressing regional needs, the need for investments in IT infrastructure and expansion of service remains a challenge.

Human Health Campus (HHC)

In order to respond to the requests of Member States to develop skills and competencies for existing and new professionals, the IAEA has adopted novel approaches in the use of ICTs and launched ICT tools including webinars, e-learning modules, recorded seminars and remote training online (DATOL) as part of its Human Health Campus (HHC) (www.humanhealth.iaea.org). This initiative offers online educational resources to enhancing professional knowledge of health professionals developed in collaboration with medical societies and international health experts.

Attuned to the continuous advances in the medical field, as well as progress in a range of methods for delivering capacity-building efforts in this digital age, the IAEA provides online educational resources for health professionals with its repertoire of projects to further its commitment in addressing the needs of its Member States in the fields of radiation medicine and nutrition. Serving as a 'virtual campus' with regular and increasing site visitors from health professionals in radiation medicine and nutrition, the HHC educational website maintains high-quality standards in providing up-to-date technical information via webinars, e-learning modules, recorded seminars and remote assisted training online. The HHC attracts over 5,000 visitors from some 100 different countries each month.

Webinars allow the dissemination of content to many simultaneous listeners/viewers individually or in auditoriums around the world, thereby facilitating access to even remote locations. Webinars are recorded in universities, allowing live interactions between learners and experts or on-demand access to lectures at the most convenient time/place for users. In 2016, the IAEA conducted five webinars with 300 registered participants per webinar.

To improve understanding of the medical diagnostic field, two new e-learning modules on Positron Emission Tomography-Computer Tomography (PET-CT) and nuclear cardiology have been added to the collection of educational material on the Human Health Campus. Around a thousand users access these modules monthly. In addition, three e-learning modules have been made available, targeted at nutrition and health professionals applying nuclear techniques in nutritional studies, covering:

1. The deuterium oxide 'dose-to-mother' technique (monitoring breastfeeding patterns and average milk volume consumption by babies);
2. Dual-Energy X ray Absorptiometry (measuring bone mineral density and body composition), and
3. The urea breath test (to detect the presence of *H. pylori* in the stomach).

The IAEA, in cooperation with the European Association of Nuclear Medicine (EANM), initiated a series of **recorded seminars** on 'Basic Nuclear Medicine' and 'Paediatric Nuclear Medicine' under the HHC. The IAEA has made 21 recorded seminars available, each viewed by over 1000 viewers each month.

To help address gaps in training programmes, the IAEA has also launched an online platform of **Distance Assisted Training Online (DATOL)** under the HHC for health professionals. DATOL can be used as an informative resource and will offers structured access to formative learning. This is an effective professional training platform that facilitates enhancing knowledge, exchanging of information and strengthening the skills necessary for nuclear professionals, to develop the knowledge and skills necessary for nuclear professionals to conduct and practise quality and safe nuclear medicine practice.

DATOL's interactive syllabus currently offers 39 subjects, representing approximately 900 hours of study, and strikes a balance between disciplinary theory and practice. When pursued part-time (5-6 hours per week), the DATOL syllabus can be completed within a 2-3 year period. So far, DATOL has been used to train approximately 800 students in nuclear medicine techniques, most notably in the Latin America, Asia and the Pacific regions.

In addition to HHC, the IAEA makes full use of modern technologies to help share knowledge and experiences among practitioners in radiation medicine and nutrition via telemedicine, mobile apps and livestreaming. Telemedicine uses ICTs to overcome geographical barriers and increase access to healthcare services. This is particularly beneficial for rural and underserved communities in developing countries – groups that traditionally suffer from lack of access to health care. Three mobile applications have been launched by the IAEA: 1) A Cancer Staging App (TNM) (over 1,200 times downloads already), 2) A cancer staging app for gynaecological cancer (FIGO), and 3) an App for the Management of Cardiovascular Diseases (NUCARD).

This platform is particularly beneficial for rural and underserved communities in developing countries, which might otherwise suffer from lack of access to healthcare. It offers customized, accessible and high-quality elearning training programmes with courses designed to upgrade skills of working professionals as well as students to address the most pressing regional needs (for both developed and developing countries); as well as continuous 'on-demand' access convenient for users. The platform can occasionally prove difficult to use, due to poor connectivity and low bandwidth (although generally, the system has proved very robust).

AFRONET (Africa Radiation Oncology NETwork)

The IAEA established the Africa Radiation Oncology NETwork (AFRONET) in June 2012 as a pilot with the aim of strengthening the process of clinical decision-making in the radiotherapy centres in Anglophone African countries. A multi-disciplinary Virtual Tumour Board (VTB) was created under AFRONET as a teleconference or a teleseminar, where cancer professionals can present and discuss challenging clinical cases. VTB provides a unique opportunity for participating centres to discuss cases with peers and experts from both within and outside Africa (e.g. the USA, Europe, Canada, and India). An overall goal of the AFRONET is to upgrade the knowledge of radiation oncology trainees in Africa.

Virtual remote AFRONET meetings are hosted monthly by the IAEA. Meetings include case presentations and a lecture on a preannounced topic of common interest by a leading expert. The project has been running since 2012 and 54 meetings have been organized so far. There are currently 56 radiation oncologists on AFRONET's mailing list from 17 Member States. More than 140 challenging cases have been discussed and 20 web-based lectures on seminal topics of interest have been delivered. Based on the increasing popularity and success of AFRONET, it is planned to roll out this initiative to other regions (Francophone Africa, Asia-Pacific, and Latin-America) and in other languages (French, Spanish and Russian).

AFRONET activities are coordinated by a single staff member from the IAEA, which confirms that positive results can be achieved using ICT tools with minimal human resources. It can have a greater impact via regular information exchange and knowledge sharing, with minimum human resource requirements. The AFRONET project has also helped in reducing the inequality of knowledge, training and quality of radiotherapy. However, the initiative has experienced some challenges, in terms of poor connectivity and low bandwidth (although generally, the system has proved very robust).

The AFRONET initiative should help contribute to SDG 3 (healthy lives and well-being) and SDG 10 (reducing inequality) by bridging knowledge gaps and inequalities in medical training. AFRONET makes it possible to discuss CT scans, pathology reports, target volume delineation and plan evaluation, all critical in the delivery of high-quality radiotherapy and patient management.

Quality Education

Leveraging ICTs and digital innovations to achieve SDG 4 and ensure inclusive and quality education for all and promote lifelong learning

By Irina Bokova, Director-General, UN Educational, Scientific & Cultural Organization (UNESCO)

The world is changing rapidly, driven partly by new ICTs. We must ensure that the digital revolution is a revolution for development that bridges divides, strengthens inclusion, and leaves no one behind. In this respect, new technologies can be both drivers and enablers of progress for Member States in taking forward the 2030 Agenda for Sustainable Development – and specifically SDG 4, to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'. For this, we must support States and all relevant actors in making the most of ICTs as development multipliers, through new investment in access, skills and relevant content[26].

Education is a human right – it is also a force for transformation, empowering individuals, bolstering health and productivity, strengthening societies and economies. Today, we must do everything to harness the power of new technologies to reinforce education systems, to bolster knowledge dissemination, to widen information access, to advance quality and effective learning and to ensure more effective service provision. This is how ICTs can play a vital role, notably in low-income countries, in moving towards SDG 4.

The increasingly powerful capacities and lower price of ICTs have enabled a rapid diffusion of digital devices and applications, and made ICTs more affordable in many countries. ICTs can enable countries to close many gaps at a "leapfrog" pace. ICTs are also significantly reducing the cost of deploying innovative services across sectors. ICT-enabled cost-saving delivery models of service provision are already changing, if not disrupting, the education sector in high-income countries, and enabling the innovative digital services essential for education systems in low-income countries. In addition, through broadband connectivity, social media and mobile applications, ICTs can mobilize new public awareness about the potential of digital innovations for achieving the SDGs, which, in turn, can help to accelerate the demand and readiness for ICT deployment.

The Power of ICTs to achieve SDG4

ICTs can dramatically expand access to knowledge, and offer unprecedented opportunities to reduce the long-existing learning divides, especially for low-income countries. Access and inclusion are the first multiplier benefits of new technologies. We see this power at work in countries across the world. In Bangladesh, ICTs have enabled students to access quality online teaching, even when qualified teachers may be scarce. The Jaago Foundation of Bangladesh (UNESCO 2016 Prize Winner for the Use of ICTs in Education) is working towards providing education to underprivileged children in rural areas. The project provides children with only limited access to qualified teachers with free-of-cost high-quality study programmes delivered by quality teachers in urban areas

through video-conferencing services. In another example, some 10,000 girls and women were reached through programmes using computer and mobile-based literacy through a partnership of UNESCO with Proctor & Gamble and the Ministry of Education in Senegal. Building on successful results, the programme was extended to Nigeria, using traditional and e-learning courses to reach some 60,000 girls and women.

To make the most of the power of ICTs for access and inclusion calls for deep engagement by policy-makers and the public sector. Governments have a special responsibility to ensure that key public education institutions are fully supported by high-quality ICT infrastructure. This is not to say that all girls and boys should own digital devices, but rather that they should have easy access to devices and Internet connections in their schools, local communities or in their homes. In this light, all education stakeholders should recognize enrolment in quality-assured online courses as an alternative or complementary mode to face-to-face programmes of study. Online learning programmes, especially those offered at the secondary school level, can provide access to core school courses, elective courses, and offer college courses that are designed to prepare students anywhere for future study. In crisis situations, ICTs have also demonstrated their power to help Governments and partners craft responsive and resilient systems meeting the needs of children, youth and adults. "Education in Emergencies" is the theme of the 2017 Mobile Learning Week, organized by UNESCO, with ITU.

In addition, mobile technology can offer flexible solutions to monitor the functioning of the education system in the rapidly-changing conditions that characterize emergency situations. In Jordan, OpenEMIS, an open source management information system developed by UNESCO, has been customized for collecting educational data on Syrian refugee children in schools and education centres in the Za'atari refugee camp. In Germany, the Kiron Open Higher Education organization (another UNESCO 2016 Prize Winner for the Use of ICTs in Education) is harnessing the power of ICTs in higher education for refugees. The project has established a hub of openly licensed Massive Open Online Courses (MOOCs) curated from 23 partnering universities. Qualifying refugees are helped to find courses matching their background and needs, and are supported by a coaching service to undertake online learning offerings. To sum up, ICTs can help to ensure the continuation of education in uncertain times and provide hope to people for a more promising future.

In addition to broadening access, new technologies can enhance the quality of learning. This requires new policies and resources at all levels. At best, this calls for education institutions and programmes to have access to textbooks and other learning materials, including online and Open Educational Resources (OERs), along with easily accessible ICT facilities, and sufficient numbers of qualified teachers, who have adopted learner-centred pedagogical approaches and open education practices. The benefits reach across the board. Strategy is essential. The education sector's uptake of ICTs will not automatically result in the improvement of student performance, unless it is guided by effective strategies. Governments must transform existing practices by, for example, reforming curriculum and assessment, making purposeful deployment of ICT applications and systems in education institutions and incentivizing educators to employ 21st century pedagogies.

The most significant and sensitive way for effective policies to successfully integrate ICTs in education is through **teacher training and professional development.** The challenge is both to prepare teachers to integrate ICTs in their pedagogy and to offer real-time support, as well as providing them with

the incentives and the professional motivation to do so. We need to rethink the role of teachers and reform their training and professional development. In this, the UNESCO ICT Competency Framework for Teachers (ICT-CFT) promotes a competency-based approach to re-defining teacher qualification, and to providing teachers with system-wide support for the effective pedagogical use of ICTs. In that regard, mobile technology can offer a cost-effective means for providing in-service support to teachers, notably in low-income countries.

UNESCO has successfully conducted projects in Mexico, Nigeria, Pakistan and Senegal, to advance and deliver teacher development through mobile phones. In Africa, we are harnessing technology for quality teacher training in eight countries through a China Funds-in-Trust project. This involves integrating ICT pedagogy in the curriculum and equipping teacher training institutes with ICTs. In Myanmar, UNESCO is working with the Ministry of Education to leverage growth in access to ICTs through strengthening pre-service teacher training, in a project supported by the Australian Government, to train ICT educators to teach in education colleges.

Cost-saving is a major driver for OERs, but there are other reasons for adopting their use, including content. Indeed, educators are able to adapt and repurpose OER to support innovative pedagogical approaches and practices. In low-resource settings with little or no Internet connectivity, this can result in the deployment of digital devices preloaded with content. To realize these benefits, however, it is vital to follow the OER approach of shifting the means of production of content to local producers, such as local master teachers, curriculum developers, experts and publishers. Enabling these groups to develop content in digital format makes offline server solutions a virtual and dynamic library for students. This is why it is important for governments to develop sector-wide strategies and capacity-building programmes to make the most of OERs in enhancing the quality of learning. We must look to harness emerging ICTs, such as big data and AI, to accelerate progress towards SDG 4.

Big data analytics has informed developers of online learning about students' learning behaviours, and led to the improvement in the design and organization of online courses. Empowered by big data analytics, intelligent tutoring or learning systems can automatically diagnose students' learning styles and problems. In this way, these learning systems can provide teachers and students with advice on further learning needs and career development. For this to happen, Governments must develop policies and systems to ensure secure, appropriate and ethical use of data, including safeguarding the privacy and confidentiality of students' personally identifiable information.

Promoting Lifelong Learning, including Higher Education

This is an essential new feature of SDG 4, and one for which ICTs can play an essential role, to bridge learning gaps and enable professional progression and mobility. ICTs can be used to deliver education and training (TVET), in both formal and non-formal settings, at all times and in all places. In this way, ICTs can improve and diversify learning pathways improve learning quality, and further reach vulnerable and underserved groups, including rural youth and adults, women and girls, out-of-school youth and people with disabilities.

Online learning, including via MOOCs, can enable students to gain free access to high-quality skills development opportunities and university courses. Training materials and social media-based online coaching are also accessible over tablets, laptops, smart phones and other devices. These multiple channels

for training materials have radically transformed the ways in which continuing education services are provided. The combination of mobile technology and self-directed learning can open up vast new options to train or retrain millions of youths, unemployed people and working populations, and can contribute to catalysing new pathways for lifelong learning. Innovative ICT-based approaches in certification and assessment can also provide tools to support flexible professional progression and mobility across workplaces and career stages. This will require the establishment of transparent quality assurance measures for online learning and integrating them into existing quality assurance mechanisms. All of this will be important to recognizing the knowledge, skills and competencies acquired through informal settings, and to building bridges between formal and non-formal learning.

Strategies to Leverage ICTs

- *Ensuring equitable access to digital devices and Internet:* Governments need to ensure that both girls and boys, women and men, have equitable access to high-quality ICT infrastructure. In 2015, the *World Wide Web Foundation* reported that women's chances of benefiting from the advantages of ICTs are one-third less than those of men. On average, women are 14% less likely to own a mobile phone than men. Even when they own one, they don't necessarily use it as much as men, which prevents them from reaping the full benefits of mobile phones.
  The greatest barriers affecting women's access to and the use of ICTs are low literacy levels, affordability, and a neglected or undelivered commitment to gender equality in ICT policy decisions. Concrete targets for gender equality in access to and use of ICTs should be integrated into national strategies for SDGs, backed up by adequate budget allocation. At the same time, the gender gap should be monitored through the collection of timely gender-disaggregated data to guarantee equitable access.

- *Shift from device shipment approaches to self-evolution approaches:* To make the use of ICTs for SDG 4 sustainable, we must foster ecosystems in middle- and low-income countries that give local communities agency in the process of developing technology and digital content to meet their needs. Without the emergence of an ecosystem for developing and upgrading digital devices rooted in local communities, the well-intentioned efforts of external stakeholders will either fall short in terms of limited impact and sustainability, or result in the further drain of resources from low-income countries.

- *International standards for collaborative digital innovations:* Existing fragmented ICT-enabled education delivery systems in many countries may need to be integrated into a more harmonized system. Considerable development in ICTs, including students' own ICT creation practices, occurs beyond the borders of any single country. For instance, the Maker movement is promoting a culture of everyday people designing and building technology products or learning materials and sharing these openly. How can we encourage and promote such initiatives without cross-border policies? We should advocate for Open Source Software (OSS) and the adoption of standards for interoperability concerning the development of open source ICT solutions for SDGs. This open and collaborative culture underlying OERs and the Maker movement should be further promoted when we strive for digital innovations for SDGs. In summary, ICTs are widening the horizon of new opportunities to take forward SDG 4, which requires political will, effective planning and resources for strong implementation. The future can be bright for ICTs in education, but it must be bright for all.

How ICTs can help the world overcome the barriers that stand between millions of children and an education

By Anthony Lake, UNICEF Executive Director

It has been said that teachers affect eternity, because they can never tell where their influence stops. The impact of education both in the lives of children -- especially the most disadvantaged children -- and in the strength of their societies is commensurately limitless. Children who learn more, earn more as adults – providing more for their own families and helping boost economic growth while breaking intergenerational cycles of poverty.

That is why education is at the heart of sustainable development: it lays an indispensable foundation for today's children to carry on -- sustain -- development progress in the next generation. Recognizing this fundamental link, Agenda 2030 sets ambitious education targets, calling for global action to provide every child with free, equitable, quality primary and secondary education.

The challenges of meeting this goal are enormous and we will need every tool we have – and some we don't yet have – to overcome them.

In 2013, the year for which we have the most complete data, an estimated 91% of the world's primary school-aged children were enrolled in school – and as many girls as boys were enrolled in primary education in two-thirds of countries in developing regions where gender parity once lagged. That is a victory for millions of children, but millions of children are still being missed.

In West and Central Africa, for example, the enrolment rate in 2013 stood at only 74%. The education of millions of children living through conflicts and crises is at urgent risk -- with around 24 million children living in 22 countries affected by conflict out of school. And the quality of education children receive when they are able to go to school is often very poor: Globally, more than one in three children of primary school age – around 250 million children – leave school without ever learning how to read, write and do simple arithmetic, according to a 2014 estimate.

ICTs can help us reach these left-behind children – supporting our efforts to increase their access to learning opportunities; to improve the quality of the education they receive; to help identify the obstacles children face in accessing education and the challenges schools face in retaining students; and to monitor our progress toward realizing the SDGs pledge to "leave no one behind".

Although ICTs are not a solution in themselves, examples abound of ways in which they are helping expand children's horizons by increasing their access to higher quality education and promoting their learning. For example, in Sudan, the Can't Wait to Learn initiative uses solar-powered tablets and interactive, self-paced software to help out-of-school children access the official Sudanese primary-level mathematics curriculum. The children use the tablets in community spaces that are staffed by trained facilitators – a necessity to maximize the value of digital devices.

Argentina is building a network of tech-based, rural high schools to help more children attend secondary school – a real falling off point in school enrolment. Well-qualified teachers stream lessons in real time from urban headquarter offices to community centers. Each urban headquarter can provide ICT-supported education to 10 classrooms, making precious educational resources go farther and expanding access to higher quality teaching. Not only does this programme connect more students to quality learning opportunities, it also connects them to each other. Once classroom exercises are over, students from hundreds of schools can interact with one another in open chat windows. This programme is currently covering 40,000 students in 3,000 community centers.

These are comparatively low-cost, high impact interventions that can change the lives and futures of millions of children. Distance learning systems can also help improve teacher training and support other community programmes, such as teaching parents and caregivers about the importance of stimulating play in early childhood development, which can not only help children learn later in school, but to learn more as adults.

And the role ICTs can play in helping every child realize a quality education goes beyond distance learning or laptops in schools. ICTs can also help us identify barriers that stand between too many children and a quality education, and track progress to overcome those challenges.

We are beginning to realize the potential uses of ICT-enabled 'perception data'- information provided by the intended beneficiaries of development interventions about how programmes and initiatives are working, or not working.

For example, U-Report, a mobile polling tool developed by UNICEF now used by 3 million young people in 34 countries, enables young people to voice their opinions and provide crucial perception data about problems in their communities. In Liberia, U-Reporters working with the Ministry of Education helped shed light on why enrollment and completion rates were dropping drastically, providing direct evidence of the reasons that prevent them and their peers from enrolling and completing school. Is it because walking to school is unsafe? Is it because teachers are absent or abusive towards students? Are there adequate hygiene facilities for girls?

Answers to questions like these can help illuminate where and why progress is lagging – and, in turn, can help governments to develop more efficient, effective and targeted interventions to address the situation.

ICTs can also serve as effective tools to monitor performance and boost accountability for results. In Peru, the EduTrac initiative uses mobile technology to gather data in remote communities, including data about teacher and student attendance, timely delivery of school materials, and school maintenance. Students, teachers and communities are all involved in the collection, interpretation and use of such data – an inclusive way to improve school quality in communities far from urban centers.

Similarly, ICTs can help deliver education and learning opportunities to children living through emergencies – monitoring the impact of conflicts on children's ability to access classrooms, mapping the location and condition of schools, tracking the distribution of learning materials, and providing distance learning opportunities. With an estimated 24 million children forced out of school as a result of violent conflict, and 50 million children on the move in search of safety and a way out of crushing poverty and climate-related crises, the potential impact of such programmes is enormous.

ICTs also can help us achieve the SDG education targets by helping educate people about the SDGs. Already reaching children in 160 countries, the World's Largest Lesson (WLL) is a new curriculum and online learning platform designed to teach the world's children about sustainable development.

More broadly, the SDGs recognize the critical role ICTs can play in boosting so many of our development efforts. SDG Target 9.C calls for governments and their partners to significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020.

Gender Equality

Reshaping the future: Women, Girls, ICTs and the SDGs

By Phumzile Mlambo-Ngcuka, UN Under-Secretary-General and Executive Director, UN Women

Technology in its various forms, including ICTs, continues to redefine and revolutionize the way we all live and work. Harnessing this technology to advance gender equality and women's empowerment is not only vital for women and girls, but critical throughout the 2030 *Agenda for Sustainable Development*. The link between technology and women's rights is clearly reflected in SDG 5 on gender equality and the empowerment of women, which includes a specific target on utilizing technology and ICTs to realize women's and girls' empowerment. However, realizing gender equality reaches far beyond any single, individual goal. Gender equality is key to ensuring that no one is left behind, and is intrinsic to the success of each and every SDG.

Where women and girls are able to change their opportunities and perspectives through ICTs, their empowerment affects a wide range of outcomes even in informal work settings: in Pakistan, an innovative food-ordering platform links home-based women in the informal food industry to a wider pool of customers, and provides a safe virtual marketplace for them to sell their meals. In Rwanda, some 3,500 women farmers are now connected through mobile technology to information, markets and finance. ICTs offer vast potential for women and girls: from ending poverty, to improving education and health, to agricultural productivity, and creating decent jobs.

ICTs are shaping future employment – but who will get those jobs?

ICTs are especially relevant today, as we face a rapidly changing world of work. How can we ensure that women and girls acquire the right ICT and STEM (Science, Technology, Engineering and Mathematics) skills to compete on a par with boys and men in the 21st Century economy, enjoy greater choice and access better-educated, better-paid jobs?

By 2020, it is expected that more than 7.1 million jobs will be displaced, and by 2050, half of the jobs that currently exist will have disappeared[27]. That means that 65% of the children entering primary school today could eventually work in jobs that do not yet currently exist. The 'Fourth Industrial Revolution' is also bringing advanced robotics, autonomous transport, AI and machine learning, all of which will have a major impact on the future labour market[28].

Along with these challenges come opportunities. It has been estimated that 90% of future jobs will require ICT skills, and some 2 million new jobs will be created in the computer, mathematical, architecture and engineering fields. The use of technology, manufacturing and production therefore have the potential to support upskilling, redeployment and productivity enhancement[29]. Mobile broadband – or using tablets, mobile phones and other portable devices to access the Internet – represents the fastest technological uptake in human history. Hotspots are being set up by individuals and technology companies are experimenting with drones, balloons and other innovations to extend access to and use of the Internet[30]. Technical and ICT-related skills across industries also need to be supplemented by broader, stronger collaborative and social skills – such as persuasion, emotional intelligence and the ability to learn and teach others.

Are our children learning the right lessons?

A recent study, 'Gender stereotypes about intellectual ability emerge early and influence children's interests'[31], shows that already, by the age of 6, girls are already less likely than boys to describe their own gender as 'brilliant', and less likely to join an activity labelled for 'very, very smart' kids. When a young girl believes she is less intelligent and capable than a boy, she is also less likely to pursue STEM subjects that are often perceived as 'hard' through school and beyond. This study is one of many that paint a worrying picture of generations of girls being affected by negative stereotyping. New findings from a study of 9,500 girls and young women aged 11 to 18 in nine European countries underline the 'leaky pipeline" finding: in Finland, 62% of female teenagers said they see the natural sciences as important, but only 37% said they would consider a career in that area.

Un-learning these biases and changing the stereotypes is no simple matter, yet it is essential, if we are to see boys and girls able to compete on a more equal footing for the jobs of the future. This goes hand-in-hand with practical programmes that teach immediately relevant skills. For example, in the Republic of Moldova, GirlsGoIT teaches girls digital, IT and entrepreneurial skills and specifically promotes positive role models through video; similarly in Kenya and South Africa, 20 Mozilla Clubs for women and girls teach basic coding and digital literacy skills in safe spaces.

A recently launched Unilever report on stereotyping shows that 77% of men and 55% of women believe that men are the best choice for high-stake projects[32]. Such beliefs have a sizeable impact on gender equality issues globally, with 60% of women and 49% of men indicating that stereotypes impacted their careers, their personal lives, or both. At the same time, nearly three out of four respondents (70%) believe that the world would be a better place if today's children were not exposed to the gender stereotypes so prevalent in media and marketing, and so easily disseminated via online media[33].

So, how do we change the sexist messages that girls and boys are receiving?

This is a complex task that requires action on a number of fronts. We need to invest in programmes that deconstruct negative stereotypes and traditional gender roles, and work with marketers and the media to stop sexist – and sexualized – advertising, and ensure women are portrayed accurately and equally in TV, film and the news media. We also need to work with schools to change the curriculum and with teachers to ensure that they do not have different expectations for boys and girls. Work with private sector partners who are prepared to engage seriously in rectifying gender inequality is a very important aspect of influencing changes for women in the workplace, with results that improve conditions for men too. And we must continue engaging with non-traditional allies, such as local and religious leaders, young people and men and boys. This process of 'un-stereotyping', and empowering women to create their own narratives will be crucial to ensuring that ICTs drive progress towards achieving the 2030 Agenda.

Positive role models have also proven to be a powerful tool in eliminating gender stereotypes, especially those relating to ICTs and women in STEM, including both perceived role models in the media, as well as real-life mentors and success stories. We must expose girls and boys to role models in non-traditional fields – such as female engineers or male carers – and give women the chance to tell their own stories through programmes such as the #HerStory campaign, which showcases the stories of women leaders and women who have been forgotten in history books.

The education-to-employment skills gap

Around the world, we are now facing a mismatch between the skills that employers demand and those that workers possess. The global "talent shortage" is currently at 38%, with the top ten hardest jobs to fill in STEM professions (Manpower 2015). There is currently a 200-million-person shortage of ICT-skilled workers around the world. Although more women than men now graduate from tertiary education in some countries (e.g. in many Pacific small island states), this is not resulting in increased economic opportunities.

To bridge this skills gap, we need to understand and teach the skills that women of all social classes need to take full advantage of ongoing technological advances. As digitization replaces workers (mostly in sectors such as the garment and agricultural industries), the need to offer women updated skills is becoming more critical. In manufacturing, service and agricultural industries (where women are overrepresented), jobs are slowly being replaced by automation. We must help women to learn new skills and competencies, so they can adjust to the changes in these industries or retrain to take up positions in other sectors. Bridging this skills gap can have added economic advantages. We know that the gender pay gap is often reduced in the STEM fields, where demand for skills is high. According to the US Department of Commerce, in 2009, women in STEM careers earned 33% more than those in non-STEM jobs at comparable levels.

ICTs can also help to bridge the skills gap by extending the reach of education and literacy to a population that was previously excluded due to a lack of infrastructure or political instability. According to UNDP, 103 million youth worldwide are devoid of basic literacy skills, and more than 60% of them are women. UN Women is currently developing a Virtual Skills School to ensure that no woman or girl is left behind and to offer a second chance at learning to those who had to leave formal education. Through the Virtual Skills School, we intend to provide women and girls with learning pathways that would facilitate their re-integration into formal schooling, and allow them to progress into non-traditional sectors as either job seekers or job creators.

Overcoming the gender digital divide

There are some 250 million fewer women online than men, and the gap is widening (from 11% in 2013 to 12% in 2016 – ITU 2016[34]). Access remains concentrated in the developed world – around the world, 53% of the world's population (equivalent to some 3.9 billion people) are not connected, and in several of Africa's poorer and more fragile countries, only one person in every 10 people is on the Internet.

Increasing access to online resources is crucial to ensuring women and girls are not left behind in an increasingly digital world, and can, in some cases, catalyze women's interest in the opportunities offered by technology and ICTs.

However, the gender digital divide goes beyond simple access issues – it is also inextricably linked to factors such as technical know-how, education about the benefits of technology, and the content and methods by which relevant skills are taught. For instance, women and girls need to be informed about the opportunities posed by technology and ICTs, so they are empowered to demand greater access.

Bridging the digital divide, changing stereotypes about women in the tech industries and equipping women with the skills they will need to thrive in today's economy will not happen overnight, but UN Women has several projects underway that are harnessing the power of technology to transform women's narratives and their way of life.

We are also leveraging partnerships with the private sector, UN agencies and civil society to ensure uptake and use of ICTs and move us closer to closing the gender digital divide. One example of such a successful partnership is UN Women's HeForShe IMPACT 10x10x10 initiative, which works with ten Heads of State, ten CEOs of major corporations and ten university presidents, on game-changing gender equality commitments. Some of these commitments include expanding mobile phone access to underserved women, providing scholarships to women in STEM fields and teaching girls how to code computer software and apps. UN Women has also partnered with ITU to launch the EQUALS partnership, with the aim of creating an unstoppable global movement where women and girls are equal participants in the digital technology revolution. EQUALS will bring together global technology and ICT partners to empower women and girls by driving progress as well as collecting and analyzing data and statistics in the areas of access, learning and leadership.

Conclusions

Women and girls comprise half of the world's population. When they are involved at all levels in the implementation of the SDGs, as well as in driving the tech sector, they can help to create user-friendly technology that is responsive to their needs. Each of us have a part to play a part in closing the gender divide, overturning stereotypes and encouraging women and girls to use ICTs and pursue careers in the technology sector. In doing this, we not only empower women and girls, we move closer to the achievement of the *2030 Agenda* and a better world for all – including for men and boys, as well as women and girls.

Clean Water & Sanitation

ICTs and SDG 6 to Ensure the Availability and Sustainable Management of Water and Sanitation for All

By Guy Ryder, Director-General of ILO and Chair of UN Water

What are the problems we are trying to solve?

Today, we are facing unprecedented challenges in ensuring that everyone has access to sustainably managed water and sanitation services. In 2017, out of a global population of around 7.5 billion people, some 1.8 billion people use a contaminated source of drinking water, 2.4 billion people lack access to adequate sanitation facilities[35], and over 840,000 people die every year from preventable water-borne diseases[36].

No person or community can function properly without access to safe water and sanitation. Beyond the obvious need to quench one's thirst, how can people stay clean, maintain a toilet, manage menstruation, run a business, a hospital or a school without a supply of clean and safe water? The wider impacts of this crisis are profound. Diarrhoeal illnesses caused by unsafe water, poor sanitation and hygiene are linked to around 50% of cases of child undernutrition, which can lead to stunted physical and mental development[37]. What's more, loss of productivity due to those same illnesses is estimated to cost many countries up to 5% of GDP[38].

Climate change risks further exacerbating this situation. Changes in water availability will impact food security and health, which have already proven to be a trigger for the instability and insecurity that forces people to become refugees. More variable rainfall mean much greater uncertainty for people, especially smallholders or farmers. Groundwater, reservoir levels and water resources can be depleted where the climate is getting drier, while conversely, floods can kill or devastate lives and ruin homes in areas where rainfall is heavier and more concentrated. Rising sea levels can contaminate coastal groundwater with saltwater. And in all these different situations, it is often the poorest and most vulnerable communities who are hardest hit and least able to cope.

Of course, the more people there are, the greater the demand for water. By 2030, our rapidly growing global population will have at least a 40% gap in its resources and water needs for drinking, washing and cooking, and to maintain sanitation systems to keep clean and healthy[39]. And the greater the number of people without decent toilets or practising unsafe hygiene, the greater the risk of deadly and contagious disease outbreaks, and even international pandemics.

Overall, the water and sanitation sector needs to be prioritized and well-funded. Water is increasingly scarce and the costs of upgrading sanitation and supplying water (for drinking as well as all other human activities) are rising. Urbanization makes the technical, political and financial challenges of service delivery even more complex, especially in rapidly expanding informal settlements. Put simply, we urgently need to become smarter in how we improve the sustainability and scalability of water and sanitation services, so that we can reach everyone currently unserved.

How ICTs could help us manage water and sanitation services

SDG 6 commits us to ensuring the availability and sustainable management of water and sanitation for all, including an end to open defecation, by 2030 – just 13 years away. Technology will play a pivotal role in achieving this ambitious goal, not just in terms of engineering technology in the delivery and maintenance of water and sanitation facilities and systems (such as taps, toilets and pipework), but also in the more extensive use of ICTs in helping us to manage water itself – the resource on which sanitation and hygiene depend.

Good governance, based on reliable information gathered by and shared through ICTs, is essential to manage uncertainty and reduce the risks of over-exploitation and pollution of water resources and to extend and maintain sanitation systems that are proven to massively reduce the spread of disease. Without an integrated, data-driven approach to water and sanitation that takes account of the needs of the whole economy and protects the environment, we risk jeopardizing the success of the SDGs as a whole.

The Main Areas where ICTs can Revolutionize Water and Sanitation Management

Mapping and forecasting

Governments and water utility companies need to be able to accurately assess the state of their finite water resources, so they can meet current demand and make plans to meet future growth in demand. Networks of sensors, for example, can be used to measure groundwater levels, and satellite imaging is helping give decision-makers a clear picture of how the water system is prepared to respond to people's needs. Today, satellite remote sensing of groundwater in Somalia is allowing researchers to accurately gauge water quality.

In the case of sanitation, ICTs can be used to change behaviour and spark community-led change. In Kenya, the Ministry of Health has implemented an online, real-time monitoring system of maps and reports to show national progress towards the goal of communities becoming 'open defecation-free'. The public nature of the system helps participating communities to contextualize the changes they are implementing and serves as inspiration to other communities just beginning the journey.

Agriculture

Agriculture accounts for around 70% of global water withdrawals[40], so improving the efficiency of this sector will play a major role in the sustainability of the world's water resources. For instance, knowing when to irrigate crops, and how much water to use, is crucial to maximizing yields. Wireless sensors are being used in the fields to monitor humidity levels and soil moisture, and can automatically turn on irrigation systems, based on the specific needs of those crops at that location and at that point in time.

Advanced monitoring also allows for better planning and management, especially during cycles of drought and flooding. For example, the Somalia Water and Land Information Management project developed by the FAO has developed sophisticated systems for monitoring surface and groundwater to support sustainable development of scarce water resources in Somalia.

Smarter systems and services

ICTs are also proving effective in the treatment and recycling of wastewater. A pilot scheme in the Netherlands is linking up five municipalities' sewerage networks and wastewater treatment plants, so sewage can flow through the entire system under an automated centralized control, and this plan could eventually be scaled up to the national level.

While projects at the regional and national level are very important, we must all take responsibility at the individual level to reduce the amount of water we use, reduce the pollution we may contribute to the water system, maintain our household sanitation facilities, and reuse water where it is safe and practicable to do so.

ICTs can help us to do that, through the use of smart water meters and apps to monitor home usage or, for people living in informal urban settlements with no connection to sewerage networks, using apps and text messages to alert local latrine emptying services, so waste is properly disposed of.

ICT-based advances also may imply a reduction in staff for specific water-related tasks, as well as increased knowledge, skills and capability requirements. They may also raise the qualifications for professionals in water sectors. At the same time, new job opportunities are being created through efforts in R&D and for a broad range of ICT-professionals and/or ICT-versed water professionals who will benefit from new employment opportunities in water organizations.

Some of humankind's earliest technology was applied to water supply. So technology has always been, and will always be, central to giving people access to water, sanitation and hygiene. But while engineering and science are not new, the current pace of technological change, and the way ICTs have transformed society, are unprecedented. Our ubiquitous screens have become portals, giving us access to a domain where we can learn from each other, gather information and act in concerted ways that were inconceivable even a few years ago.

There is no one-size-fits-all solution to the water and sanitation crisis, but there is now an urgent priority: with respect to water as a resource, we need to do much more, with less. ICTs have the power to revolutionize water and sanitation management by helping us develop innovative, efficient, scalable solutions, based on data and evidence.

We need to adapt the technologies at our disposal, mixing physical infrastructure, data management and communication in different ways to meet the needs of different contexts and to live within the limits of the water availability. ICTs are based around communicating and sharing, so ICTs in the context of SDG 6 must be focused on sharing the benefits of water and sanitation equitably to everyone on the planet to help drive progress across many of the other SDGs.

Affordable & Clean Energy

Using ICTs to implement SDGs

By the International Atomic Energy Agency (IAEA)

The IAEA plays an active part in helping Member States to achieve the SDGs. Far from being the preserve of industrialized countries, nuclear science and technology offer prospects for addressing the broader energy needs to developed and developing countries alike, by offering more options and choice. The IAEA uses ICTs to support Member States in improving the functionality, safety and security of existing and new Nuclear Power Plants (NPPs) to ensure Affordable and Clean Energy (SDG 7) and improve Industry, Innovation and Infrastructure (SDG 9) by managing complex nuclear lifecycle technology systems. However, the applications of nuclear techniques – and the IAEA's work – in fact extend far beyond just nuclear energy.

The IAEA helps countries to use nuclear and isotopic techniques, thereby contributing directly to attaining many of the goals in areas of poverty, hunger, human health, clean water, affordable and clean energy, industry and innovation, and climate change, to name just a few. The IAEA's work extends into the education and training of health professionals in nuclear medicine techniques (SDGs 3 and 4 on health and education, respectively), monitoring of marine contaminants (SDG 14), ensuring agriculture and food safety (SDG 2), and enhancing industry, innovation and infrastructure (SDG 9). These are areas in which nuclear science and technology have much to offer. The IAEA makes wide use of ICTs in order to provide more effective assistance to IAEA Member States with the view to help them achieving the SDGs.

Plant Information Models (PIM)

The IAEA continues to assist Member States in understanding and applying new computerized information system technologies to manage nuclear facilities. Multiple information systems and databases from different vendors and for different purposes are used in nuclear power plants. Most of these systems are not integrated with each other and cannot share plant data throughout their life cycle, resulting in redundancies in capturing, handling, transferring, maintaining and preserving plant's data. Problems in interoperability can stem from the fragmented nature of the industry, paper-based business practices, a lack of standardization, and inconsistent technology adoption among stakeholders.

Recent developments in computer graphics, 3D visualization and models, distributed networks and wireless capabilities, coupled with more powerful enterprise software applications, make it possible to apply ICTs in all phases of a facility lifecycle, creating potential for streamlining historically fragmented operations. The power plant information model (PIM) consolidates these diverse data management tasks in a comprehensive and detailed manner which can be integrated and interoperable with plant design, operations, and maintenance processes, as well as databases, document systems, and records systems of the organizations that own and operate them. The IAEA also assists Member States with guidance on how to apply new technologies in the design, procurement and construction new NPPs using modern Computer-Aided Engineering (CAE)

Affordable & Clean Energy

and Computer-Aided Design (CAD) systems – for example, through multi-dimensional modelling along with data, databases, and electronic document sources (i.e. a "Virtual Power Plant").

The use of such technologies can improve the sustainability of managing complex and inter-disciplinary nuclear lifecycle technology systems. They can contribute to safety and economics at all phases of the nuclear lifecycle, as well as preserving knowledge of the designer's decision process for the entire span of a nuclear power plant's lifecycle. However, it can prove tough to conceptualize and standardize a new framework model with which all vendors, builders and operators can conform and interface and integrate different systems, using various legacy technologies in a somewhat technology-fragmented industry.

Knowledge Organization Systems and Semantic Technology

The rapidly increasing amount of data, records, and information in every knowledge domain of nuclear knowledge poses challenges to their capture, storage, retrieval, integration, and effective reuse, relevant in specific contexts. This becomes particularly important in the nuclear sector because complex nuclear technology systems require that massive quantities of digital artefacts (e.g. drawings, test results, verification reports, inspection records, licensing submissions, on thousands of systems and their components) be archived and maintained over many decades. Methods of knowledge modelling and representation play an increasingly important role in addressing this problem.

'Knowledge organization systems' (KOS) is a term which describes knowledge structures such as controlled vocabularies, taxonomies, thesauri and ontologies, providing the basis for describing complex knowledge domains. Over the last decade, the capability of machines to present, share and act upon knowledge has dramatically increased. New technologies are enabling much higher levels of information storage, sharing, retrieval, aggregation and re-use, customarily defined as "semantic information technologies".

The IAEA has been developing KOS for several years and is assisting Member States to organize their digital materials for archival and retrieval purposes, as well as enabling Member States to better manage large digital collections. Semantic technologies are being utilized across many applications, including classification systems, knowledge bases, search engines, recommender systems, storage technologies and metadata management. The numerous capabilities of the semantic technologies are especially relevant in the nuclear field, which is fundamentally knowledge-driven, and which depends on sharing nuclear knowledge in and between all phases of designing, constructing, operating and decommissioning nuclear facilities.

Within the nuclear field, the vast body of knowledge involves many scientific, technical and managerial fields, and is distributed among many organizations of different types. Managing and provisioning distributed knowledge is therefore becoming a major challenge. The IAEA provides guidance, training, and tools to aid in the adoption of advanced semantic information technology to strengthen knowledge management in the Member States.

Organizing knowledge systems and archival records in common vocabularies, taxonomies and thesauri in the nuclear sector offers advantages of: automatic text analysis and term extraction; the possibility of integrating heterogeneous knowledge sources; and organizing and benefitting from knowledge-driven information portals and databases. However, it is not always easy to integrate new semantic technologies and methods with existing legacy KOS.

This IAEA activity contributes to SDG 4 (Quality Education), by providing guidance, training, and tools to aid in the adoption of advanced semantic information technology to strengthen knowledge management in IAEA Member States, as well as SDG 9 (Industry, Innovation and Infrastructure). The strengthening of knowledge management in Member States contributes to nuclear safety overall and these new technologies have enabled much higher levels of information storage, sharing, retrieval, aggregation and re-use.

Nuclear Knowledge Management Wiki

The IAEA launched and operates the Nuclear Knowledge Management (NKM) Wiki for NKM practitioners and professionals to collaborate more effectively, exchange opinions and share experiences on common issues and approaches. The Wiki is based on an ontological model, which will allow for professionals to approach the subject of NKM in a more systematic and structured manner. They can contribute to a critical mass of NKM-related resource and reference materials, such as, topical articles and descriptions of key concepts, all with referenced sources. This Wiki enables improved lifecycle knowledge management practice and approaches that contribute to the nuclear industry. It is easy to use and cost-effective. It helps collect, organize, and share information, and facilitates collaboration and communication.

Cyber Learning Platform for Network Education and Training (CLP4NET)

The IAEA has developed and operates the CLP4NET platform, which helps contribute to SDG 4. This platform aims to facilitate sustainable education and to support capacity building and knowledge transfer by empowering web-based development and dissemination of learning resources in a way that is cost-effective, scalable and easy to use. The platform also promotes awareness, understanding and confidence in the peaceful applications of nuclear technologies. It constitutes a learning environment to support instructor-led courses and disseminate e-learning self-study resources to a wider audience, and an online database of resources on education and training that allows users from Member States to find easily educational resources. The CLP4NET's learning management system (LMS) has been established as the IAEA's official LMS and a decision has been taken to consolidate, over time, all IAEA externally facing elearning content in the CPL4NET.

Decent Work & Economic Growth

ICTs and SDG 8 on Full and Productive Employment and Decent Work for All

By Guy Ryder, Director-General of the International Labour Organization (ILO)

Ever since we invented the wheel, human beings have had reason to celebrate new technology. That is certainly also the case with ICTs, which have transformed our economies and societies, indeed our world, over the past few decades. Just think of the Internet and mobile phones – in less than a generation, the worldwide web and the global reach of 4.7 billion mobile phone subscribers have revolutionized the way we live and work, creating what the UN has dubbed the 'Information Society' – a society of globalized interdependence.

This has tremendous consequences, not least for the world of work and its governance. For the most part, new technologies are beneficial, in creating opportunities to make and do things that were previously impossible, or opportunities to make and do things better and more efficiently than before. ICTs can thus boost productivity and economic growth, and reduce poverty. In other words, ICTs can certainly help us achieve the SDGs.

However, we also know that new technologies are disruptive. Workers are often the first to feel the pain. So there are good reasons for many workers, their families and communities to be anxious and even mobilize resistance to change in the face of new technologies. That is also the case with ICTs, which may challenge society's existing norms and compel us to revisit our attitudes and expectations.

That being said, we should not give up on our values and ultimate objectives, namely social justice, prosperity and peace for all. The challenge before us is to ensure that these technologies are embedded in the best possible framework to facilitate adjustment, minimize adjustment costs, compensate those who lose out and ensure the broadest and fairest possible distribution of the gains from technological innovations. Fundamentally, these are also questions of political economy, and questions that require a political response, at the local, national and global levels.

SDG 8 – Decent Work for All

The UN's *2030 Agenda for Sustainable Development* and the SDGs represent an important political breakthrough in the way the international community deals with these challenges. While all SDGs are equally important, mutually supportive and should be pursued holistically, SDG 8 – to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all – is of particular relevance and importance to the ILO.

First of all, let me emphasize that 'Decent Work' as understood by the ILO and our tripartite constituents (the world's governments, employers and workers) is more than just employment. 'Decent Work' refers to employment with social protection and social dialogue between these groups, as well as to fundamental principles and rights at work, including freedom of association, the right to collective bargaining and adequate earnings.

So, how are we doing in this regard? Is it fair to say that the ICT revolution over the past generation has indeed made important contributions to Decent Work? Or has it been destructive? Or perhaps ICTs have no effect at all on Decent Work? While there is no lack of expertise on these important questions, the experts obviously disagree on the answers. So I would say the jury is still out. It is clear, however, that after several decades of productivity enhancing innovations in ICTs, global unemployment is unacceptably high, and increasing. The ILO's World Economic & Social Outlook from January 2017 forecasts that global unemployment will increase by 3.4 million to surpass 201 million people this year.

Rising inequality

A joint study prepared by the ILO and the OECD for the G20 in 2015, with contributions from the IMF and the World Bank, concludes that the labour share of national income had fallen in 26 of 30 the countries studied between 1990 and 2009, with the average labour share down from 66.1% to 61.7%. The ILO Global Wage Report 2014/2015 further shows that, in a number of countries where labour shares declined, wage growth has significantly lagged behind productivity growth. We also found that this fall was by and large due to declines within industries and widespread across industries. In other words, the shift of many economies away from labour-intensive sectors, such as agriculture, is not enough to explain the fall in labour's share of national income.

Again, the experts disagree on who – and what – is to blame for these negative trends for workers. Technological change is often considered the main culprit, with some authors considering capital accumulation and capital-intensive technical change as important drivers. Others point to globalization, referring to the integration of large emerging economies into the global economy which provides a rapid and huge increase in the global supply of labour. Others point to the gradual, but consistent, loss in workers' bargaining power following decades of continuously falling rates of trade union membership across most of the advanced economies.

I would claim that all these factors are at play – and that they are intimately linked and mutually reinforcing: the ICT revolution has enabled automation, outsourcing and globally integrated supply and value-chains of production – just think about microchips, robotics and the Internet. However, these technical enablers would not have transformed the world without important political decisions, in particular international agreements to promote and protect the global flow of information, trade and investment.

In summary, ICTs and political decisions at the national, regional and global level have had incredible benefits, not least by helping to lift hundreds of millions of people out of poverty. However, at the same time, both ICTs and these policies – separately and in combination – have fundamentally altered the balance of power in many labour markets, to the detriment of workers. This effect has been particularly strong in countries with mature and highly developed labour market institutions, which have thus come under pressure.

Creative destruction?

History does not necessarily repeat itself. But looking back in time is nonetheless helpful in combatting pessimism. While technological change can be destructive for jobs in the short term, the effect over time has repeatedly been that of net job growth. The ILO's World Employment Reports of 1996/97 and 2001 both conclude: "Aggregate data do not support the fear of massive technological unemployment". However, many experts claim this time might be different. Aren't today's new technologies, driven by ICTs and including AI, the IoT and Industry 4.0, of an entirely different order of magnitude, scope and consequence, with an unprecedented and exponential pace of productivity growth? Automation has also intensified, resulting in much stronger job-replacement effects.

Indeed, some expect increasing and persistent technological unemployment due to the disruptive effects of emerging innovations, including the innovative use of ICTs. A recent ILO study[41] explores these issues, in particular the dynamics of job destruction and job creation induced by new technologies. Historical evidence shows that competitive pressures have been driving automation and fragmentation of production systems that enhance productivity by saving labour and thereby destroying jobs. While there will certainly be regional and national differences, many fear this 'Fourth Industrial Revolution' will have a permanent negative effect on the number and quality of jobs. And the jobs at risk are no longer merely routine or manual in character. Now, even sophisticated non-routine and highly cognitive jobs can – and will – soon be taken by machines. And this is not only the case in manufacturing, but increasingly also in the labour-intensive service sector.

While robotics may bring manufacturing and low-skilled jobs from developing countries back to developed countries, the digital break-up of professional jobs into a series of less complex tasks may well lead to relocation of such high-paying jobs in the other direction. New ICT-enabled services, such as those provided in the cloud, give reason to believe that even complex tasks will be outsourced to developing countries with a growing number of high-skilled professionals currently earning a fraction of what their colleagues in developed countries take home. This is good news for some and bad news for others.

But the picture is even more nuanced and potentially promising. Besides job destruction and re-locations, technological innovations will also trigger new economic activities and create new jobs, in multiple ways. First, cost-cutting technologies can enable expansion in volume of production, thus having a job-creating effect. Second, technological spill-over creates jobs – for example, robots need to be created, produced, maintained and managed. Third, technological innovations create new products as yet unimagined. Fourth, productivity growth – if translated into lower prices, higher wages, and broadly shared increase in purchasing power – will increase demand and thus lead to expanded output, which in turn generates jobs. And fifth, labour saving production process technologies can lead to reduced working hours. This allows for more leisure time, thus creating demand for new industries and services – think of tourism, sports, health and recreation, which are all quite labour-intensive sectors.

Triple hit

This combination of job destruction and job creation raises several issues of concern to the world of work. The first concern is related to **income and wealth inequality:** we are facing a more polarized labour market. While there are more, and better, jobs for those with special skills at the top and many more at the bottom, the mid-level jobs fundamental for a vital middle class are disappearing in large numbers. This contributes to increasing income inequality among workers, which has gained deserved attention and raised concern over the past few years. An even more important driver of inequality is the fact that productivity gains from the combination of technological innovation and the economy of scale from globalization have gone disproportionately not to workers but to the owners of capital and innovations, as previously noted with regard to labour's share of national income.

Our second concern is the **adjustment costs:** the adjustment and change that follow job destruction and creation can often be painful and costly, especially for workers and their families, but also for many employers, in particular in smaller and vulnerable companies which find themselves at the losing end of the competition driven by rapid technological change and globalization. This is not only a matter of economic hardship, but also about social stigma and community cohesion, and how best to cope with a rapidly changing world.

The third concern is **macro-economic in nature**: the rapidly increasing concentration of productivity gains, income and wealth in favour of certain privileged groups (e.g. owners of capital and innovation, as well as top-skilled workers), leave an increasing number of people with less to spend, depressing overall consumption and aggregate demand in the economy. This represents a major threat to economic growth, as we have seen over the past few years. To summarize: while ICTs certainly are a gift to humanity in the form of new opportunities and productivity gains, they also confront us with significant new challenges. A broad and fair distribution of costs and benefits, risks and opportunities is key to solving this problem.

A matter of fairness, social justice – and sustainability

In light of the SDGs, and in particular SDG 8, the question we are facing now is the following: how do we ensure that ICTs are developed and utilized for the greater good? This is not only about creating new applications for consumers and producers, and astronomical fortunes for innovative entrepreneurs and their investors, but also about providing full and productive employment and decent work for all, in line with the 2030 Agenda. This will require innovative institutions, societal learning and political re-thinking – technological determinism and blind faith in the market are simply not sufficient!

The direction and impact of technological change, innovation and structural transformation is not written in the stars, nor merely a product of individuals' pursuit of self-interest. Political choices determine the direction and impact of these changes. The transition process needs to be managed. While history does not always repeat itself, it can teach us that job-destruction can be followed by job-creation – if we take the appropriate measures to adapt our institutions, laws and regulations to improve the rules of the game and make them fit for the challenges of the 21st century.

I believe that the ILO and our Decent Work Agenda have a lot to offer in this regard. First, the pursuit of **full and productive employment** with adequate pay must be an end in itself and be actively pursued through macro- and micro-economic policies and supportive measures. Skills development, education and re-training should be a key priority in all countries. Second, **social protection schemes,** including health and unemployment insurance, should be made universally available, thus facilitating more flexible labour markets and enabling workers to adjust. Third, **social dialogue** bringing together governments, workers and employers to face these challenges will inform decisions, facilitate adjustment, and ensure a just transition in the course of this Fourth Industrial Revolution. And finally, **fundamental principles and rights at work** must be fully respected and protected. Freedom of association and the right to collective bargaining are particularly important, to address one of the most serious challenges of our time: establishing a fair and legitimate balance of power in labour markets.

To conclude: ICTs can indeed be instrumental in achieving the SDGs – if developed and applied within the framework of the Decent Work Agenda. While all four components of decent work are the responsibility of national governments, to be implemented at the national level, the globalized interdependence of our times will require more, and better, international cooperation, coordination and policy coherence at the global level. To achieve the SDGs and have the Future We Want, we need better Global Governance!

The Role of ICTs in Facilitating Trade for Sustainable Development

By Roberto Azevédo, Director-General, World Trade Organization (WTO)

Trade can play an important role in boosting economic growth and supporting poverty reduction. The increased market access opportunities it offers can help countries create jobs, improve incomes and attract investments. The SDGs put significant emphasis on the role that trade plays in promoting sustainable development and recognize the contribution that the WTO can make to the 2030 Agenda. A central contribution of trade and the WTO's work will be to support SDG 8 on promoting 'sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all'. This is at the very heart of the WTO's mission. But our work contributes to delivering a wide range of the other SDGs in a variety of ways.

Indeed, in December 2015, WTO Members made a substantial contribution towards the SDG on 'zero hunger' (SDG 2) through the adoption of a Ministerial Decision to eliminate all forms of export subsidies. This was a specific target of SDG 2 and this decision represents an important step in reforming agriculture trade and reducing distortions, especially for low-income countries whose economies depend on agriculture for the livelihood of their populations. The WTO's specific contributions to the SDGs also include: ensuring access to affordable medicines in developing countries (SDG 3.b); implementing the principle of special and differential treatment to help reduce inequalities (SDG 10.a); and ongoing discussions on eliminating subsidies that cause overfishing and overcapacity (in order to help achieve SDG 14.6). In addition, the WTO's work on the reduction of tariff and non-tariff barriers on environmental goods and services can facilitate the diffusion of green technologies and therefore directly contribute to environmental sustainability.

Along with these actions, the WTO makes a major contribution to the SDGs through underpinning and ensuring a predictable environment for trade. SDG 17 on strengthening the global partnership for sustainable development contains a commitment to promote a "universal, rules-based, open, non-discriminatory and equitable multilateral trading system" under the WTO. In this way, the WTO can ensure that the multilateral trading system contributes to building a more favourable global environment for inclusive growth and development.

Creating a stable and open multilateral trading system will require not only addressing longstanding issues in international trade, but also responding to emerging trends. Over the past twenty years, international trade has undergone major changes due to a variety of economic, political and technological factors. Undoubtedly, one main leading factor of change has been the unprecedented pace of technological innovation, which has transformed traditional ways of conducting trade.

The benefits of ICT-enabled trade

ICTs have been an important driver of economic growth, triggering a digital revolution. Advances in ICTs have led to reduced costs and increased speed and efficiency of economic transactions, with significant productivity gains for the global economy. ICTs have direct benefits on international trade – for example, customs automation and the introduction of modern customs practices such as single window, import alerts systems and prearrival processing, significantly reduce transit and clearance time and facilitate trade flows. This will play an important role in the effective implementation of the WTO Trade Facilitation Agreement (TFA), which entered into force on 22 February 2017.

More broadly, ICTs have enabled the rapid growth of ecommerce. Despite the continued slow pace of global trade growth, e-commerce has increased steadily, supported by increasingly fast and efficient technologies which help to lower barriers to trade for both businesses and consumers. Current estimates indicate that e-commerce in goods and services was worth USD 22.1 trillion in 2015, a 38% increase since 2013.

The adoption of e-commerce has helped businesses overcome some of the traditional obstacles to international trade. By reducing the trade costs associated with physical distance, e-commerce allows a larger number of businesses – including small businesses and those located in remote areas – to access the global marketplace, reach a broader network of buyers and participate in global value chains. At the same time, consumers across the world benefit from ecommerce by gaining access to a broader selection of products, from a wider range of suppliers, and at more competitive prices.

By reducing communication costs, ICTs also allow access to timely and up-to-date market information. Thanks to advances in mobile technologies, farmers can use their phones to access information on prices for their agricultural products, receive weather information to manage their crops, or make and receive payments without needing a bank account. This can contribute to the proper functioning of food commodity markets and translate into improved incomes for those living in rural areas.

E-commerce also offers new opportunities for employment. Developments in ICTs have facilitated cross-border trade in services and allowed businesses to engage in commercial activities which were previously not considered technically or financially feasible. Ecommerce is also helping women overcome some of the barriers that they traditionally face, assisting them in building their own business, expanding it or finding new employment opportunities. Moreover, with the increase of online education services, the Internet provides additional opportunities for training and skill improvement, thus favouring the development of a more skilled labour force. All of this makes e-commerce a force for inclusion and builds on the SDG principle that no-one should be left behind.

The digital divide

It is clear that the broader uptake of e-commerce, supported by ICT adoption, offers significant opportunities for inclusive growth, development and job creation. However, as these opportunities are not accessible to everyone, the benefits of digital trade continue to be unevenly distributed. While some developing countries have been making significant headway in recent years, others are struggling to access these benefits. Unequal levels of digital

development are generating a divide that risks broadening the development gap and limiting some countries' successful participation in ecommerce. Gaps exist also within countries, where those living in rural areas often lack the same access to ICT services and infrastructure that is available to those in urban centres.

Some of the major challenges to the development of e-commerce include access and affordability of ICTs, as well as connectivity issues. The SDGs themselves recognize the important role that ICTs can play for economic development. SDG 9 urges the international community to work to "significantly increase access to ICTs and strive to provide universal and affordable access to the Internet in LDCs by 2020". The presence of reliable infrastructure remains critical to creating the conditions for e-commerce to thrive, but despite the increasing availability of the Internet and widespread mobile coverage, around four billion people remain offline. Internet access costs, combined with network reliability and quality of service, continue to be a major issue in many developing countries and represent an important barrier to their ability to engage in e-commerce.

Ensuring affordable and high-quality Internet access requires efforts to promote competition and encourage investment, especially in rural areas and in those countries that need it the most. Trade policy can play an important role here. Reducing barriers to services and enhancing openness to foreign direct investment, when coupled with the appropriate regulatory regime, can help create an enabling environment that allows for competitive services markets. This is especially important for ICTs and the provision of affordable, reliable and fast Internet access. The openness of services also underlies the success of e-commerce. For example, elements such as financial services, transport, business and computer services, postal and distribution services, and other professional services, are essential.

WTO disciplines already play an important role in supporting enhanced Internet access by promoting competitiveness in telecommunication markets. As e-commerce-related services are increasingly becoming important elements of many business activities, further attention to these services, at both the national level and at the WTO, can help develop an environment conducive to the sustainable growth of ecommerce.

While it is true that ICTs support trade, it is also the case that trade in turn supports ICTs by facilitating the diffusion of technologies around the world. The WTO Information Technology Agreement (ITA) commits its participants to eliminate tariffs on a number of IT products and makes an important contribution in this regard. Its recent expansion in 2015 eliminates import tariffs on an additional 201 new-generation ICT products, including multi-component integrated circuits, touch screens, GPS (Global Positioning Service) navigation equipment, telecommunication satellites, portable interactive electronic education devices, and medical equipment. By 2019, some 95.4% of participants' import duties on these products could be fully eliminated, which should contribute to the affordability and broader dissemination of ICT products globally.

While connectivity and ICT access are necessary conditions, they are not sufficient for people to automatically benefit from the greater opportunities offered by online trade. A range of other economic and regulatory barriers can still hinder the broader uptake of ecommerce. Underdeveloped financial and online payment systems are an obvious obstacle to online transactions. At the same time, developing IT skills are important to ensure that businesses can use

ecommerce to improve and expand their activities. Other complex and sensitive issues include consumer protection, privacy, internet neutrality, and data flows. In some of these areas, the lack of clear legal and regulatory frameworks can undermine confidence in online trade and erode consumers trust.

These challenges create market barriers for the participation of new players in digital trade and push up costs for businesses. While bigger companies are often in a position to overcome most of these obstacles, smaller companies might not have sufficient resources or skills to do so, especially when trading across borders. This is why it is important to look at how new technologies can facilitate the participation of smaller players in the global economy.

An enabling environment for e-commerce through a global partnership

For the equitable and sustainable development of e-commerce, it is important that the international community strives to create an open and enabling environment for ecommerce that generates equal opportunities for economic growth and development. This will require a global approach that promotes dialogue and the open exchange of information between different stakeholders, so as to fully understand the issues, address the challenges and bridge the remaining gaps. Attempts at regulating e-commerce have more recently been made through bilateral and regional trade agreements. However, a coherent and harmonized response to e-commerce is fundamental.

Discussions are taking place at the WTO under the Work Programme on E-commerce, which could prove an important complement for better understanding these critical issues. In addition, a number of submissions tabled by WTO Members touch upon, among other things, the need for cooperation, the role of regulatory frameworks, and the importance of addressing infrastructure gaps. However, there are concerns that the digital divide and knowledge gaps between Members could limit an inclusive conversation on e-commerce issues. These concerns need to be addressed to ensure that all voices are heard and no one is left behind.

Given the complex nature of e-commerce and its social as well as economic implications, no organization alone can address all of its aspects. Any effort to effectively address ecommerce will benefit greatly from the expertise of a wide range of actors. For this reason, strengthening the global partnership for sustainable development, as per SDG 17, will be critical to adequately identify and address relevant technical, administrative and regulatory challenges. International organizations need to pool their efforts.

A lot of work is already being done in this regard and there are numerous opportunities for information exchange and coordination. One of these opportunities is the Sixth Global Review of Aid for Trade, to be held at the WTO from 11-13 July 2017. In preparing for this event, we are looking in more detail at the different circumstances in which countries find themselves with respect to ecommerce and the specific challenges that they face. The Global Review will be an opportunity for interaction between donors, recipients and providers of technical assistance on the need and availability of resources to address gaps in ICT infrastructure and connectivity.

International organisations, regional development banks and national agencies should work together to support developing countries' participation in ecommerce. The WTO is working closely with the World Bank, UNCTAD, ITC, OECD and ITU to explore areas for cooperation. In consultations with national governments and the private sector, these initiatives and many others will help foster a coherent approach to the various aspects of e-commerce.

The private sector has been especially engaged in exploring ways to reduce barriers to digital trade. In response to this increased interest, the WTO has facilitated a series of trade dialogues with business representatives. These interactions focused on how to create an enabling environment for e-commerce to allow all companies, regardless of size or location, to enjoy access to the global trading system.

Among possible actions, promoting connectivity and capacity-building are important first steps. Enhancing the quality and affordability of telecommunication services and facilitating investment in ICTs and related sectors are especially important for creating better conditions for online trade. Reducing regulatory barriers and ensuring regulatory coherence are also important to enable SMEs' participation. This can be promoted through sharing of best practices on, for example, consumer protection, privacy and data flows that have a significant impact on the ability of SMEs to market their products and gain consumer trust. Finally, at borders, some stakeholders have suggested exploring trade facilitation measures that further expedite the clearance of shipments and simplify the processing of low-value parcels, so goods sold online can be traded more efficiently.

These are just a few examples. Whatever the course of action, we must ensure that ecommerce is a force for inclusion. This means having the right policy framework in place to create an environment where equal opportunities are available to different stakeholders and where new technologies can be leveraged to empower all segments of society.

The international community has a unique opportunity to ensure that this digital revolution is truly inclusive. International trade can deliver on its development promise, if its challenges are addressed in a concerted manner and its benefits are more equitably distributed. By reducing the digital gap between countries and opening up new trade opportunities for all, worldwide access to ICTs can help make trade more inclusive and therefore make a major contribution to the WTO's efforts under the 2030 Sustainable Development Agenda to build a more universal, rules-based, open, non-discriminatory and equitable multilateral trading system that works for inclusive economic growth and sustainable development. The WTO will continue to play its part towards achieving the SDGs.

Connecting the Dots for Sustainable Development

By Mukhisa Kituyi, Secretary-General of the UN Conference on Trade and Development (UNCTAD)

With a few swipes on a smartphone or clicks on a computer, these days many of us choose and purchase a wealth of goods and services without giving technology a second thought. This is how the best technology works – so simple and easy to use that not so long ago it would have seemed like magic. But those of us concerned with improving the lives of people in developing countries know that there are systems behind this technological wizardry: policy systems that enable and reward innovation; economic systems that allow raw materials, components and finished goods to flow across borders; financial systems that secure investments and payments; regulatory and legal systems protecting workers and consumers.

As with any complex system, the digital transformation of our economies and societies requires a multiplicity of moving parts. The international community has a responsibility to promote more effective collaboration between these moving parts to avoid widening the divides between those positioned to reap the rewards of technological change and those who risk being left behind.

Recent years have witnessed a rapid growth in electronic commerce as both consumers and enterprises go online to find what they need. UNCTAD estimates that global e-commerce grew from USD 16 trillion in 2013 to USD 22 trillion in 2015, at a time when world production and trade grew only slowly. The trend is set to continue in the coming years. Digitalization will further transform what we do and how we do things. The rise of robots, automation, the emergence of completely new products, services and business models (such as Uber and Airbnb, self-driving cars, smart grids and many more) will create opportunities for entrepreneurs and businesses, as well as bringing massive consumer benefits.

At the same time, these trends will disrupt existing practices in many areas, expose incumbents to competition, change the skill requirements of workers and lead to the loss of jobs in some countries and some sectors. Like previous large-scale economic transitions, the benefits will be immense, but they will not materialize automatically through a smooth, cost-free process. The effects will differ between countries, industries and people, depending on their ability to adapt and respond to the new digital economy. This increases the need for all countries, industries and people to consider carefully which actions to take, in order to prepare as best as possible.

In the context of the 2030 Agenda for Sustainable Development, it is our common responsibility in the UN and other international organizations to provide the necessary support to those countries that are less equipped to face this transformation. As we look towards how technology can be harnessed to achieve the SDGs, the case of e-commerce provides a case in point. What does this transformative method of trade offer?

E-commerce can:

- become a driver of inclusive growth and sustainable development by empowering women as entrepreneurs and traders (Goal 5: Targets 7 and 8);
- support productive activities, create decent jobs, entrepreneurship, creativity and innovation, and encourage formalization and growth of micro-, small- and medium-sized enterprises (MSMEs) through access to ICT-enabled financial services (Goal 8: Target 3);
- help MSMEs gain access to financial services (including online and mobile payments) and their integration into markets, value chains and virtual marketplaces (Goal 9: Target 3);
- contribute to significantly increasing the exports of developing countries, in particular doubling the share of global exports by LDCs by 2020 (Goal 17: Target 11).

But the e-commerce divide is huge. While 60–80% of people in many developed countries already shop online, the equivalent share in most of the world's countries is below 3%. Current efforts are simply inadequate. They are highly fragmented and of insufficient scale. To raise a country's e-commerce readiness, a number of policy areas need to address holistically the development of affordable ICT infrastructure, logistics and trade facilitation, the legal and regulatory environment, payment solutions, skills development and entrepreneurship financing, as well as the funding of e-commerce innovation. That is why a much more concerted approach is essential.

An UNCTAD-led initiative, eTrade for All, was launched at our Ministerial Conference in Nairobi in July 2016 as a concrete example how the international community, in partnership with other stakeholders, can come together to make our support fit for purpose. This initiative raises awareness of opportunities, challenges and solutions related to e-commerce in developing countries, mobilizes financial and human resources for e-commerce projects in developing countries, and strengthens coherence and synergies among partners' activities.

The main tool is an online platform, which can help developing countries and donors navigate the technical and financial support available to foster e-commerce and digital trade, learn about trends and best practices, and to raise visibility for the various partners' initiatives and resources. The platform was launched in April 2017 during UNCTAD E-Commerce Week in Geneva, with over 20 national and international organizations had joined the initiative by February 2017. Some 25 private sector entities have also joined the Business for eTrade Development initiative, which helps public-private dialogue.

To make e-commerce a vehicle for sustainable development we need to connect the dots. There is a need to bring all relevant stakeholders together – as opposed to continuing our bad habit of working in silos – and to work simultaneously across different policy areas. It is my hope that the approach applied by *eTrade for All* can be emulated in other areas where ICTs should support the SDGs. In this way, we will respond more effectively to the desire among people in developing countries to connect to the new world of technological progress and the prosperous future they deserve.

Leveraging Digitalization for Development: A Toolbox for Enhancing Financial Inclusion

By International Monetary Fund (IMF)

Given its mandate, global membership, and role as a leading provider of economic and financial policy advice, the IMF has actively participated in the global debate on *2030 Agenda*, focusing on key issues within its mandate[42]. The IMF is undertaking initiatives to support achievement of the SDGs by boosting resilience in member countries and strengthening institutions and capacity. In addition to overall macroeconomic, fiscal and financial policy management, this includes support to fragile states and improvements in public infrastructure. This work encompasses several domains in which ICTs can play a crucial role, such as financial stability and inclusion, and domestic revenue mobilization. IT and the ensuing transformations have already begun to reveal how governments can use the 'digital toolbox' to reach the SDGs.

Harnessing Digital Financial Inclusion and Its Benefits to Support the SDGs

Financial inclusion is of particular importance to the IMF and other international financial institutions (IFIs) and other stakeholders, because it can foster high and inclusive growth and therefore sustainable economic growth. There is a broad consensus that financial inclusion – defined as the access to and use of formal financial services by individuals and SMEs – can enhance the welfare of individuals and the benefits could extend to the broader economy. It could lift many people out of poverty, reduce inequality, and encourage entrepreneurship and investment. IMF staff estimates suggest that whether a country is in the bottom or the top quartile in the access point density (one of the proxies for financial inclusion) means a 2–3 percentage point difference in average economic growth (Sahay et al, 2015[43]), thereby potentially contributing to the achievement of SDGs. Staff work also underscores that closing gender gaps, both in the use of finance and in bank leadership, can help in achieving SDGs. In recent years, financial inclusion worldwide has improved, as evident for example from the increased share of adults with an account at a financial institution or a mobile service account (estimated at 61% in 2014, up from about 50% in 2011); although this improvement masks wide variation across countries and groups (Sahay et al, 2015[44]).

The advent of new technologies—including software and digital platforms—is changing the way banks deliver financial services and creating new, efficient and cost-effective means of providing financial services. Digital financial inclusion is helping to leapfrog access to financial services at affordable prices: the costs of mobile accounts and remittances through digital channels are estimated by McKinsey Global Institute (2016) to be 80-90% lower than traditional accounts[45]. Accordingly, technology-enabled digital platforms like mobile banking, e-wallet and other technology-led business model innovations have the potential to reach more people with appropriate services at lower cost, particularly given skyrocketing smartphone adoption and mobile data use.

Recent Trends in Digital Financial Inclusion

The IMF's Financial Access Survey (FAS), launched in 2009, is a key source of data on access to financial services around the world. Recent FAS work has expanded the survey to include indicators capturing access to, and use of mobile money services (defined as sending, receiving and storing money using mobile phones). The 2015 FAS results for Bangladesh, Kenya and Mexico show interesting regional variations in the use of, and access to financial services. For example, while the growth in the number of registered mobile money accounts per 1,000 adults was the fastest in Bangladesh (increasing from 1.2 in 2011 to 78.3 in 2014), Kenya still had a much higher number of registered mobile money accounts per 1,000 adults in 2014 than Bangladesh and Mexico combined. Over the same period, Bangladesh also expanded dramatically the number of registered agent outlets per 100,000 adults from 5.3 to 386 and came close to catching up with Kenya (Financial Access Survey, IMF 2015).

Overall, Sub-Saharan Africa has been leading in the adoption and use of mobile technology to enhance financial services. There are 15 economies in Sub-Saharan Africa in which the number of mobile money accounts exceeds the number of depositors in commercial banks. Uptake has also been rapid and significant in other markets. For example, bkash in Bangladesh reached almost a quarter of the adult population in just over 2 years of operation (CGAP 2015). Due to the accessibility and affordability provided by digital financial services, millions of poor customers are moving from cash-based transactions to formal financial services, enhancing welfare and facilitating attainment of the SDGs.

Emerging Risks from Digital Financial Inclusion

The benefits notwithstanding, the use of technology in finance presents important risks that need to be mitigated. It changes not only the avenue through which individuals and firms receive financial services, but also the financial sector landscape and the risks to financial stability. First, it changes the nature of the payment system, with a fading role of banks as clearing houses, as technology provides direct contact with market participants rather than through a third party. Second, it is altering the model of lending, hitherto the preserve of banks, with the emergence of peer-to-peer lending platforms where depositors are able to lend directly to project sponsors that are looking to crowd-sourcing platforms to fund equity investments. Third, the nature of risk assessment is being changed by the presence of big data-based applications that facilitate the assessment of risks, trends and customer preferences (Narain, 2016[46]).

Overall, the new technological revolution in the delivery of financial services has brought new partnerships between banks, technology and telecom companies. The latter two are increasingly outside the regulatory realm, thus presenting risks at both the consumer and financial institutions level that need to be mitigated by new regulations. Risks for consumers include personal data breaches, potential electronic fraud, evolving consumer protection frameworks and the lack of safety nets by nonbanks and unregulated providers, which may in turn result in inequities or inequality, potentially leaving some customers worse-off.

Risks at the level of financial institutions relate to the operational risks arising from the failure of systems and processes and risks posed by third party technology and service providers, cyber-risks from inter-connected systems and the need to re-invent their business models in order to remain competitive. It is imperative that these risks be mitigated so that digital financial inclusion can contribute to drawing in the previously unbanked with better, safer products. The creation of an enabling and proportionate regulatory environment that supports safer digital inclusion is key.

Industry, Innovation & Infrastructure

ICTs for Achieving SDG 9 to Revitalize Industry, Enhance Innovation & Improve Infrastructure

By Houlin Zhao, Secretary-General, International Telecommunication Union (ITU)

All too often, it is assumed that improvements in ICT connectivity rates will automatically translate into improvements in development. In fact, as ITU has long been highlighting, this can only be the case where an enabling environment with flexible and adaptive ICT regulatory frameworks are in place, to capitalize on the benefits of the digital revolution. Indeed, ITU organizes the annual Global Symposium for Regulators (GSR) to debate new and emerging ICT regulatory issues in ICT. Real-world drivers and constraints cannot be neglected at the expense of the virtual world – we need concerted efforts to harness the power of ICTs and the online world to enrich people's lives.

Against this background, it is instructive to think about the impact of ICTs on the SDG framework, which recognizes ICTs as having 'great potential for human progress', and identifies ICTs as an important cross-cutting 'Means of Implementation'. Nowhere is this more the case than for SDG 9, 'Industry, Innovation and Infrastructure', where ICT infrastructure constitutes a goal in its own right, while driving and underpinning progress in many of the other SDGs, as this report shows. In this insight, I briefly consider the impact and transformative power of ICTs, digitalization, including the data revolution for 1) Industry, (2) Innovation and (3) Infrastructure. I believe that ICTs, just like many other technologies and tools, are neither 'good' nor 'bad' – their outcome and impact depend on the purpose for which they are used.

1. Industry

At **the macro-economic level**, the issues surrounding the digitalization of industry are complex. During the economic slowdown of 2007-2008, many Governments turned to tech-enabled start-ups and ICT-enabled media companies as a growing, but strategically important economic sector. Various estimates pointed to a substantial contribution by the ICT sector to:

- **Gross Domestic Product (GDP):** e.g. in 2012, BCG estimated that "the Internet accounted for 4.1% of GDP in G20 countries", forecast to grow to 5.3% of GDP by 2016;

- **Economic growth:** e.g. in 2009, World Bank estimated that +1.38% increase in GDP for 10% increase in broadband penetration;

- **Labour productivity:** e.g., Booz & Company, 2009 found that a 10% increase in broadband penetration in any year is correlated with a 1.5% increase in labour productivity over the following five years (although this argument has been hotly debated, in the US in particular).

- **Job creation:** e.g. McKinsey Global Institute (2011) study found that 2.4 jobs are created through Internet industry for every job lost.

However, subsequently, age-old concerns have resurfaced about the role of new technologies in replacing, rather than assisting, labour and this last point in particular about job creation is now hotly contested. McKinsey (2017) has just published a report analyzing over 2,000 work activities across 800 occupations, concluding that automation could raise productivity growth globally by 0.8-1.4% annually. The report estimates that almost half the activities people are paid almost USD 16 trillion in wages to do in the global economy have the potential to be automated. McKinsey projects that less than 5% of all occupations can be automated entirely, while about 60% of all occupations have at least a third of constituent activities which could be automated. In the United States, these activities make up just over half (51%) of activities in the economy, accounting for almost USD 2.7 trillion in wages, mainly in manufacturing, accommodation and food service, and retail trade.

At the individual level, the workforce can take advantage of ICTs and online opportunities to upgrade their skills, either individually or as groups. There is an explosion of new learning opportunities online for staff and youth to gain new skills or different skills and/or job opportunities – via online training, remote learning, LinkedIn etc. There is evidence that jobs with greater digital skills tend to be better paid (EU report). But once again, here, a change in mindset is needed. The sought after, but rare, "jobs for life" must now be seen as my "job for this year or next", subject to employees reskilling in the changing technologies needed to compete – both within the workforce and the marketplace. Greater investments are clearly required to equip, train and retrain workers with tomorrow's digital skills.

New technologies (and ICT innovations specifically) can have huge disruptive effects, both positive and negative, in generating new creative and economic solutions and sectors, displacing and transferring revenues and assets. Mobile money and its impact on bringing financial inclusion to millions in the developing world is one case in point – mobile money is bringing millions of people into the formal economy, while enabling large transfers of remittances & assets between countries for migrant labour. **ITU's Focus Group on Digital Financial Services** has published some 30 reports and 80 recommendations on what makes digital financial services work in some countries but not in others

For many developed economies, ICTs may perhaps have the greatest impact of ICTs structurally, at the **macro-economic level**, depending on the structure of the economy in question. One traditional view of economic development sees it as a chain encompassing:

Natural resources & primary industries -> expansion of secondary manufacturing -> growth of tertiary services

This view may now be blown apart by the ICT sector, with countries (and firms) now engaging in 'de-industrialization' and leapfrogging to engage in tertiary or Internet services, without having fully industrialized. Such leapfrogging is part of the opportunity of ICTs, but concerns persist about the depth and quality of this industrialization. Structural leapfrogging clearly has to be managed astutely, to maximize the opportunities it offers to increase economic growth and social inclusion in agrarian economies, while reducing the negative environmental impact of industrial development.

Meanwhile, at **the micro-economic level**, it is unclear that many firms are using ICTs in an optimal way. For example, according to the World Bank, many firms in Europe and Central Asia have only just acquired web presence, and are not making use of ICTs for more sophisticated purposes which could potentially improve productivity (e.g. automating their supply chain, engaging in online procurement, ERP processing, accounting etc.). There is an inevitable learning curve association with the take-up and absorption of new technologies (ICTs and other technologies, including R&D activity).

To participate fully in the digital economy, firms need to master a range of different skills extending far beyond web presence and online sales and procurement. The most important factor of all may be an open, agile mindset and willingness to embrace change in a fast-moving economy – it is this open mindset which has seen a book provider become a major cloud services provider, a social media network become a major news outlet/distributor, and a search engine engage in everything from satellite imagery to translation services to self-driving cars.

Furthermore, even where firms are making use of the Internet to research and buy goods abroad, they must also be able to sell their produce to new and larger markets abroad to expand a country's footprint abroad and improve its balance of payments. E-commerce can help economies open up to new markets abroad and the opportunities of the online economy, but some commentators have suggested it may also leave economies with shallow, or incomplete industrialization vulnerable to a flood of imports from abroad. Indeed, **the role of consumers in driving the supply chain** has also yet to be clearly understood in many countries. If consumers and the growing middle class go online to purchase goods from abroad in a number of countries, the overall net effect may be of a slow loss of purchasing power abroad. In this sense, the development of Ali Baba in China and Flipkart in India represent significant steps in enabling domestic firms to sell to domestic consumers.

2. Innovation

The positive contribution of ICTs to innovation is somewhat clearer. The invention of the Internet and worldwide web were themselves fascinating technological breakthroughs. Today, Internet and ICTs are enabling and underpinning an explosion in research, scientific collaboration and innovation. Some of this is through exciting formal developments such as massive or distributed computing, tech start-ups to solve new problems, Big Data or the sharing of data, but no less important is the contribution of individual efforts to solve everyday problems or crowd-sourced efforts to find solutions – the ability of the Internet to connect individuals and to connect researchers.

To take the most obvious example, one of the main benefits of the Internet and ICT connectivity is to put researchers in touch. These connections and connectivity can exist on several levels. National Research and Education Networks (NRENs) have established high-capacity backbone networks in many countries, enabling academic collaboration and testing high-speed networking technologies. ITU data show that in 2010, 120 countries had established a NREN[47]. By 2017, this number stands at minimum 128 countries with a functional NREN, while a further ten research networks operate at the regional level (e.g. the Asia-Pacific Advanced Network APAN, the GÉANT backbone network in Europe and the West and Central African Research and Education Network, WACREN).

Further, such connectivity means that scientific and university researchers can collaborate remotely on collaborative projects, experiments or crowdsourced computing (e.g. the famous search for Extra-Terrestrial Intelligence, the SETI project). Researchers from a range of professions can access scientific articles, open data, technical journals and formal databases. For example, ESR Journal provides resources, support and advice for early-stage researchers as well as more advance researchers for publishing their scientific papers, while offering free access to scientific research under creative commons licenses.

Innovation is leading to economic acceleration. Among the current top ten Fortune companies (US companies classed by annual revenues), two are technology players – Apple, established in 1976 and the operator AT&T. In February 2017, based on total market capitalization, the top three of the top ten companies listed on the New York Stock Exchange by market cap were all tech companies, which accounted for half the top ten companies. The major impact of ICTs and the Internet may be to facilitate individual innovations in any number of goods and services, and to give wings and full flight to the strength of an idea. Steve Jobs' original idea of doing away with a QWERTY keyboard to give us the touchscreen tablet helped create the biggest company on the New York Stock Exchange with a huge market capitalization, while advances in IT, intelligent automation and AI are now even doing away with car drivers and helping create self-driving cars.

3. Infrastructure

ICTs are today critical infrastructure in their own right. The roll-out of national broadband infrastructure has become a priority policy goal for many nations. According to ITU's most recent data, 151 countries had introduced a National Broadband Plan (NBP), with a further seven countries planning to develop one. ITU estimates that 2G networks cover 95% of the world's population, with 84% living in coverage of 3G networks. 4G networks are being launched in many countries, with some 160 countries having introduced 4G or upgraded their networks by mid-2016[48]. (Conversely, we are seeing the first decommissioning of 2G networks by AT&T in the US, with Verizon Wireless set to follow). At the city level, smart technologies, digitalization and data are drivers of smart urban development and smart sustainable cities.

'Equal' or 'fair' coverage of networks is more problematic, however, with the urban/rural digital divide remaining a key digital divide in many countries. For example, for 2016, it is estimated that mobile-broadband networks (3G or above) reach 84% of the global population, but only 67% of the rural population. By and large, 4G networks are layering in on top of existing 3G connectivity in higher income, urban centres, while universal service in more remote, rural areas remains problematic. This may be problematic for the SDGs, as the highest incidences of poverty, hunger and inadequate health coverage are often found in the more remote and rural areas. Therefore, it is important to encourage demand driven private/public partnerships and economic and marketing strategies targeted at rural consumers in order to mitigate persistent access divides. Fresh investment models are needed to unlock the power of ICT connectivity that fuels growth in today's digital economy. Without more innovative PPPs and leadership, we will miss our opportunity to fast-forward progress on the SDGs.

Meanwhile, far from narrowing, the digital gender divide is in fact growing. ITU records that the digital gender divide in fact grew from 11% in 2013 to 12% in 2016, reflecting the fact that more men are coming online earlier, and more rapidly, than women, equivalent to a gap of about 200 million fewer women online globally[49]. A global difference of 1% may sound small, but it is the trend that the digital gender divide is headed in the wrong direction, which is significant, and alarming. This translates into millions of lost opportunities for individual women and girls, who will struggle to gain the skills and digital literacy needed to survive in the digital economy.

Critical information infrastructure also creates new risks and vulnerabilities, however, with cyberspace becoming a new battlefield and a new recruiting ground for conflicts around the world, political or ideological. Cyber-attacks now becoming critical in terms of how countries could now target other countries' critical infrastructure (or even 'critical processes') first and foremost – either by outright attack or by harder-to-detect meddling in vital processes, hacking or media manipulation. Notable instances of cyber-attack include alleged attacks on Estonia and Georgia, but targets are varied and may also include businesses and commercial interests, such as the 2014 Sony Pictures hack. The importance of cybersecurity and need to prevent cyber-attack even led to a recent call by Microsoft for a "Digital Geneva Convention" to help protect civilians[50].

In summary, ICTs are transforming industries, enhancing innovation and improving infrastructure, at an ever-accelerating pace. Capitalizing on the opportunities offered by these new technologies, while safeguarding against some of the downsides, needs us to be vigilant and attentive, and to continue to monitor – and debate – the far-reaching changes ICTs are inducing in our society. ITU stands ready to assist in monitoring and debating the impact of emerging technologies for the benefit of all, as part of its mission to connect the world.

The Contribution of ICTs to Socio-Economic Change & Industrial Development

By Yong Li, Director-General, United Nations Industrial Development Organization (UNIDO)

Innovation, as a critical driver of economic growth and development[51], is crucial for economies to develop, maintain and create new wealth in inclusive and sustainable ways[52]. This is reflected in the SDGs, in particular in SDG 9 – 'to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation' – which is in line with UNIDO's mandate to promote and accelerate 'Inclusive and Sustainable Industrial Development (ISID)'. Fostering ISID, and investing in scientific research and innovation, are crucial for realizing SDG 9 and other industry-related goals.

To achieve the targets of SDG 9, it needs to be understood that innovation happens on a sustained basis only if it is managed systematically. This applies to both the private and the public sector. To this end, it is vital to have an effective and efficient system of innovation, including at national and regional levels. This in turn will enable a country to become innovative, productive and internationally competitive[53]. This requires broader thinking about drivers of economic and industrial development, with greater emphasis on knowledge, new technologies, and especially ICTs as a conduit for knowledge flow[54], storage and communication and their convergence with other technologies and applications in new business models, and less on traditional factors of production, such as physical capital and labour. This in effect leads us to a richer model of development[55].

As a result, "knowledge is now recognized as the driver of productivity and economic growth, and there is a new focus on the role of information, technology and learning in economic performance"[56]. Access to knowledge empowers people and may help to reduce inequality, for instance by reducing the digital divide[57]. In particular, "the Internet, especially, has become a critical enabler of social and economic change, transforming how government, business and citizens interact and offering new ways of addressing development challenges"[58]. And this is true for industrial development as well.

At the end of 2016, close to one out of two people (47%) in the world was using the Internet, but only one out of seven people in LDCs. However, in developing countries, the number of mobile broadband subscriptions continues to grow at double-digit rates, reaching close to 41%[59]. This is a major achievement and the Internet provides a potentially unique platform for innovation, creativity, economic opportunity and social inclusion, which can make a major contribution to achieving SDG 9. Bridging the digital divide is crucial to ensure access to information and knowledge to all, as well as to foster innovation and entrepreneurship. The following areas require greater focus:

a) Integrating the information society and sustainable development, with a better understanding of the potential of ICTs for inclusive and sustainable industrial and economic development, and removing the barrier of ICT uptake in specific development contexts.

b) Identifying synergies between the SDGs and WSIS Action Plans and developing practical proposals for implementation.

c) Better monitoring and measurement of progress through the facilitation of data gathering, and analysis of indicators for specific targets related to the SDGs and other industry-related SDGs.

d) Leveraging big data analytics to facilitate evidence-based policy-making and better understand the specificities of different development contexts. The issue of "big data analysis also raises challenges concerning data privacy and security, while governments and other stakeholders will need to build capacity and resources to maximize its value" (ITU, 2016).

e) Enabling more effective collaboration between development stakeholders on new ways to manage programmes using ICTs.

These areas are all the more important particularly with the advent of Industry 4.0, marking the Fourth Industrial Revolution. Increasingly, companies are applying innovative solutions, including through the IoT, cloud computing, miniaturization and 3D printing, which will enable more interoperability and flexible industrial processes and autonomous and intelligent manufacturing. The physical components of industrial production are being transformed by smart, digital networking into cyber-physical systems, allowing for the management of production processes in real-time across great distances and customized products.

Industry 4.0 has the potential to improve productivity and competitiveness, increase energy and resource efficiency and effectiveness and hence protect the environment. It could further enable the transition to a circular economy, or industrial economy in which end-of-life products are reused, remanufactured and recycled. Taken together, these developments would lead to the emergence of more sustainable production and consumption patterns, and thus could provide opportunities for developed and developing countries to achieve economic growth and sustainable development in line with the 2030 Agenda for Sustainable Development. ICTs have a very clear and important role here –without ICTs, it will be difficult for developing countries to technologically advance their manufacturing production to higher levels of technological sophistication.

The consequences of Industry 4.0 on job creation, income and wealth creation and distribution are not fully understood, and one of the biggest concerns is the impact of Industry 4.0 on jobs in developing countries. Increasing automation of production processes, made possible by ICTs, may cause the displacement of workers by machines and is likely to eliminate routine types of jobs and increase inequality. A global net decrease in jobs could be especially challenging for developing countries where, unlike developed economies, millions of young people are entering the job market every year. However, developing countries are still lagging behind in terms of ICT penetration, buying them time to figure out how job loss may be compensated or combatted.

More than ever, developing countries and economies in transition must be made aware of the implications and challenges of this paradigm shift. For example, apart from dealing with implementation of Industry 4.0, developing countries must prepare to face the consequences of its implementation in advanced economies. Some of these consequences relate to reversed flows of foreign direct investment (FDI) and already widening technology gaps. While the ramifications for developing countries and economies in transition could turn out to be dire, economic history tells us that economies have remarkable adaptive abilities to deal with broader technological evolution and the mechanization of production. As such, the arrival of Industry 4.0 also brings opportunities for development, for example in terms of achieving the objectives set forth in the recently adopted SDGs.

Importantly, within the group of developing countries there is great heterogeneity in terms of their ability to handle the advent of Industry 4.0. Indeed, the World Economic Forum recently argued that some more advanced developing countries could leapfrog into Industry 4.0, and that its impact could be far-reaching for possibly attaining – within a generation – inclusive and sustainable industrial development.

To adapt and respond to this inevitable change, it becomes all the more important to recognize that data, content and knowledge are global public goods[60] and collective actions of the international community are needed to correct for their provision to the socially desirable level. Once again, this clearly underscores the role of international organizations, including UNIDO. To address these challenges, UNIDO is closely partnering with other development organizations, including many of the IOs represented in this report. Partnerships are a fruitful way forward to make the best and most productive use of ICTs for ISID, and to ensure that everyone benefits equally from the opportunities brought about by ever-sophisticated advances in ICTs and their application in modern manufacturing.

A 'System of Systems' Approach to Resilient Infrastructure

By Grete Faremo, Under Secretary-General & Executive Director of UNOPS

The year 2008 was a landmark year in human population. For the first time in history, the population living in rural areas equalled the population living in urban areas. The world's population is becoming increasingly urban. According to the *2014 Revision of World Urbanization Prospects* produced by the Population Division of UN-DESA, 54% of the world's population now lives in urban areas, a proportion that is expected to increase to 66% by 2050[61].

The world's urban population is expected to surpass six billion by 2045. Much of the expected urban growth will take place in countries of the developing regions, particularly Asia and Africa. As a result, these countries face numerous challenges in meeting the needs of their growing urban populations, including for housing, infrastructure, transportation, energy and employment, as well as for basic services (such as water, electricity, drainage, and waste management).

The growing urban population, and especially, the sharp growth in the number of people living in high density urban areas, means that more and more people now live in an environment of densely packed, built-up structures. Sustainability and resilience in physical infrastructure are now critical. Resilient infrastructure can save lives, prevent economic loss, and instill a sense of security within the growing communities around the world who live in urban areas. Sustainability requires ensuring the robustness of infrastructure to perform in the future and in response to the challenges it will face.

Evidence-Based Infrastructure Development

The Evidence-Based Infrastructure Development Framework (EBIDF)[62] was created by UNOPS and the UK Infrastructure Transitions Research Consortium (ITRC)[63] to help governments achieve infrastructure systems that will be robust or 'resilient' in the face of future uncertainty, while continuing to serve the socio-economic demands of a growing population. The framework enables a holistic, 'system of systems' approach to address the core issues with building sustainable resilient infrastructure.

The EBIDF is the concept of interdependencies between the systems of infrastructure in which the assets of infrastructure exist – between institutions that develop, regulate, and maintain the infrastructure, as well as between policy instruments that govern infrastructure systems. The framework requires that infrastructure development is seen from a holistic perspective in terms of these interdependencies and that planning horizons are longer term, accounting for the full lifespan of the system and of the individual assets.

It is easy to see how IT can be used to operationalize EBIDF. IT has always been used for collecting and analyzing data and to relate different datasets. Relational databases that enable us to structure and analyze data have been part of mainstream product offerings since the mid to late 1970s. Spatial databases to represent objects defined in geometric space are common today, as are geospatial systems that enable us to work with detailed geographical information. IT offers the tools to transform frameworks like EBIDF into implementable constructs in the real world.

Level 0: Gathering the evidence

We start with level zero, the baseline. While it may seem obvious, the availability of quality data is an essential first step for the implementation of any methodology that relies on facts. For analyzing and predicting the 'system of systems', detailed data is required on current and planned national infrastructure assets, information on the performance and capacity, supply and demand placed on the assets, information on related institutions, as well as any additional data on context.

While level zero may seem obvious, governments around the world struggle to collect and store the data required for any analysis in a systematic manner. This is especially true for post-conflict as well as developing nations. Digitization of information on national infrastructure needs to be a key focus for funding activities. Without this first step, precious development dollars will continue to be spent without an analysis of the impact on related infrastructure assets and on the system as a whole.

Data quality

It is of paramount importance to ensure the validity and quality of data collected and to ensure that the data is kept up to date. A variety of established statistical models and other techniques as well as tools are available that use rule-based approaches, indicators, random sampling, or statistical outlier detection to aid with maintaining high quality data. Tools like OpenRefine[64] can also be used to clean-up data to some extent although there is no substitute for collection of high-quality data to begin with.

As with any digitization effort, the security of information assets needs to be carefully thought about from the very beginning. It's easy to adopt an 'all or nothing' approach to information security. Entirely protected and sealed off means that the information is unlikely to be discovered by people that need it and therefore unlikely to be put to any good use. Entirely open could mean exposure to vulnerabilities, and in this case, infrastructure vulnerabilities, which could have severe implications on national security. Carefully constructed information architecture with information security built in as an inherent component is essential.

Level 1: Understanding the evidence

While level zero may be the first step from an ICT perspective, understanding the evidence is the bedrock that can support all the other value-added functions and services that the application of ICTs can provide in this context. Making data available to relevant stakeholders creates opportunities for coordination and holistic planning processes but to truly understand and leverage the data, modelling methodologies and tools can be used.

Computational modelling

While ICT implementations very often focus only on dealing with things like networks, servers, system and application software, etc., ICTs are as much about the mathematical basis that underpins the technologies and tools that are created for widespread use. Computational modelling is the use of computers to simulate and study the behaviour of complex systems using mathematics, physics and computer science[65]. Data on national infrastructure can be leveraged to build computational models for a deeper understanding of the properties of the system as a whole and the effects of factors such as demand and supply, demographic changes, and climate change.

Modelling can expedite analysis by conducting thousands of simulated 'experiments' that would otherwise either be prohibitive in terms of time and cost, or not be feasible to conduct at all. Several tools exist to create and work with computational models. Proprietary tools like MATLAB[66] as well as free tools like Scilab[67] are used by hundreds of thousands of researchers, academics and engineers around the world to build complex computational models to design everything ranging from space crafts to smart power grids. Computational models can also be built using almost any programming languages although declarative programming paradigms such as those offered by languages like Modelica[68] are typically best suited for this.

The UK's Infrastructure Transitions Research Consortium (ITRC) has created the National Infrastructure Systems MODel (NISMOD)[69] as UK's first national infrastructure system-of-systems modelling platform and database and plans to release the platform to academia and industry by 2020. NISMOD consists of four models, focusing on different aspects such as: long-term performance, risks and vulnerability, regional development, and demand and performance. In collaboration with UNOPS, ITRC is also developing NISMOD-INT[70], a generic framework for international applications of NISMOD which provide a series of open-source analysis tools for the application of evidence-based decision-making in a range of international settings. NISMOD-INT will give countries the capacity to develop and assess alternative infrastructure transition strategies for meeting the SDGs.

NISMOD-INT uses techniques such as spatial aggregation on combined datasets from various sources, as well as data on supply and demand, geospatial information, and historical as well as prediction data on climate changes. Models such as this can enable planners, designers, and decision-makers with the information needed to assess vulnerabilities in infrastructure systems and make decisions based on likely scenarios and create high resilience infrastructure as well as plan for swift repair and recovery.

Machine Learning

Machine learning (ML) is becoming one of the most frequently used buzz word these days, and rightly so, as machine learning applications have tremendous potential in many spheres. In fact, all of our lives have already been touched by machine learning in one way or another and the future will bring many more applications into our daily lives. Recommendations for products from websites like Amazon and Netflix, sentiment analysis of social media embedded into several products, and Google and Tesla's self-driving cars, are just a few examples of machine learning algorithms at play.

ML is a method of data analysis that automates analytical model building. Using algorithms that iteratively learn from data, machine learning allows computers to find hidden insights without being explicitly programmed where to look[71]. Unlike data mining, ML has the ability to use computers to probe the data for structure, even if we do not have a theory of what the structure could look like.

ML algorithms can be used to build models that can learn from the data to help us achieve a variety of objectives. Whether these are simple algorithms using Bayesian analysis or complex neural networks or deep learning algorithms, ML applications have demonstrated success at recognizing patterns, recognizing anomalies, and in prediction. Available datasets can be used to seed ML models for categorization or clustering to identify different characteristics of infrastructure assets for analysis. Supervised learning can be used to supplement historical data with human intervention when the confidence in predictions is low. This can accelerate review processes and enable scarce expert resources to focus on outliers rather than entire datasets.

Pattern recognition algorithms can be used for predictive fault diagnostics of complex infrastructure assets. Image recognition algorithms can be used to analyze images from aerial surveys for a large scale assessment of damage after a natural event and although this not provide information on the operability or performance for all forms of infrastructure, it can form a useful basis for on-the-ground mission planning activities. The computational models we build can help us deepen our understanding infrastructure systems. ML models can expose patterns we may not have spotted, by enabling and automating early warning alerts, and by helping us improve our own mental and computational models.

While computational modelling and the application of AI constructs such as ML are powerful tools for building theory, we need to remember that all such models are a result of experts operationalizing their own cognitive models into specific terms required for the models. This requires experts to make a series of reasonable assumptions to fill unanticipated 'specificity gaps'. Using such models or even the best AI algorithms should therefore always be tempered with human understanding and knowledge. Computational models and AI are just tools and at this time, not a replacement for human cognition and certainly not for human intuition[72] – yet…

Level 2: Using the evidence

While technology can enable us to gather and understand the evidence, it is only useful if we are able to take timely action based on it. Information and the insights provided to us by computational models or ML models can help us plan the development of national infrastructure better, as well as enable us to make plans to prevent disasters during natural or man-made crisis events. Besides this, several technologies, tools, and products exist to enable the conversion of raw data or data from models into actionable information for use in regular maintenance and repair, as well as during times of crisis.

Integrated Command and Control Systems

National infrastructure consists of a host of infrastructure assets for everything ranging from communication, transportation, and utilities to food, water, and housing. EBIDF requires that all of these assets as well as the relevant institutions are thought about as a 'system of systems'. Integrated command and control systems can be used to implement this thinking on an operational level.

Integrated command and control systems integrate information on all infrastructure assets, or at least critical infrastructure assets, including interdependencies between them, with a mechanism for managing, reporting and alerting relevant national or private institutions responsible for the management of the assets. Systems like these are in use in some form within most developed nations for daily operations and especially during crisis situations. Besides building sustainable and resilient infrastructure through better planning and design based on the understanding derived from computational and ML models, the implementation of systems like these within developing nations can help prevent natural events from turning into disasters.

Building Information Models

While computational models can help us understand and use data at the macro-level, building information models (BIM) enables us to manage individual assets or sets of assets more comprehensively. BIM systems contain detailed information on all the systems and sub-systems within the specific infrastructure asset, as well as asset tracking, maintenance and management information. It is normal for most developed countries to require contractors to provide a complete set of BIM data for any infrastructure built using public funds. BIM data and systems are, however, largely missing for most infrastructure work done in developing countries, including infrastructure built using international aid funds. The availability of BIM data and introducing BIM systems into national institutions managing public infrastructure will enable the timely maintenance of infrastructure assets, an essential component of sustainable infrastructure.

Level 3: Touch the real world

While the collection and integration of structured data on infrastructure assets and other related datasets including supply and demand, geographical information, and climate information can help us build computational and machine learning models to understand, plan, design, and manage infrastructure systems, interfacing and receiving information in real-time from within the assets can further improve performance. Instrumentation is not technologically new and sensors have been in use since the late 1800s. Sensors can detect the physical qualities of objects and convert this information into a signal that can be read by instruments which may either take specific actions or communicate the results to a human operator.

The IoT has been defined by the IoT Global Standards Initiative as a global infrastructure for the information society, enabling advanced services by interconnecting physical and virtual things based on existing and evolving interoperable information and communication technologies[73]. The IoT enables us to monitor the condition of infrastructure assets and relay that information via the Internet. Capabilities such as these can provide integrated command and control systems much needed real-time information to enable rapid response that may help prevent disasters or conduct fault diagnostics.

There is a high degree of innovation taking place in all areas of IoT. As an example, The Things Network (TTN)[74] is an initiative to create a low-power, low-bandwidth network of gateways and sensors to communicate with the Internet using unlicensed radio spectrum. This could help address the needs of developing countries, where 3G/4G or wireless Internet is not feasible. TTN has already provided coverage throughout the City of Amsterdam as a proof of concept for the approach[75] and UNOPS is currently exploring projects where this technology can be put to use. The IoT can enable us to manage and monitor our infrastructure systems in real-time, helping us built resilience by averting disasters and enhancing preparedness.

Conclusions

One of the key objectives of SDG 9 is to build resilient infrastructure. The EBID Framework is designed to address the challenges of resilience and sustainability to ensure that infrastructure is robust in the face of current and future challenges. The framework proposes that resilience can be achieved through the understanding of the 'system of systems' comprising of interdependent infrastructure assets and the interdependent institutions and policies that govern the development and maintenance of these assets. The implementation of EBIDF together with the application of ICTs can help us understand, monitor, plan and prepare for resilience as well as respond during times of crisis to save lives and minimize economic loss.

Reduced Inequalities

Internet and Mobile Connectivity for Refugees – Leaving No One Behind

By Filippo Grandi, UN High Commissioner for Refugees, Office of the UN High Commissioner (UNHCR)

The number of people compelled to flee their homes by conflict and persecution currently stands at 65.3 million – a level unmatched in decades. The vast majority are displaced in their own countries, or hosted in frontline countries within their own regions, often for many years on end. The refugee experience is in essence one of exclusion and disconnection. Uprooted from their homes, separated from family members, dislocated from their communities, and without the protection of their governments, they are effectively cast adrift.

Securing protection and solutions for refugees is fundamentally about fostering – and eventually restoring – relationships, by connecting refugees to communities, services and opportunities in the countries that receive them, and by cultivating an environment in which their rights are protected, and that allows them to flourish and rebuild a vision of a future. This means promoting their inclusion in national education and health systems, freedom of movement, access to livelihoods, and participation in local economies – laying the ground for the time when they are able to return home or to establish themselves permanently in another country. The inclusion of refugees, the internally displaced, and the communities hosting them in development frameworks is a central element of this approach, and intersects with the 2030 Agenda's commitment to 'leave no one behind'.

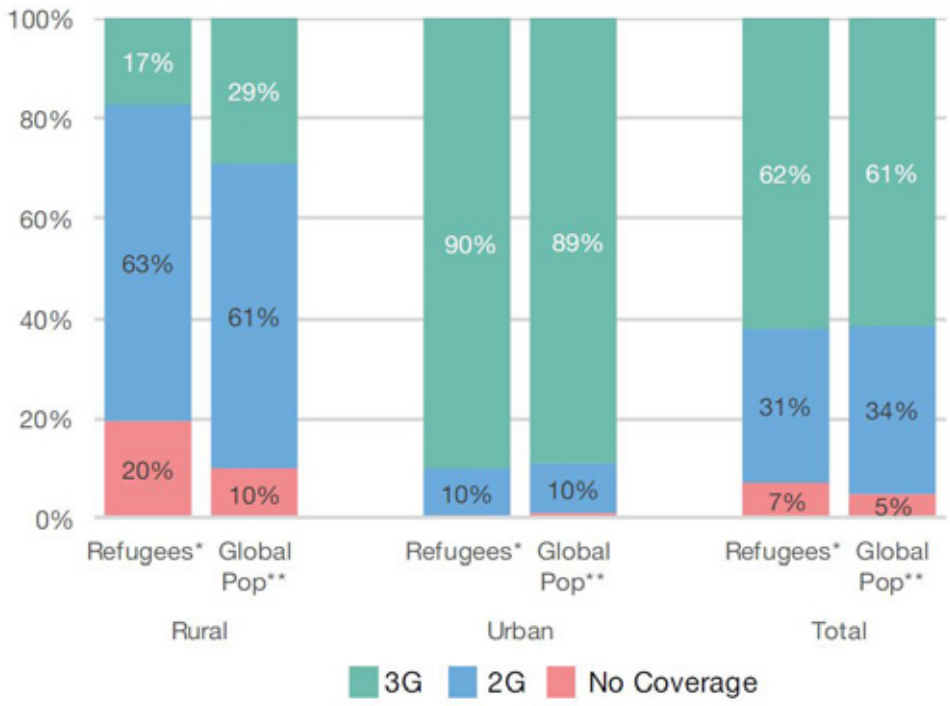
Internet and mobile connectivity are increasingly central to this process, and for many refugees, they have a similar level of importance as basic needs such as water, food and energy. Recent research carried out in 2016 by UNHCR and our partner, Accenture, revealed that refugees see connectivity as a critical survival tool, often prioritizing it over items such as education, clothing and healthcare[76]. For many, it is a lifeline through which they can inform themselves about their new environment, access services and support (including cash transfers, digital education, and job opportunities) and become connected to the national and global communities around them. Connectivity also provides a platform for innovative, better-targeted programming by governments and organizations helping refugees, and helps facilitate two-way communication, including with people in insecure locations where access by humanitarian agencies may be limited.

At a very immediate level, connectivity allows refugees and the internally displaced to contact family members, to let them know they are safe, and to stay in touch with the situation back home. I saw this very vividly when I talked to Syrian refugees disembarking from boats in Greece last year, for whom their first concern was how to get online. After travelling thousands of miles, dealing with smugglers and risking their lives on the sea, the main thing on their mind was getting online and letting their family and friends know that they had survived their perilous voyage – this is no small thing.

Despite the fact that connectivity is critical to enabling refugees to overcome the dislocation and exclusion that characterize in their experience, for now the digital revolution is leaving them behind. Refugees are 50% less likely than the general population to have an Internet-enabled phone, and 29% of refugee households have no phone at all. In rural areas, around 20% of refugees live in areas with no connectivity (Figure 3), and language and digital literacy levels are also a barrier for many.

Mobile phone ownership is considerably higher in urban areas, where the majority of refugees live and where 68% of refugee households have an Internet-capable mobile phone. In rural locations, the figure stands at just 22%. Globally, the proportion of people with mobile connectivity continues to increase, and the GSM Association predicts that, by 2020, there will potentially be nearly one billion more new mobile subscribers compared with 2016. But for people fleeing across borders as refugees, the challenge is not only providing an immediate connection, but ensuring that this is transformed into affordable, reliable, sustainable connectivity.

Figure 3: Refugees versus Global Population – Mobile Network Coverage



Source: «Connectivity for Refugees » report, available at: www.unhcr.org/connectivity-for-refugees.html

UNHCR has been working with a number of private sector partners to support transformative connectivity initiatives, and now has a Global Strategy for Connectivity for Refugees. Central to this strategy is the understanding that connectivity cannot be pursued through classic humanitarian approaches, but requires the engagement of a broader range of actors from the outset of an emergency – in particular, the private sector and government regulatory bodies – and must be informed by solid data and market analysis.

Since early July 2016, the world's fastest-growing refugee crisis has unfolded in northern Uganda, where more than half a million refugees have fled a new wave of brutal conflict in South Sudan, now compounded by famine. Despite significant challenges, the Government of Uganda has continued its generous long-standing policy of allocating plots of land for shelter and farming to the refugees, in four new sites in the West Nile region, and giving refugees access to the same education and health services as Ugandans. The largest of the new sites, Bidi-Bidi, was established in August 2016 and is now home to 270,000 people.

The West Nile region has very limited infrastructure, including roads and electricity, and when Bidi-Bidi was established last year, the mobile network coverage across the vast settlement area was a patchy 2G signal at best. UNHCR's Innovation Service has worked closely with three mobile operators to build the business case for expanded coverage, with the result that 3G connectivity has been achieved in large areas of Bidi-Bidi in a matter of months, with speeds fast enough for video calling. With at least 150,000 refugees now in areas with coverage, this is an excellent example of how sustainable connectivity can be fostered by looking at the opportunities presented by the presence of refugees, and the new markets that can be built up by and around them. Competitive pricing plans, mobile money services and free SIM cards have helped fuel the rapid expansion in access.

However, it is not only mobile operators and other private sector tech companies that support building a sustainable connectivity ecosystem. Connecting refugees is not only a matter of bringing in infrastructure, but also ensuring appropriate policy and regulatory frameworks. It also means overcoming barriers related to affordability, language and digital literacy. This may be less exciting that some of the latest 4G technology, but no less important.

Telecom regulators and other government agencies can create crucial incentives for technology service providers to expand their infrastructure and coverage, as well as electricity coverage. They can also play a key role in facilitating access to SIM cards and connectivity plans for refugees – for example, by reducing regulatory barriers linked to proof of identity (refugees may be unable to satisfy requirements for presentation of national identity cards or other forms of formal identification). They can encourage pricing segmentation practices to help people on low incomes access connectivity. Through cooperation between UNHCR, mobile operators and telecom regulators, and at an international level, the ITU, a legislative and policy environment can be established that facilitates better connectivity for both refugees and the communities hosting them.

The 2030 Agenda promises to 'leave no one behind' and builds on the principles of universality, equality and human rights for all. Reliable mobile and Internet connectivity is critical to ensuring that refugees are able to access the economic and social benefits brought by the digital revolution, and to building broader connections between refugees and the communities and societies hosting them, as well as in their own countries. Through these connections, refugees are better protected, are able to become agents of their own development and that of the communities hosting them, and have the prospect of dignity and self-reliance. Ensuring access to affordable and usable mobile Internet connectivity is both achievable, and potentially transformative, and the private sector and national and international regulatory authorities can play a powerful role in making this happen.

Meeting the Migration Aspects of SDG 10: Facilitating Orderly, Safe, Regular and Responsible Migration and Mobility of People

By H.E. Ambassador William Lacy Swing, Director-General of the International Organization for Migration (IOM)

The growth and impact of ICTs is staggering. According to World Bank and ITU (2016), there were more than 7.3 billion mobile-cellular subscriptions worldwide, and some 3.5 billion people were using the Internet, most of them in developing countries[77]. ICTs influence many aspects of our societies and daily lives, promoting innovation and new economic opportunities, and enabling better access to basic services such as health and education. It is perhaps unsurprising then that ICTs also feature prominently in the world of human mobility.

"Distance-shrinking technologies" are one of the important drivers of international migration. And, in turn, migration provides the impetus for even greater connectivity. As migrants lead increasingly globalized lives – with friends, family and co-workers often straddling multiple geographic locations – staying connected to one another over vast distances has become a pressing necessity. ICTs provide the answer. Put another way, ICTs are now inseparable from migration and migrants.

The closeness of this relationship can be put to good use. ICTs can assist governments with the movement of people across borders, balancing security and other policy interests with the needs and rights of individual migrants. Beyond that, ICTs have the potential: to enhance the migration experience; to help promote safer, legal forms of migration; and to enhance the benefits that migration offers to migrants and the societies they move between.

The SDGs clearly recognize the positive contributions of migrants to inclusive growth and sustainable development. They challenge us to harness those benefits to useful ends, but equally to manage migration in a way that protects migrants and supports the societies in which they live. Effective use of ICTs can help us do this. Of course, there are also many risks that must be addressed – for instance, the use of ICTs by criminal networks that seek to exploit migrants – but these too are issues that the 2030 Agenda strives to tackle head on. For us to understand how ICTs can help meet the commitments outlined in the *2030 Agenda*, especially those related to migration, it is helpful to have a broad view of what the *2030 Agenda* says about migration.

The Critical Policy Challenge

Promoting forms of migration that benefit migrants and societies is a daunting challenge, and one that runs across the entire *2030 Agenda* - in particular SDG 10 on reducing inequality within and among countries. Migration has the potential to profoundly influence people's lives for the better. It offers individuals the promise of new opportunities – in work, education, health and family life – and can enhance the overall well-being and standards of living of both those who move and the families they leave behind. Whole societies also stand to benefit from what migration has to offer: migrants help to meet

the demand for much-needed labour and skills; they contribute to the tax base; establish businesses to supply goods, services and employment to host populations; and they create more vibrant, innovative societies.

Of course, the story of migration is not always a good one. Often, when people leave their homes to migrate, they leave behind their family and support networks, and subsequently suffer from social isolation and vulnerability. Indeed, there are many migrants – sometimes, whole communities – who suffer from discrimination, violence, exploitation and abuse. For some, the migratory journey may have begun due to war and conflict, or as a result of natural disasters, poverty or inequality. Increasing numbers of people are risking their lives to escape such conditions, often with tragic results.

For their part, receiving countries may struggle to cope with the arrival of large numbers of people and with their need for public services. They are sometimes tempted to see newcomers as threats to social cohesion, security or stability. We are unfortunately witnessing a rising tide of anti-migrant sentiment in many parts of the world, fueled by racism, xenophobia and intolerance, and aided and abetted by populist political discourse and actions. Social media, in particular, now plays a key role in disseminating and amplifying such political messages and can also influence how people organize themselves.

Target 10.7, which calls on governments to "[f]acilitate orderly, safe, regular and responsible migration and mobility of people", is a response to these challenges. Yet many of the other goals and targets also have important implications for migration, including access to health and education, employment and decent work, and gender equality, as well as goals related to climate change and peaceful societies. Addressing the needs of migrants is an inherent part of the overall objective of leaving no one behind.

ICTs have much to offer in the field of migration and development. ICTs can be used to empower migrants; to provide them with essential knowledge about the migration process to improve their work skills; and to enable them to send money back home speedily and safely. For governments, ICTs are essential to facilitate the movement of people across borders, to manage labour migration programmes and to provide information on the services they provide.

Meeting the Objective of Safe, Orderly and Regular Migration

Establishing a framework for governance

The international community needs a new and transformative approach to migration. This is crucial for achieving SDG 10.7, and all other SDGs that have a bearing on migration governance. For IOM, making progress towards target 10.7 requires orienting (or reorienting) migration and related policy, law and practice towards three key objectives:

(i) Advancing the socioeconomic well-being of migrants and society;

(ii) Effectively addressing the mobility dimensions of crises; and

(iii) Ensuring that migration takes place in a safe, orderly and dignified manner[78].

The pursuit of these objectives should, in turn, be grounded on three foundational principles underlying migration governance: 1) promoting migration systems that adhere to international standards and fulfil migrants' rights; 2) developing an evidence base to inform policy and a "whole-of-government" approach; and 3) working in close partnership with other migration stakeholders. Each of these objectives and principles are critical to making progress towards the *2030 Agenda*.

Advancing the socio-economic well-being of migrants and society

Realizing human potential and contributing to shared prosperity are among the overall objectives of the *2030 Agenda*. Considering the benefits that migration can bring to development, they should also be reflected in the central objectives of migration governance. Migration and related law and policy should be designed both to enable migrants to participate in local economies, as well as to ensure that the migrant experience is a positive one for migrants and for migrant communities. Empowering migrants to fulfil their development potential requires that they have access to basic public services, healthcare, education and housing, regardless of gender, age, migratory status or other characteristics.

In this context, ICTs can be most useful: through digital literacy, migrants can obtain the information they require to adapt to their new environment, to learn how to access essential services and to tap into new support networks. They can, at the same time, keep in touch with relatives back home. IOM is active in this area - for example, in its orientation training for labour migrants moving to Canada, which includes ICT-related training.

ICTs can also encourage migrant entrepreneurship and investment, for instance, by enabling migrants to have access to investment capital. With the help of ICTs, migrants can promote flows of financial, social and cultural assets across borders. Further, ICTs can contribute to balanced labour market outcomes both for employers and migrants - for example, through online skills-matching systems that match the skills and competencies of migrants with job openings.

Effectively address the mobility dimensions of crisis

The current unprecedented spate of protracted humanitarian crises has displaced large numbers of people and highlights the need for governments to address the mobility dimensions of crisis. The complex and often large-scale migration flows and mobility patterns caused by crisis leave many migrants in vulnerable situations but their needs are often overlooked, highlighting the importance of enhancing coordination and building capacities both to prepare for and respond to the mobility dimensions of crises. Critical aspects include the capacity: to identify and analyze patterns and consequences of human mobility before, during and after a crisis; to determine the needs of vulnerable, mobile populations; and to respond swiftly to the needs of the affected population[79].

ICTs can be very useful tools in this regard, helping humanitarian actors identify needs and vulnerabilities, and determine responses to a crisis. For example, IOM's Displacement Tracking Matrix (DTM) tracks and monitors displacement and human mobility, and has been designed to capture, process and disseminate information to provide a better understanding of the movements and evolving needs of displaced populations, whether on site or en route.

The DTM uses a variety of technological solutions ranging from standalone tools and software to comprehensive web-based application systems. Since the DTM is a modular system, its tools can be tailored to operational circumstances. DTM data includes information relevant to all sectors of humanitarian responses. It has proven to be a highly effective preparedness tool, although it can also be equally useful during phases of recovery and transition.

Ensuring that migration takes place in a safe, orderly and dignified manner

The use of ICTs in the context of migration has become common-place before, during and after movement. ICTs can be enablers of safe, orderly and dignified migration – both for migrants and governments – but can also be channels for smuggling and trafficking. The recent large movements of people into Europe have demonstrated very clearly how ICTs (in the form of smartphones) can influence decision-making about where to migrate and how to get to the chosen destination.

For instance, studies on migration flows from Iraq to Europe have shown that the most common sources of information for people on the move included the Internet and social media[80]. Various platforms, including Facebook, Twitter, WhatsApp, Skype and Google Maps, are used regularly to seek information about migration options[81]. However, these channels do not always provide reliable and consistent information and can, unfortunately, be used to connect people to smugglers and traffickers.

Providing accurate and reliable information that is user-friendly and readily available to migrants throughout the migration process is therefore crucial to promoting the type of safe, orderly and dignified migration envisaged in the SDGs. It is especially useful to discourage ill-informed decisions that put people at risk of exploitation and abuse. ICTs can: 1) offer access to migration information from authoritative sources; 2) enable two-way communication allowing migrants to tell their stories and share their experiences with other migrants; and 3) establish databases and analytics to help inform future programming and migrant support.

IOM is developing a mobile phone application – MigApp – to achieve these very outcomes and to help migrants make informed decisions about migration by increasing two-way communication between IOM and users. Recognizing the increasing use of mobile phones by migrants, MigApp aims to offset the enormous amount of misleading and unreliable information currently being accessed by people on the move by providing a reliable, easily accessible source of migration information and services. The application will also provide a platform for migrants to share their experiences and feedback, including reports of abuse and needs[82].

For governments, ICTs are a pre-requisite for good border management – one of the many components of migration governance. Border management functions (such as data management, intelligence and risk analysis, verification and related visa services) all require advanced ICT tools[83]. To achieve SDG 10's prescription for safe, regular and orderly migration, governments therefore need to build their professional capabilities. One of IOM's priorities is to help them acquire the ICT competencies they require to operate successfully in policy areas such as integrated border management, identity management or risk analysis[84].

Harnessing the potential of ICTs

ICTs are now an integral part of migration governance and it is unthinkable for a government to work without them. Likewise, migrants have come to rely on ICTs, the Internet and social media networks to plan their itineraries, to obtain travel information and documentation, and to maintain contact with their communities of origin or destination. Today, ICTs are essential to the realization of SDG 10 and the other goals and targets of relevance to migration, and to enhance the benefits of migration for migrants and societies alike.

Sustainable Cities & Communities

Trends, Implications and Consequences of using ICTs for Achieving SDG 11

By Dr. Joan Clos, Executive Director, UN Habitat & Secretary-General of UN Habitat

The world is rapidly urbanizing. More than 50% of the world's population already lives in urban areas, a figure that is estimated to rise to 70% by 2050. Some geographical analyses in fact suggest that if we add the official urban figures of peripheral municipalities located in the vicinity of cities, current figures would be already at 70% of the world's population, implying an estimated 85-90% of the world's population could be urbanized in the coming years. Planning and managing urbanization is a critical issue for every country and region in the world.

The UN Conference on Sustainable Urban Development (Habitat III) held in Quito, Ecuador, in October 2016 created widespread recognition of the role of towns and cities and proposed 'planned urbanization' as an engine of growth, development and prosperity for all. It elaborated further on SDG 11 to make cities and human settlements inclusive, safe, resilient and sustainable.

The preparatory process of Habitat III was an international conversation that took more than two years, with the conclusion that the current model of urbanization is not sustainable. Unplanned urbanization is causing cities to choke with congested traffic and air pollution; basic services like water and sanitation are not reaching citizens, particularly the poor; joblessness, crime, conflict and social strife are major problems, including in so-called developed countries; and natural disasters are becoming more destructive as people concentrate in dense areas.

The reality is that even with such problems and the fact that cities account for 70% of green-house gas emissions, they also generate 70-80% of global GDP. The relevance of cities in economic terms is absolutely remarkable, considering they occupy only between 3-4% of the world's available landmass. The New Urban Agenda, adopted at Habitat III, supports the implementation of SDG 11 and outlines a new paradigm. Fundamental to this paradigm is a shared vision where cities and human settlements fulfill their social function, engender a sense of belonging and ownership amongst all inhabitants, practise civic engagement, empower women and girls, meet the challenges and opportunities of future growth enhancing urban economies and value-added activities, and link people, places, services and economic activities. This includes cities and human settlements that strengthen sustainable urban transport and mobility, ICT communication networks, e-government strategies, as well as citizen-centric digital governance tools, tapping into technological innovations.

Along with urbanization, another important global trend is the rapid development and uptake of ICTs, initially through the growth of the Internet and mobile phones, and increasingly through advances in technologies such as mobile broadband, big data, the IoT, 3D printing, VR and AI. Digital technologies have impacted urban development and management over recent years. Ubiquitous sensor networks, digital data and urban dashboards, as well as data accessibility, are becoming common concepts as part of urban development worldwide. ICTs offer new ways for citizens to take part in decision-making and governance processes and hold policy-makers to account, thus providing an opportunity to contribute to the achievement of SDGs. ICTs have played a central role in young people's rise to prominence on a global scale, helping them to mobilize, collaborate and communicate. ICTs play a crucial role in making progress towards each of the SDGs: from diminishing poverty, to good health and wellbeing, quality education, sustainable cities, climate action, peace and justice.

Internet access is increasing in all regions of the world and mobile cellular subscription penetration is now nearly universal at 95% (ITU, 2016). This success has been achievable thanks to the high degree of urbanization in the world, among other factors. Fibre-optic networks are being installed or expanded in many cities, data from the use of mobile phones is being used to plan transport and health services, sensors are collecting and transmitting data on air pollution, and basic services such as water supply and flood management and smartphone applications are making commuting more convenient and environmentally friendly, while promoting collaborative working and the sharing economy.

However, challenges remain. As reported by the ITU, 53% of the world's population is not using Internet despite its widespread proliferation, and men outnumber women in Internet usage in all regions of the world – a gender gap that seems to be growing. The World Bank's 2016 World Development Report highlights that, although digital technologies have spread rapidly, what they call "digital dividends" have lagged behind and been unequally distributed. A degree of digital divide remains in place.

In most countries, ICT services are managed by the principles of the market economy. Private corporations compete to provide ICT service that is priced accordingly. Since the beginning of telephone technology, two models were developed: free competition in some countries and a regulated monopoly in the majority of them. Nowadays, the market solution is the dominant strategy although an oligopolistic provision requires careful attention to avoid collusion, cartels and other malpractices.

In general, the evolution of technology has allowed continuous decreases in prices as a complement to Moore's Law, driving the huge success of the ICT market. Of course, nobody knows how technology will develop in the future, but the expansion of the ICT market has had positive effects on the quality of daily life. The predominantly market-drive nature of ICTs means that companies are seeking to compete by looking for new niches in the variety of services or the expansion of geographical areas. Even without incentives, this sector has seen rapid growth.

In order to meet the SDGs, high-quality local ICT systems and related data collection systems are important and, if well-used, can become an accelerator of development given their capacity to transmit and diffuse information and also to generate information (such as big data). There are different views about how ICTs will influence the nature of human settlements. On one hand, telecommunications could facilitate access to services when living in low population density areas, enabling the continuation of urban sprawl and suburbanization. On the other hand, the per capita consumption of ICTs is higher in denser areas, indicating the possibility of a different scenario when telecom usage is associated with a more compact living modality. In any case, what is clear is that ICTs increase the degree of choice available when deciding which type of habitat to opt for.

Another element to be considered in the advancement of ICT services is the issue of democracy, human rights, individual freedom and the right to privacy. Literature is rife with references to dystopian risks associated to the authoritarian control of ICTs (e.g. Huxley, Orwell). But reality has also provided clear examples of wrong-doing as frightening as the nightmares of fantasy. Espionage, manipulation of social media and other malpractices can become systemic risks of this technology. We cannot rule out at a certain point the emergence of a minority refusing to enter into any contact at all with ICTs, as a reaction to any unethical excesses. Time will tell how an open, democratic and liberal society will protect itself from such abuses.

Confronted with the opportunities and risks of such transformative technologies, we will need very careful follow-up, guided by the principles of transparency, accountability and respect to individual dignity. The public governance model of ICTs should be therefore scrutinized openly and transparently in the pursuit of truly sustainable development. The reach and influence of ICTs in our individual lives are now so relevant that a whole new world of issues and topics on dealing with it will emerge.

We face similar moral dilemmas in urbanization, as it deals with the requirements of the human society living on an environment of close proximity, sharing quite a number of common spaces and services in a relatively dense settlement. Urbanization also requires a governance system that we hope and dream of as democratic, open, transparent and caring for the common interest, while respecting privacy. This is why urbanization is guided by policies and is governed by the principle of "the rule of law" being the most fundamental element of urbanization, as embraced in the New Urban Agenda.

Urbanization also demands a good deal of "physical design" to prioritize the inter-relationship between public spaces (such as streets, plazas and open spaces) and private, buildable space. The achievement of a model of urbanization that induces prosperity and well-being demands a relative degree of participation and social consensus on the aim of enhancing the positive effects of urbanization. Urban planning and design are critical elements of good urbanization. Here, a new set of conflicts and tensions emerge between various partners. The nature and quality of an urban plan are crucial in obtaining good results. It should be prescriptive enough to avoid chaos, but open enough to allow for change and adaption. Urban planning and design become

very sophisticated processes which should balance functionality of design with political participation, and must reject authoritarian prescriptions but deliver efficiently. As a city is a place to live, so the beauty, the preservation of landscapes and cultural engagement become relevant issues for consideration. Urban design lies between science and art, and requires the ability to engage a diverse group of people. This complexity explains why it is so difficult to attain an excellent city, and how all too often, ugly solutions without soul are the result.

A third fundamental of urbanization accompanying the "rule of law" and urban design is municipal finance. The nature of urbanization – where public spaces and urban common services exist for communities of people – requires a system of financial governance to cope with the costs and investments requirements. The good news is that urbanization is capable of generating economic value and measurable prosperity. It is an endogenous source of development, and its profits outpace its costs. But its success is related to the capacity for proper financial management, to invest wisely and to conduct the affairs of state so that it leads to a virtuous circle of prosperity.

A system of value sharing is needed to obtain the financial resources that sustain the evolution towards good urbanization. Here, as under many other circumstances, there is no such thing as a free lunch. Such fundamentals are well stated in the New Urban Agenda. The problem is not a question of definition, however, but of implementation. Unfortunately, leapfrogging in municipal finance is not possible: a well-crafted framework at every level of development is required. This is an area where ICTs can help in the implementation.

In conclusion, we are advancing towards a future where urbanization and ICTs will be dominant trends of human society. Given its overwhelming presence in the daily lives of people, both will contribute to define the model of a new human society. Both have highly technical components where science and knowledge carry a great deal of weight and both require a governance model that guarantees human rights, individual freedoms and a transparent system of checks and balances to attain high-quality outcomes. Furthermore, both work together in time and place and therefore a "relational interface" is required between urbanization and ICTs. Many cities have ICT master plans that try to address this interface, but we are only beginning a dialogue that will change and adapt, given the speed of innovation in both urbanization and ICTs.

Responsible Consumption & Production

From Energy to Air: Building a Cleaner Planet with ICTs

By Erik Solheim, Head of United Nations Environment

As kids, many of us marvelled at the kind of computer gadgets we saw in Star Trek, Bond or Mission Impossible. Yet today, much of that once unattainable technology has already come of age, and has even been replaced by the next generation. As processing power continues to grow and prices drop, the ICT sector offers some of the biggest challenges and some of the most incredible opportunities for sustainable development.

Our obvious challenge is E-Waste. Last year, consumers bought around 1.5 billion smartphones and 440 million computers and tablets. As processors become more powerful, they become more fragile along with the products they operate. As those products become more powerful, they become obsolete more quickly for consumers hungry for the latest kit. Either way, the products have a shorter and shorter shelf life. According to recent estimates, up to 90% of world's electronic waste is illegally dumped, and at present rates, we could soon be dumping 50 million tonnes a year. That includes huge quantities of harmful lead compounds, mercury, cadmium and chromium, and ozone-harming chlorofluorocarbon gases, which end up in our soil, water, air and food.

But that also makes eWaste a huge urban mine waiting to be tapped to recover and recycle materials worth USD 52 billion. For example, we are literally throwing away about 300 tonnes of gold a year – about 11% of the world's total annual production – even though we have already invested huge levels human and financial resources to extract it. Consumers need to vote with their wallets. Companies need to help stop the waste and help start the clean-up. Governments need to legislate to make all of this happen much more quickly.

Along with the big technological advances come big data, citizen science and huge opportunities. In my home, Nairobi, affordable technology is at work for our good health and well-being. Air pollution is one of the world's biggest killers, causing an estimated seven to eight million premature deaths a year, and leaving many more of us with ailments such as asthma, respiratory illnesses and a catalogue of other afflictions. Around the world, an estimated 92% of people do not have access to clean air and the costs of urban air pollution could amount to around 2% of GDP in developed countries and 5% in developing countries. Enormous work is needed to ensure greater and more widespread realization of the scale of the problem among governments, producers and consumers.

Even if we can hear the noise of traffic on our streets and can smell the toxic fumes coming from vehicles or burning waste, we are mostly ignorant about the precise quality of the air we are breathing. Technology is providing solutions in the form of affordable air quality monitoring systems developed by UN Environment. For just around USD 0.02 per city inhabitant per year, cities can develop an accurate network that will measure, map and track their air quality. They are all connected to the burgeoning world of affordable sensor-web enabled devices and the IoT. In this new, networked world, data from

satellites are merged with real-time information on pollutants and key aspects of the environment, geographically situated and then tagged with images and comments from citizens. The picture emerging is not fiction, but a new kind of story-telling, anchored in reality and based on factual evidence and accompanied by social commentary.

The monitoring units contain sensors that can detect the level and sources of key air pollutants such as sulphur dioxide, nitrous dioxide, particulates, carbon monoxide and a range of other more specific gases. Readings, many times a minute, are mapped to show concentrations of pollutants. Nairobi City Council used the network in their inaugural Nairobi Placemaking Week in November 2016, to quantify the traffic emissions and air quality improvements from closing off streets and reducing traffic in the central business district.

One of the objectives of the project was to advocate for a healthier, inclusive and vibrant city through safe and pedestrian-oriented streets using these temporary closures. The sensor network showed that there was a significant reduction in pollutants, especially in the larger sizes of particulate matter. Now UN Environment is working with governments, cities, citizens groups and schools, especially in developing countries, to deploy inter-connected sensor-networks, with satellite and ground-based observations and social media. The outcome is a cognitive mapping of pollutants to help authorities make better decisions on improving air quality and help people reduce their exposure to harmful air.

In China, where the new national ambition is to bring blue skies to cities, ICTs are literally driving car sharing initiatives. They also are behind our mapping of marine litter and plastics in the oceans, or tracking sand and dust storms, the environmental damage from conflict-related oil fires in Iraq and tracking naturally occurring forms of asbestos, erionite, that are causing extremely high levels of cancers in places such as Central Anatolia, Turkey and the US. Big data covering environmental indicators is being fed into Environment Live, our real-time online data and knowledge platform. It provides UN Member States, businesses and private citizens open access to information and knowledge on the environment at the global, regional and national levels. It supports the development of policy and action plans critical to delivering the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change.

There are countless other initiatives elsewhere on the web, driven not only by big business or government, but by entrepreneurs and students – for example, in applications such as Logging Roads (which maps over 10,000 logging roads in the Congo Basin to identify violations, degradation and highlight potential land right conflicts) or 'Hack The Rainforest' (which uses digital maps and drones to combat environment threats in the Amazon by empowering frontline communities).

ICTs are also driving the energy revolution. For example, Kochi airport in Kerala, India, is a powerful symbol of how technology is transforming the grid, transport and the economy. Reliable transport and energy connections are key for stable economic growth. Fed up with high electricity bills and an intermittent supply, the airport decided to try solar panels. After a small-scale test, they invested in a twelve megawatt solar plant that provides all its energy needs and even feeds excess capacity back into the grid. This is not a luxury item – the project will pay for itself in just six years.

It's an example that is resonating across India, not to mention the rest of the

world. In a country where 300 million people still don't have access to electricity, the falling cost of renewable energy offers solutions from the smallest village to biggest city. Cheaper smart controllers, which allow the creation of smart grids and micro grids, are key to this. Places such as Kochi provide testimony as to why this is a sound economic investment. Widespread realization that going green makes perfect business sense is reinforcing climate action and many of the SDGs.

For example, take the goals around our cities or consumption and production, and apply the same common sense lessons to manufacturing and construction. The solutions – or at the very least, the technology to create the solutions – are already in place. The 3D printing revolution could slash the use of raw materials, dramatically cut waste and produce better products. Lighter, smarter vehicles with alternative fuels and flexible sharing options will cut emissions and congestion. If we can crack the power storage hurdle (e.g. through better batteries and smarter controllers), the roofs and walls of our homes could collect and store power. Modern technology is turning citizens into a potential monitor or database, and therefore, an activist. Global industrialists are sharing big data for full lifecycle management across their supply chains. Countries are tracking where tourists put pressure on ecosystems or even basic resources, like food and water. Remote fishing communities are using mobile apps to balance supply and demand. The list goes on.

It still holds true that knowledge is power. But at UN Environment, that means the power to inspire – and to deliver – incredible change. We need to make all that science and data, not just easy to access, but easy to interpret and easy to act on. The ICT sector is opening up an entirely new toolbox for policy-makers; now those policy-makers need to start moving at the same speed as the sector. For both sides, success depends on taking the technology and the numbers, and transforming them into more than just junk for landfills.

Climate Action

ICTs in Weather, Climate & Water: Contributions towards Advancing Global Development and the SDGs

By the World Meteorological Organization (WMO)

The Importance of ICTs in the Delivery of Weather, Climate, Water and Environment Information

Many enhancements in the availability of weather information have taken place over recent decades from high-resolution satellite observations to high-quality weather forecasting using more and more sophisticated super-computers operating ensemble models configuration. The sharing of model output allows national centres to benefit from advanced high resolution modelling over their area of responsibility, which in turn can support automated decision and warning processes. On the global scale, we can today predict out to six days ahead with the same accuracy as we could achieve for a period of four days, 20 years ago. This means society has much more advance warning of weather hazards than before, allowing people to prepare and, thereby, limit the loss of lives and property.

WMO is fostering the development of a seamless weather prediction system which provides accurate and timely information on a range of time and space scales regarding the location, timing, and structure of weather-related hazards. This information can make an effective contribution to mitigating the impacts of weather-related hazards, when it is translated into products suitable for end-users and communicated in a manner that allows it to be integrated directly into decision-making processes. Technological capabilities with regards to observations, numerical weather prediction, integration of available data into long-term reference climatic data-sets are the cornerstone of the weather enterprise. Advances in the quantity and quality of information can directly and indirectly contribute towards achieving progress in the global SDGs and their targets. Conversely, the need for the information is driving the advances in data collection and delivery.

ICTs can play a critical role in strengthening weather information service from data collection to information delivery. The entire value chain of the 'weather enterprise' could further benefit from advanced ICTs:

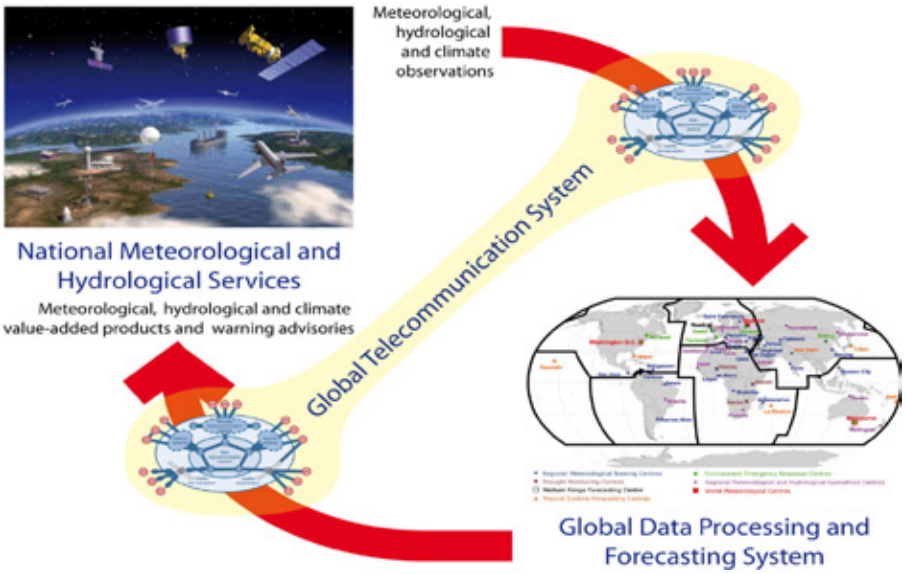
1. Observing better and designing new observational systems;
2. The future technologies for a new seamless global prediction system; and
3. Interfacing the operational seamless global prediction system with a multi-faceted ***decision-making world.***

Observing better and designing new observational systems

How to integrate different source of information into an operational system, which can deliver tailored data for a variety of sectors, has been the main goal of WMO since it was established in 1950 (but also back to its origins as the IMO in 1873). Today, technology and its near-term trends show new possibilities:

- **New opportunities for observing the weather, climate, water and environment systems.** New chip sensors can be integrated with high-quality measurements (i.e. air-quality observation at high resolution) and new indirect measurements obtained from communication technologies (e.g. rainfall inferred from operational efficiencies of mobile phone networks) as examples of the opportunities (and challenges) to integrate technology, science innovation and services.

Figure 4: WMO's Integrated Global Observing System (WIGOS)



- **High-granularity down-stream services** are needed by end-users who, for instance, may be looking for new predictive tools that are able to detail weather conditions down to the neighbourhood level in urban regions. Fusing traditional data with new direct or indirect observations requires new ways to use different sources of information and to communicate this information to end-users in real-time.

- **How to set up the most feasible observational network in remote regions?** How can we communicate large amounts of data in remote regions in real-time (i.e. polar and high mountain regions)? One of WMO's main research activities will be the Year of Polar Prediction (YOPP) in order to enable a significant improvement in environmental prediction capabilities for the polar regions, and beyond. The YOPP will entail intensive observation and modelling campaigns in both the Arctic and Antarctic from mid-2017 to mid-2019, as the information from these campaigns will provide a benchmark for the technological capabilities in remote regions.

The WMO Integrated Global Observing System (WIGOS) is increasing the quantity of weather, water and climate observations by allowing observations from within and outside the WMO community to be integrated together, forming a composite observing system. WIGOS includes quality assurance, as well as data tracking designed to ensure greater confidence in quality, leading to better products and services.

Future technologies for a new seamless global prediction system

Over recent years, operational numerical weather prediction centres have provided predictions from the very short range (at the kilometer-scale) multiple times per day, up to global seasonal forecasts (at tens of kilometers) horizontal resolution once per month. These forecasts relate to the weather, but are now being extended to air-quality and hydrological applications.

Data assimilation algorithms take in tens of million observations per day to derive the initial conditions for the forecast model. The initial conditions are physically consistent in three dimensions: over the globe, from surface up to mesosphere (80 km) and along time windows (from hours to days). Operational models are updated frequently to incorporate new science that enables improvements in the representation of model physics and model uncertainty, algorithms and observational data usage, enhancing computational efficiency. Gauging the contribution of ICTs to the success of this process is difficult, as the efficiency of data assimilation algorithms and observational data usage are interdependent. Nonetheless, ICTs continue to play an important role in the improvement of these processes.

Many technological opportunities and challenges will arise from future Earth observation systems. At the high-end, new satellite instrument technology is moving towards hyper-spectral radiometers, with thousands of spectral channels sounding the atmospheric thermodynamic state and composition, together with active instruments (such as high-resolution radars and lasers) sounding surface characteristics, aerosols, wind, water vapour, clouds and precipitation. The data rate can easily be of the order of 100 Gbytes per day that requires downlinks, pre-processing, data dissemination within a few hours and ingestion in forecasting systems. These advances in Earth observing systems are driving changes in the use of ICTs, which will only be feasible if advanced data-handling methods are embedded within the communication technologies.

All these advancements should be integrated into the WMO Information System (WIS), which allows authorized information providers to publish the availability of their information and services in a global catalogue. This information can then be shared via the public Internet or WMO's dedicated private network called the Global Telecommunication System connecting all WMO Members worldwide.

Interfacing the operational seamless global prediction system with a multi-faced decision-making world

Forecast services over the next 10 to 20 years are envisioned to span all lead-time ranges literally from minutes to months ahead, to convey uncertainty information throughout, and to be seamless, multi-hazard and multi-scale. 'Seamless' refers to a vision where the different products and services are consistent regardless of the method of access or creation (push, pull, automated, human-generated) and regardless of the lead-times involved. The concept of consistent seamless forecasting was first introduced to help merge weather and climate models, but in future, this concept may become even more important in the field of high-impact weather forecasts.

An important stream of services under development is statistical post-processing, which refers to the development of predictive statistical relationships between the forecast output of a Numerical Weather Prediction (NWP) model and observations. The last twenty years have seen a dramatic

increase in the range of NWP models, making it vital that applications derived from these models are presented to users in a consistent way. Efficient tools, techniques and applications are needed to extract the relevant meteorological information to enable meteorologists and automated systems to assess, forecast and communicate weather-related hazards and their impact efficiently.

The optimal statistical blending of forecasts applies for both 'nowcasting' and longer ranges, and needs a new way to integrate forecasts with all available source of information in real-time. One powerful example is the high-density cell phone pressure measurements, the use of which could help provide real-time automatized services in highly populated regions. This technology could serve multiple stakeholders and dramatically increase the dissemination of weather and environment products.

Integrating technology and weather-climate information to support the SDGs

Dramatic advances in science and technology are enabling investments to strengthen monitoring infrastructures, handle large or complex datasets and improve the quality and access of predictions and services. By fostering data production, access and exchange, the meteorological, climate and hydrological communities under the umbrella of WMO contribute directly to SDG 17 implementation mechanisms. WMO communities also contribute directly to indisaster prevention, socioeconomic planning and realization of greater socioeconomic benefits to mitigate and adapt to high-impact weather, climate and hydrological extremes, over land or sea.

The projection of trends in various key climate and weather elements (e.g. temperature, precipitation, atmospheric composition etc.) in combination with sector-specific knowledge can produce highly valuable, connected and integrated climate services. These products can be communicated directly to different communities, policy-makers and the public. For example, in relation to food security (SDG 2), farmers and local agricultural experts now receive rainfall forecasts which they can connect with other concrete region-specific information to protect crops and yields. Weather, climate and water-related risks in agriculture can be very complex, including aspects of: the low availability of water resources (SDG 6); drought, desertification, land degradation (SDG 15), erosion, and flooding. Effective weather and climate information related to indicators in SDG 13 and advisory services can inform short, medium and long-term decision-making by governments across a combination of factors, including national adaptation and resilience planning.

It is vital to ensure that the final weather, climate and water products are efficiently communicated to the public. Communication channels and venues are necessary to ensure that vulnerable communities and national planners receive timely and correct information. WMO is working through and with its Members strengthen operational weather, climate and water services. WMO also collaborates closely with other UN agencies and other partners to support the Sendai Framework for Disaster Risk Reduction 2015-2030, the Global Framework for Climate Services (GFCS), and other multi-stakeholder partnerships. The Climate Service Information System (CSIS) of the GFCS is the means of delivery of climate data and products. It comprises global, regional and national centres and entities that generate and process climate information (observations and predictions), and exchange data and products, according to internationally agreed standards and protocols.

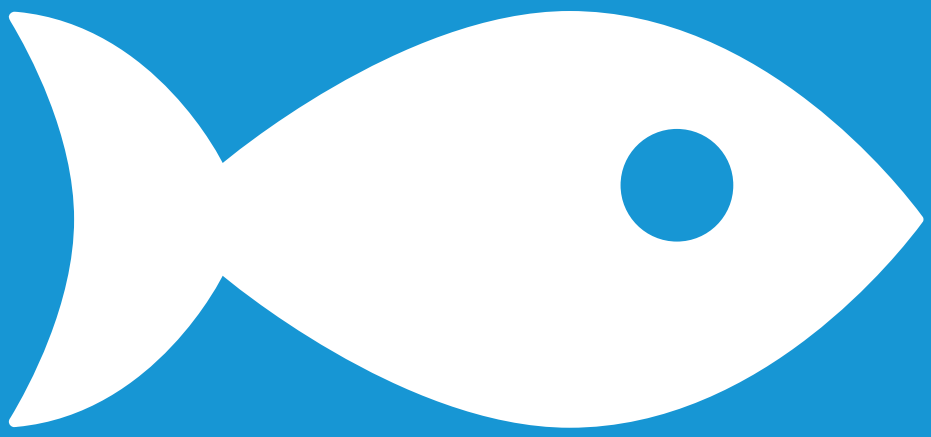
Conclusions

Weather, climate and water information are available from many sources. However, the availability, quality and consistency of this information vary considerably across sources. Quality data and derived products delivered in a timely manner are crucial during weather emergencies or emerging disasters, which threaten populations. This is universally true in developed and developing countries, regardless of income or local or national resilience. The strengthening and enhancement of ICTs at the national level is also a major priority for WMO in building an effective Climate Services Information System.

ICTs already play an important role in weather, water, and climate services. They have the potential to expand this role across a wide range of development targets. High-quality, reliable and consistent information to protect lives and property and build resilience to high-impact weather and climate events is needed in all sectors. The stability of national investments in National Meteorological and Hydrological Services and their connections to national, regional and global information are critical to meeting the demand for this information.

Scientific and technological challenges are interlinked in many areas. The efficiency of computing and data handling imposes hard limits on model complexity and data dissemination in weather, climate, water and environmental applications. The trade-off between scientific needs and technological performance is not new, but achieving the SDGs adds a new challenge.

Life Below Water



Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development

By Kitack Lim, Secretary-General, International Maritime Organization (IMO)

As a UN specialized agency, IMO is firmly committed to helping achieve the aims of the SDGs. The maritime sector, a truly global industry, can directly support the achievement of the SDGs as shipping has a significant role to play in helping create conditions for increased employment, prosperity and stability through promoting maritime trade.

While IMO's work can support the achievement of many, if not most of the SDGs, SDG 14 to ''conserve and sustainably use the oceans, seas and marine resources for sustainable development'' will be one of the main considerations in driving the work we carry out over the coming years. Much of what happens within the oceans is in fact hidden, so it can prove challenging to engage people compared with other Goals, where the objectives may be far more visible and relatable. But given that ocean life supports all forms of life on earth, Goal 14 is an important Goal nonetheless.

IMO's mission is to ensure safe and secure shipping on clean oceans. Oceans cover approximately 71% of the Earth's surface and, as individual activities that damage the oceans can be felt beyond national borders, responsibility for the ocean's health rests with all of us. While ships traversing oceans are only one of many ocean activities, the shipping industry is one of the most visible industries taking place on the oceans. At IMO, we need to ensure that shipping continues to make its significant contribution to the global economy without upsetting the delicate balance between safe and secure shipping and protecting the marine environment.

Approximately three billion people around the world rely on fish as their primary source of protein and the livelihood of nearly half of the world's population, amongst which we can include over 1.6 million seafarers, depends directly or indirectly on the oceans. The so-called 'blue economy' is sizeable and growing each year, marine and coastal resources generate at least USD 3 trillion (or 5% of the world's GDP), equivalent to the GDP of the seventh-largest economy, each year, whilst the total value of the world's oceans is estimated at USD 24 trillion.

But we are reaching a crunch-point. If action is not taken soon to regenerate this finite resource and preserve ocean health, the continued pressure on oceans will irrevocably damage one of the world's most valuable resources and threaten life as we know it, in very many ways.

Many people may believe that what is happening in the oceans may not affect them as city residents or land-dwellers. Quite the reverse – with 80% of global trade being carried by ships, we know that what happens in and on the oceans plays a major role in the lives of many people, both directly and invisibly. We depend on our oceans to produce over half of the oxygen in the atmosphere, to act as a global reservoir for over 97% of our planet's water and we can all recall some of the scenarios possible, should the Gulf Stream and North Atlantic Current reduce in flow.

Our ability to continue to live as we do depends directly on oceans continuing their functions of regulating global temperature, water salinity, water storage and weather systems amongst others. To highlight the great and growing urgency to tackle ocean degradation, we need to educate the public not only about the big changes that we face because of the damage to our oceans, but also about all the small ways our lives will change inexorably, as the impact of our actions is increasingly felt – as well as what can be done to rectify the situation.

Challenges currently affecting the oceans include ocean acidification, the degradation of ecosystems, rising temperatures, large-scale disruption to marine life and overfishing, rising sea levels and increased ocean activity, to name just a few. In other words, there are multiple, complex issues to target in order to advance the objectives we have set out for ourselves under SDG 14, as well as the other SDGs.

Here, I focus on how ICTs can impact the achievement of one individual Goal, although it does not mean that we can forget the others. In fact, the 2030 Agenda recognizes that no single Goal can be achieved in isolation. On the contrary, we know there is little point in investing to preserve marine ecosystems, if we do not also address economic actions that are polluting the very air we breathe, and leading to the acidification of the oceans. For example, we cannot allow ourselves to believe that any efforts we make in clearing out ocean garbage will help resolve the issues affecting our oceans, if we do not teach environmental awareness at the same time, so plastics and other pollutants do not end up in the sea in the first place. In all these instances, when used wisely, we can leverage ICTs as a bridge between Goals, to facilitate the cross achievement of these 17 Goals we have set out for our planet.

There are many ways ICTs can do this – from satellite monitoring of temperatures, harmful algal blooms and pollutants, to tagging and tracking ocean wildlife and shipping activities, and much more. However, I should like to focus my thoughts on two points that are of particular interest to me personally – communications and awareness, and the use of data.

Communications, Raising Awareness & Inspiring Action

With nearly half of the worlds' population having access to the Internet, and numbers growing daily, we have an unparalleled opportunity to promote messages and to engage the global public in actions that will help us protect the oceans. The Internet is a unique gateway that enables direct communication with nearly 3.5 billion people; it provides exposure, it provides a platform for global dialogue and it holds our actions accountable to the world population.

The Internet also provides a voice to those who have until now been the most difficult to hear. Over 89 million internet users are in developing countries and places such as Small Island Developing States (SIDS) are disproportionately suffering the immediate effects of the degradation of oceans. SIDS face a two-fold challenge in their remoteness and their dependency on the shipping industry to supply them with resources. Internet connectivity affords these people the opportunity to speak out directly to the global community about their experiences and to elicit support to address these challenges by sharing their stories.

Internet connectivity can also assist with creating focal points for action, IMO and the EU have created a network of Maritime Technology Communication Centres (MTCCs) for SIDS and LDCs to promote the uptake of low-carbon technologies and operations within the maritime transport sector and to assist with capacity-building efforts, in an effort to help mitigate the harmful effects of climate change and its impact on the marine environment.

For our seafarers, the availability of reliable communications – or lack thereof – makes a real and everyday difference in seafarer welfare. Access to high-speed Internet enables them to position themselves, call for help if needed, and communicate with family and friends across vast distances. Conversely, not having access to these technologies can have high human costs, as they struggle to maintain connections beyond their life aboard ships. Our annual Day of the Seafarer takes place on 25 June each year and has in recent years leveraged the opportunities of social media to bring to the attention of the general public the unique contribution made by seafarers from all over the world to international seaborne trade, the world economy and civil society as a whole.

Interconnectedness is changing the way we work. Electronic communications are changing ship/port interfaces, where electronic certificates are becoming more widely available and accepted. Even in the way ships are navigated we have moved away from celestial navigation to satellite-based navigation. Greater navigational and operational efficiency contributes towards making shipping safer, and to balancing the needs of the industry with its impact on the environment. For example, IT may enable ships to consume less fuel, find routes that can help protect certain marine environments, map the oceans and prevent accidents such as collisions that could lead to pollution. IT is an ever increasing presence in ports and ship operations in the quest towards more efficient and cleaner shipping.

We are also seeing how media is increasingly focusing on ocean health and the consequences of past actions, as well as the costs, should we fail to take action to conserve the oceans, seas and marine resources. We see that oceans are being affected in countless ways. Any number of examples are available, from journalistic articles about how our food supplies will be affected in the next few decades, to the photojournalist piece on the bleaching of coral reefs, to the documentaries and web-based education initiatives to highlight the need for protecting marine environments. These illustrations show how ICTs can be used to communicate these messages to a global audience, seeking to provoke emotions and increase understanding on the vast and varied ecosystems that constitute our oceans, seas, deltas and estuaries.

Global connectivity also gives people the possibility to respond to emerging issues. Online communications enable networks of people across different time zones and regions to organize themselves to work and take action on an issue, regardless of where they are in the world. This increased dialogue can enrich discussions, providing different points of view and innovative ideas about how to achieve change. By leveraging the power of social media, ideas can transform into actions much faster than before. Take for example the ocean clean-up initiative, a project that aims to create the first high-resolution map of the plastic accumulation zones and facilitate the clearance of the ocean's garbage patches. The speed with which civil society can respond to the complex threats faced by the oceans and leverage the power of ICTs in doing so, one would hope, should allow us to see many of the worrying developments in ocean degradation to be positively addressed.

Social media now also plays an unparalleled role in shaping how we see the world. I mentioned above how IMO has successfully used social media to highlight the importance of seafarers. In addition to this, for example, trending topics on social media can go viral much faster, bringing more visible pressure to bear on a wider range of actors. While digital platforms can be used to reach out to larger global audiences, it is also true that there is also much criticism of social media for this use. It can be difficult to keep ocean-related stories relevant and engaging without succumbing to media-sensationalism, when these stories are effectively competing with others that may appeal more broadly (for example, the latest sporting events, celebrity baby or twist in a current blockbuster television series). Media focus can play an important role in what projects receive funding, and which do not, as it can divert attention from valuable efforts that are less media-friendly.

But it is clear that our world is more engaged in online communication than ever before, a trend which will only keep on growing. We must continue to use the opportunities afforded to us by social media and other communications to engage us through text, sound and images, to galvanize us to promote and protect the complex ocean ecosystem.

Using data

Humans know more about the surface of the moon than they do about the ocean floor. In order to know where to take appropriate actions to conserve and support the sustainable use of our oceans seas and marine resources for sustainable development, we must underpin our efforts with credible data and valid research.

With so many pressing issues to tackle, information may be used by different organizations and individuals to assess which work needs to be prioritized, while competing for limited resources. Information, data and statistics can also be used to ensure that our efforts are spent in the most efficient and effective way, and they can be used to benchmark our progress and underpin any successes.

Data collection and analysis also forms the foundation for the development of models and strategies to address issues that concern the health of the oceans. Basing any claims or appeals for the prevention of pollution or the conservation and rehabilitation of our oceans on verifiable data, will lend credence to any claims and so build trust.

However, the use of data is not without challenges. First, in a globalized world, systems for collecting the same or similar data often vary from place to place, and country to country. This lack of a common language or common data entry and analysis tools can often create learning barriers, slow down progress and duplicate efforts, so time-sensitive information which could allow us to respond much quicker to trends (for example, changes in ocean temperature) and needs (for example reducing overfishing) may not be readily available simply due to lack of comparable or quality information.

A large part of our job at IMO, indeed throughout the UN system, is to seek ways to break down these barriers to communication. The IMO Global Integrated Shipping Information System seeks to report and transfer data into a system accessible to all Member States, drafting of requirements on the establishment of a "single window mechanism" to standardize the flow of information, or providing the forum for discussion amongst Member States, to name just a few. Better granularity and frequency of data is key. Reliable, timely, quality data can be hard to obtain, more so verifying the data for accuracy. It is vital that there is trust between those generating data and those collecting it. Therefore procedures need to be in place for the best data management.

Much is also being said about the benefits of harvesting information from so-called big data. For international shipping, as ship operations becomes gradually more reliant on ICTs, it is probably a matter of time before gathering big data becomes the norm, both for the industry itself to optimize operations and trade flows, but potentially also for those that enforce global rules on a global industry. However, for a truly global industry such as the shipping industry, the patchiness of ICT coverage can be a serious hindrance to the application of our regulatory measures.

At IMO, data is central to many of our activities. For example, we take pride in our work to protect marine ecosystems by designating Particularly Sensitive Sea Areas (PSSAs), areas that need special protection for recognized ecological, socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities. The application process for the designation of PSSAs takes into account all interests (of coastal States, flag States, and the

environmental and shipping communities) on the basis of relevant scientific, technical, economic and environmental information regarding the area(s) at risk of damage from international shipping activities. In other words, a rigorous mechanism for the collection of information allows the whole IMO community to take informed decisions on designating these PSSAs.

Other examples from other organizations using data to assess ocean health includes efforts being undertaken by different initiatives for mapping underwater noise. With the increase in human activity along coasts, offshore and in deep ocean environments, noise levels in the ocean are changing. Higher noise levels can have negative impacts on marine organisms throughout their life cycle, affecting everything from their ability to reproduce, to finding food, avoid predators or navigating. In order to better understand the impact of noise on marine ecosystems, and to support the development of a strategy to deal with the problem, there are efforts to develop mapping tools to visualize cetacean density and distribution, and man-made underwater noise. Active use of ICTs in this context can ensure that any strategy for addressing ocean noise impacts is supported by robust scientific data.

As I mentioned earlier, ICTs can be a powerful tool for global communication and response. For example, in addressing the issue of ship strikes, the collision of vessels and whales, the International Whaling Commission developed a global ship strike database, an online data entry tool for submitting reports of strikes that are later on verified, to identify and prioritize hot spots where collisions occur, and help develop an understanding of the numbers of collisions, movements of cetaceans (whales, dolphins and porpoises) and circumstances surrounding collisions with the aim to reduce these events.

There are many other examples out there of people and organizations using ICTs to collect the data required to back up their pursuits of ocean conservation and preservation. ICTs are ever-evolving, and it can be challenging to keep up with how to use them, but where they are used correctly, they can be a powerful contributory tool to propel change.

In summary, the achievement of the SDGs is the responsibility of every country across the globe. Much like the oceans of the world are all interconnected, the global community can use ICTs to join efforts and actions in previously unimaginable ways. ICTs enable us to inform, to be informed, to analyze problems and develop solutions, and they can help us take action more quickly and reach more places than ever before. While remaining mindful of the potential challenges with ICTs, this must not stop us embracing their opportunities to help us achieve change. In particular, when achieving the SDGs, let us use ICTs to support our objectives and communicate our important message to conserve and sustainably use our most precious of resources, which include the oceans, seas and marine life.

Conserving and Sustainably Using the Ocean, Seas and Marine Resources for Sustainable Development

By the Intergovernmental Oceanographic Commission (IOC) of UNESCO

The ocean represents the largest ecosystem on our planet, and it performs a number of key functions supporting life, including generating oxygen, moderating the climate, offering food, improving health and wellbeing through tourism or even new medicines, and facilitating global trade and energy production. The ocean-related economy (or "blue economy") is already generating the annual wealth of the order of the gross domestic product of France, the 7th largest national economy in the world, and is actually growing faster than the land-based economy. The majority of the world population now lives in the coastal zone.

According to the First World Ocean Assessment, published by United Nations in 2015, humankind's stresses on the ocean have already triggered a massive decline in ocean health, and the challenge is now to stop the detrimental practices of the ways in which we use the ocean, before this damage becomes irreversible. This challenge is even more dramatic because our reliance on the ecosystem services provided by the ocean is likely only to increase in future, driven largely by the growth in world population and (uneven) consumption.

The ten targets of SDG 14 call on us to stop ocean pollution and unsustainable fisheries practices, to protect key marine ecosystems, to start managing marine and coastal ecosystems scientifically, and to address the damaging effects and impact of ocean acidification. Significantly, we are also expected to support the development of blue economy, especially for Small Island Developing States, and help artisanal fisheries to find their way to food markets, which has to be carried out through the development and use of ocean science, while respecting the UN Convention on the Law of the Sea. Achieving some of the SDG14 targets requires new policies, regulations, best practices and their encouragement or enforcement, as well as investments.

However, some of these targets require a breakthrough in the abilities of ocean science to come up with practically useful solutions and practices. UN agencies with responsibilities and a mandate touching on the field of ocean ecosystems are ready to work in partnership to facilitate the implementation of SDG14 through concerted action. UN Environment is leading on issues related to management and pollution. FAO is pursuing issues related to fisheries. IOC is leading on the development of scientific solutions. Contributions of other agencies, including the UN itself (e.g. via DOALOS), the World Bank, IMO, WMO, IAEA and IUCN, are also required, as well as those of NGOs, notably the International Hydrographic Organization, and many others.

Indeed, sustainable ocean management underpins all the other SDGs, including the Goals on extreme poverty (SDG 1), food security (SDG 2), health and wellbeing (SDG 3), water management (SDG 6), clean energy (SDG 7), economic growth (SDG 8), industry and infrastructure (SDG 9), and sustainable cities (SDG 11). There is also an ocean dimension in the cross-cutting goals associated with gender (SDG 5), partnerships (SDG 17), and reducing inequality (SDG 10). However, the closest ties of SDG 14 are probably with the Goal on climate (SDG 13).

Ocean acidification is often called "the other part of the carbon problem" and is a fundamental part of adapting to and mitigating the effects of climate change. For example, coral reefs are one of the major cradles of ocean biodiversity. Occupying an area of under 1% of the ocean surface, they maintain and support roughly one third of known ocean species. However, the warming of ocean waters, i.e. the gradual increase of temperatures and sporadic heat waves, in addition to ocean acidification are leading to massive bleaching and death of corals. The health problems of the ocean extend far beyond the list of SDG 14 targets and also include such devastating phenomena as ocean deoxygenation. There are now more than 600 officially recorded 'dead zones' in the ocean, associated with the loss of oxygen. Preserving and restoring ocean health therefore requires multidisciplinary approaches and is both highly complex, as well as extremely urgent.

The demand for practical solutions is shaping the development of modern oceanography. Where perhaps previously, ocean science has mainly been driven by scientific interest, now, it is turning into a science-based information technology. When IOC was founded in 1960, its objectives were focused on facilitating the scientific study of the ocean. One year after its birth, in 1961, IOC established an International Ocean Data and information Exchange program (IODE), with the initial objectives of "facilitating of exchange of oceanographic data, the standardization of forms for reporting and coding data, the encouragement of the preparation of data catalogues, and the assistance of development of national oceanographic data centres".

Today, the global network of National Oceanographic Data Centres (NODCs) includes 63 NODCs and 24 Associate Data Units. Current trends in data technologies are resulting in a shift from centralized national facilities to distributed national networks of smaller facilities. This is made possible by new and emerging ICTs – it is now possible to carry around the equivalent of a miniature data server in one's pocket. However, decentralization and the miniaturization of data handing systems lead to a number of risks and challenges, so NODCs are now embarking on new responsibilities and tasks, e.g. to ensure coordination and archiving for the data held by the distributed national networks of smaller facilities.

However, much larger changes are underway in the domains of collection and use of ocean data and information. The IOC's current mandate is "to promote international cooperation and to coordinate programmes in research, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of Member States". ICTs are now the main supporting technologies for ocean observations, data processing, and informed decision-making.

Ocean observation is greatly hampered by the fact that the ocean water is not transparent to radio waves. Since the dawn of this century, under the coordination of the Global Ocean Observing System (GOOS), new automatic buoy technologies (especially Argo buoys) have revolutionized our knowledge of ocean thermodynamics. It is possible now to make scientific statements such as "93% of the excess heat associated with the enhanced greenhouse effect have been absorbed by the ocean since the start of industrial era" and to trace the so-called "hiatus" in global warming to the penetration of warming into the deeper parts of the ocean.

Responding to the need for effective management of ocean ecosystems and to address the role of ocean in climate, GOOS expands the scope of observations by including ocean biogeochemical, biological and ecosystem variables, and is extending the domain of observations into the deep ocean areas and the polar regions. Satellites enable data collection. New observing and data collections systems are put in place, including autonomous underwater vehicles. Worldwide, this is a billion-dollar enterprise. It is essential for our ability to manage the environment sustainably that the radio-frequency bands assigned for transmission of oceanographic, meteorological and other environmental data are preserved, despite the pressing need to enhance mobile communications.

A wealth of data and information products are now required and available for oceanography. A number of ocean-born disasters can and should be predicted and their devastating consequences avoided (e.g. typhoons or hurricanes, flooding, and tsunamis). Data on water temperature in the upper ocean layer helps with the prediction of tropical cyclones. Their track is already usually predicted with sufficient accuracy, but prediction of their intensity still requires improvement. A highly complex information system that includes seismic stations, Internet, satellite and mobile communications, special buoys and modeling is used to support IOC-coordinated tsunami warnings for the world. There is potential to further reduce the time needed to detect a tsunami on the ocean surface and generate a more accurate warning, where ocean-bottom telecommunication cables crisscrossing the ocean floor can be used for additional ocean observations and data communication. An ITU-IOC-WMO Joint Task Force is developing this new technique.

Further development of our civilization is inseparable from our heavy reliance on the ocean. Unfortunately, we still do not know enough to operate in the ocean safely and sustainably. For example, ocean bottom topography is less well-known than the one of the other side of the moon. Thus, for own sake and for preserving the health of the ocean, we need to invest in ocean observations, related research, data and information technologies. This requires mainstreaming investments in ocean science, observations, services and ocean-based communications into national agendas with effective communication and significant efforts dedicated to improving ocean literacy.

To engage the global community, including the UN, into such large-scale efforts, IOC has called for a Decade of Ocean Science for Sustainable Development towards the ocean we need, for the future we want. It is hoped that the Decade will be conducted under the auspices of UN and will engage all relevant UN agencies and most nations to create better awareness about the role and state of the ocean, to strengthen ocean mapping and observation, to generate a wealth of useful information on the ocean and enable science-based solutions preserving ocean health, to improve our resilience to ocean-related risks, and to facilitate the use of ocean services for humankind. Central to enabling these advances will be a global, regional and local data and information system supported by modern ICTs.

It is hoped that this Decade will help prioritize ocean health and the wellbeing of ocean ecosystems, simply because failure is simply not an option. It is the responsibility of all of us to preserve the rich diversity and beauty of the cradle of life on Earth as we know it – the Ocean.

Using ICTs to Implement the SDGs

By the International Atomic Energy Agency (IAEA)

The IAEA is a supporter and a developer of electronics and instrumentation related to the use of nuclear technology with a strong application to environmental monitoring. Over recent years, the focus has shifted to mobile technologies and the extended operational use of remote monitoring stations through e.g. improved use of power supplies (e.g. photovoltaics), data acquisition storage and transmission via a range of ICTs (Wi-Fi, mobile phone networks, blue tooth), based around improved processing systems (improved microcontrollers and hybrid logic devices).

Nowadays, great attention is given to the IoT, which is based on innovative approaches and advances in technological developments improving the use of power supplies, transmission and processing systems. Sensor networks provide an opportunity for linking remote areas to major network grids in industrialized centres, as well as establishing regular surveillance and monitoring data to ensure sustainable and dynamic responses to common issues in major urban centres (e.g. more efficient traffic flow, monitoring of local pollution levels etc.).

These advances are resulting in the creation of: (1) large area distributed sensor networks capable of linking remote locations to bring unmonitored (or difficult to access areas) under surveillance, as well as (2) low-cost high density measurement networks across major urban centres for monitoring and dynamic response (e.g. localized air pollution monitoring in megacities driving policy controls such as traffic flow, speed and direction.) In this sphere, the IAEA has established a collaboration and cooperation with the Telecommunication and ICT for Development (T/ICT4D) Laboratory at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy.

This collaboration has the advantage of linking remote locations to bring unmonitored (or difficult to access areas) under surveillance with lower costs. It can help ensure an exchange of monitoring data and ability for dynamic response, based on data exchanges, as well as fostering innovation and general process improvements. Challenges include the high costs of technical advances and innovation, especially in the early stages of their development.

MARiS

IAEA's Marine Information System (MARiS) is an ICT tool that helps Member States and interested scientists to analyze and monitor marine contaminants and supports the use of nuclear and isotopic techniques, which could help support SDG 14. MARiS comprises both a database and a website for examination and dissemination of the data. MARiS hosts and shares the measurements of radionuclides in the marine environment recorded in laboratories around the world. MARiS is developed and maintained by the IAEA Environment Laboratories in Monaco as a service for Member States with the aim of providing comprehensive and up-to-date information on current and historical marine radioactivity levels. It contains some 170,000 measurement records from 1957 to the present day.

Sampling and analytical procedures for analyzing trends in the marine environment are very costly, and MARiS contributes to making existing information freely available in a useful format, with direct benefits to scientists in Member States. The data can be used for focusing and refining monitoring programmes and research projects. In addition, the existing datasets can also be integrated and analyzed to provide added value and insight. The system is currently being redeveloped in adherence with Open Data principles. Challenges include patchy data coverage for certain time periods and/or geographical areas; however, the advantages of MARiS have proved numerous.

Life on Land

Sustainable Development is only Possible on a Healthy & Sustainable Planet

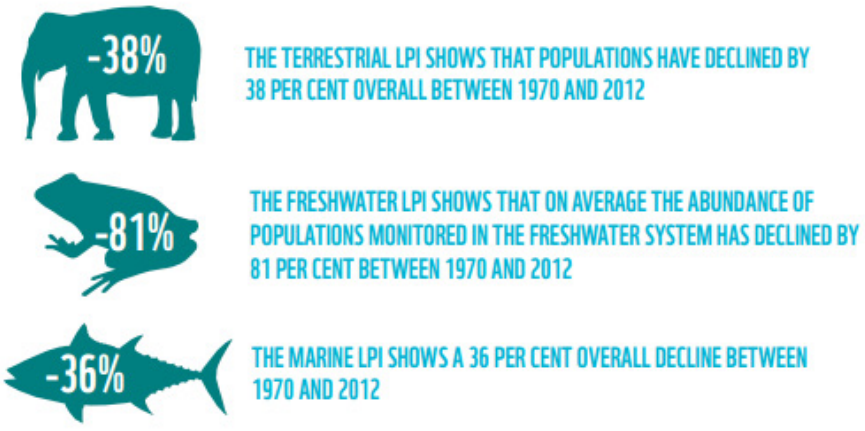
By Marco Lambertini, Director-General of WWF International

The elegant and revolutionary uniqueness of the seventeen SDGs is that they are all interconnected, but four of them are perhaps the foundation of all the others. Productive land, clean and abundant fresh water, healthy oceans and a stable climate are arguably the foundation of all the other socio-economic goals. The rationale is simple: we are not going to build a just and prosperous future for all of us, on a degraded planet with an impoverished nature. SDG 15 under the heading of 'Life on Land', along with SDG 14 ("conserve and sustainably use the oceans, seas and marine resources") and SDG 6 ("ensure availability and sustainable management of water") highlight the need for maintaining rich, productive and diverse natural systems.

Globally, biodiversity is declining at an alarming rate. WWF's Living Planet Report shows us that wildlife is in a downward spiral, with a nearly 60% decline in abundance of populations on average in wildlife across land, sea and freshwater in less than one generation since 1970 (Figure 5). The most common threat to declining populations is loss and/or degradation of natural habitat, but unsustainable exploitation, invasive species and pollution are also major threats. And let's not forget that climate change cuts through all of this.

The story of this decline in nature is not just about the wildlife that so many of us love. Biodiversity – all the animals, plants and microbial life – is the foundation for the health of the Biosphere we and all life on Earth constitute and depend on at the same time. This complex web of life is over 3 billion years old, and interacts together in a very delicate balance. All life forms that have evolved alongside us are the bricks of the walls that sustain our common home: if you remove too many bricks, the walls collapse. And a collapsed ecological balance will jeopardize the achievement of all the SDGs.

Figure 5: Monitoring the Wealth & Health of Populations using the Living Planet Index (LPI)



Source: WWF's Living Planet Report.

As biodiversity decreases, we are depleting and weakening nature's vital services which we all depend on – clean water, fresh air, food, pollination, and a stable climate – but which are especially critical for hundreds of millions of vulnerable people in developing communities who directly depend on forests, rivers, lakes and oceans for their lives and livelihoods. As the UN Special Rapporteur John Knox recently pointed out in his powerful report on biodiversity and human rights[85], the loss and degradation of biodiversity and ecosystems undermines sustainable development and human rights, including the rights to life, health and an adequate standard of living, which is the exact promise of the SDGs.

The contribution of nature to the pillars of sustainable development such as our economy, social development, health and happiness is huge. Yet its services which we use every day for free are dangerously taken for granted. To date, our development model has been based on destroying nature, rather than nurturing its resources.

We know the problem, and we understand the consequences. It is now time we focus on the solutions which we know exist. It is time we started using the resources our society needs within the boundaries of the Earth's regenerative capacity. We need to keep enough land in natural state to ensure the resilience of the vital ecosystem services. We must generate energy through clean technologies. We need to produce more food with less land, water, fertilizers and pesticides. We must harvest fish in a way that they can reproduce.

Technology can play a big role. The past fifty years have seen tremendous progress in technology and innovation and as we look for different ways to govern our natural resources, ICTs offer massive potential to develop game-changing solutions. With big data and technologies, the time for companies and governments underplaying deforestation, wildlife trade, poaching or illegal fishing is over. Artificial intelligence can now be used to help boost protection and resilience of natural systems instead.

Today, remote sensing plays an important role in planning, monitoring, and evaluating WWF's work on the ground and has enabled WWF to monitor the developments of extractive industries in socially and ecologically-sensitive areas, including World Heritage sites. The Natural Capital Project uses remote-sensing-based natural capital assessment to guide jurisdictional development planning, mapping supply risk for corporate sourcing decision, and helping conservation organizations target investments in forest restoration.

Even in the high seas, we can use satellite data and cheap GPS tracking devices to 'see' and understand global fishing and global vessel traffic. Increasingly, fisheries, the seafood-supply sector, governments and NGO partners have the opportunity to apply electronic catch documentation, seafood-traceability technologies and electronic trade information, together with big data, about the ocean and its ecosystems to enable real-time tracking, informed decision-making and responsible seafood sourcing.

Similarly various technologies and ICTs can also be used extensively to observe, monitor, track and protect our terrestrial wildlife from poachers as well as other destructive activities. We are working with governments and enforcement agencies to explore, fund, and test a wide range of technologies becoming available for wildlife conservation – from drones and wildlife tracking to radar, thermal cameras and gunshot detectors.

Over the years, WWF has found that unmanned aerial vehicles or UAVs function best as 'reactionary eyes' in the sky, deployed when an alarm is sounded by another sensor. To that end, WWF is evaluating civilian-grade UAVs for conservation applications with plans to rigorously test the technology in protected areas in southern Africa (including in Malawi, Namibia and Zimbabwe).

The recent use of thermal imaging cameras by anti-poaching teams in protected areas in Lake Nakuru National Park and in the Maasai Mara Game Reserve has increased the effectiveness of security teams. The technology has increased their chances of catching poachers hunting antelope and rhinos at night. They are now able to capture poachers most nights the teams go out, increasing their effectiveness by over 60%. Anti-poaching teams have also been able to achieve all this with smaller numbers of patrol teams.

Wildlife management using tracking collars has also proved to be a very important tool in conservation efforts. In Kenya, elephants are fitted with satellite tracking collars enabling researchers and conservationists alike to monitor individual elephant movements and chart habitat and landscape connectivity. The collars have also reduced incidences of human-wildlife conflict by alerting rangers when the elephants leave protected areas and stray close to nearby farms.

Even the use of environmental DNA (eDNA) is making strides in conservation. An innovative study in the Mekong River used cutting edge eDNA sampling to detect the presence of critically endangered giant catfish and develop a better understanding of its remaining distribution. However, these technologies carry important caveats. Drones may prove intrusive on the very wildlife they are used to monitor and imaging and camera traps can be hacked and accessed by poachers as well to locate the rare animals which should be protected[86].

These weaknesses in technology are also a reminder of the important role people play in addressing the global challenges we face today. WWF believes that saving wild species from extinction can only be achieved when people, especially local communities, are actively involved and see the gains and benefits in conserving their lands, wildlife and environment.

Whether it is companies that use tools like WWF's Water Risk Filter to assess their water risk and take steps to mitigate it or communities that use data and technology to better understand their environment and surroundings, we all have a role to play. Indeed, WWF has trained the indigenous tribe of Wai-Wais in the remote district of Kanashen in Guyana in the use of cutting-edge software, smartphones and GPS to gather data and map local communities in Guyana to report on the status of their land.

The world's new commitment to sustainable development shows that we are clearly realizing just how linked today's social, economic and environmental agendas are. This is an important step forward, but we now need to see this commitment in public and private decisions and investments too. The *2030 Agenda*, and the SDGs, if implemented effectively, will help us make the change by driving initiatives to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment that safeguards the biodiversity that is the key to all life on Earth. Nothing can be more important that protecting and preserving the planet that sustains us – all other Goals and ambitions depend on this.

Peace, Justice & Strong Institutions

SDGs, ICTs and how the fight against crime is transforming lives and communities

By Yury Fedotov, Executive Director, UN Office on Drugs and Crime (UNODC)

Countries face numerous challenges in their efforts to intercept the finances of terrorist groups and prevent them from buying weapons from transnational organized crime networks. One tried and tested method is through the use of Financial Intelligence Units (FIUs) to analyze and report on suspicious monetary transactions. To support Member States and FIUs against crime and terrorism, UNODC created goAML–Anti-Money Laundering software, which is now used by around 40 countries. The "go" family of products deliver effective software solutions to support the work of law enforcement, intelligence, anti-corruption, and drugs control agencies against the criminals. These products are evidence of how ICTs are actively working for countries on the frontlines in the struggle against transnational organized crime. But ICTs are also helping to achieve the SDGs – here's how.

Our awareness of crime is evolving. Once perceived as largely a domestic issue, crime is now recognized as a damaging transnational threat reaching deep into societies and acting as a high barrier to the achievement of peace, security and development. Crime, in the past, was viewed as marginal to the overall efforts to assist countries; today, the interrelated threats of crime, corruption, illicit drugs and terrorism are moving centre-stage in global development discussions.

The momentum for this sea-change is the adoption of the SDGs in 2015, which for the first time, acknowledged that crime hinders development and undermines peace and security. This is specifically recognized in SDG 16 of the 2030 Agenda for Sustainable Development, calling for the promotion of peaceful and inclusive societies, accountable and inclusive institutions and access to justice.

Formed in 1997, UNODC is one of the global leaders in the fight to combat illicit drugs and crime and is heavily involved in action to achieve SDG 16, as well as a number of other goals under the 2030 Agenda. Our unique selling point involves three strata and the concept is rather simple. First, we have a strong research and analysis capability which understands the scope and scale of crime and how it impacts nations[87]. Second, as part of the UN Secretariat, we are experienced at using UN forums to engage nations, strengthen cooperation and produce recommendations on action. Finally, our invaluable field network, in more than 70 countries, excels at delivery through partnerships with other UN bodies and civil society to assist crime's victims.

ICTs support and underpin this work at every level. UNODC is engaged in promoting digital forensics to search, examine and share digital evidence stored on computers, smartphones and tablets. In El Salvador, UNODC has trained numerous law enforcement officers in the use of digital forensics to tackle cybercrime. Data mining and analytics are another area. Our National Drug Control System (NDCS) facilitates the management and control of the licit movements of psychoactive chemicals and the precursor chemicals needed to make heroin, cocaine and other illicit drugs. But ICTs help in other ways. They provide insights into how to combat transnational crime through the concept of the IoT, encouraging the connectivity of devices, systems and services to the Internet to save time and money.

In many ways, fighting transnational organized crime is also about creating greater connectivity and integrating effective action. Crime is smart, adaptive and capable of moving swiftly across national and regional borders to avoid law enforcement agencies. Routes, networks, money laundering processes and the types of crimes are all capable of change. If we are to close in on the criminals, we need greater information sharing, joint operations and mutual legal assistance based on the UN Convention against Transnational Organized Crime. UNODC is imitating the IoT with its partners through our "Networking the Networks" initiative which builds connectivity with organizations, including INTERPOL, the World Customs Organization, regional police organizations and law enforcement centers, the Organization for Security and Cooperation in Europe (OSCE), among others[88].

All over the world, ICTs are helping to counter drugs, crime, corruption and terrorism at every possible level, but they also offer an overarching concept in the form of IoT that can help corner the criminals and dismantle their networks. This work is being integrated into the *2030 Agenda for Sustainable Development*, which is a powerful global blueprint for giving people in every country greater hope and opportunity. None of this would be possible without ICTs.

Using the Potential of ICTs to Advance the Goal of Building Peaceful, Just and Inclusive Societies

By Tegegnework Gettu, Associate Administrator, United Nations Development Programme (UNDP)

1. The Imperatives of SDG 16

The 2030 Agenda envisions a world transformed. Its ambitious set of 17 interlinked SDGs aims to free this and future generations from the tyranny of poverty, as well as from the inflictions of exclusion and injustice, violence and fear, and threats to freedoms and life of dignity. In SDG 16, we have global accord that, to realize this vision, we need to foster peaceful and inclusive societies, ensure that all people have access to justice, and build institutions at all levels that are effective, accountable and inclusive.

At the core of SDG 16 is the principle that peace and development are interlinked: that there can be no peace without development, and no development without peace. Its twelve targets recognize the destabilizing impact on societies and economies of all forms of violence, abuse and exploitation, the absence of rule of law and access to justice, corruption, exclusion and vulnerabilities posed by lack of legal identity, discriminatory laws and policies, and public institutions which are inaccessible and unresponsive.

If the ambition of the 2030 Agenda is to leave no-one behind, then the imperatives of SDG 16 are even more urgent than before. Today, more than 1.4 billion people live in areas affected by violence, conflict and fragility and, by 2030, the number is projected to grow to 1.9 billion. Also, half of the world's extreme poor today live in fragile settings, and experts expect this to reach 62% by 2030 if current trends continue[89]. Studies confirm that countries confronting violent conflict have a poverty rate 21% points higher than peaceful ones[90]. Radical transformation in the peace and development landscape of these countries need to take place to propel them towards sustainable development pathways.

SDG 16 could not have been more timely. In 2015, the world recorded the highest number of deaths from conflict in 25 years as well as the highest number of displaced people and refugees since the Second World War[91]. A third of the displaced are on the African continent, hosted in countries already facing enormous development challenges[92]. This trend continued in 2016, putting in peril efforts to eradicate poverty in many countries for years to come.

The impact of conflict and violence on the global economy is estimated at USD13.6 trillion[93]. Corruption adds USD2.6 trillion more (around 5% of global GDP), although experts note the figure is indicative given the clandestine nature of corrupt transactions[94]. Transparency International's survey in 2016 highlighted that corruption and inequality are closely related, and the interplay of these two challenges feeds populism and contributes to tensions in society[95]. The

"2015 Peace and Corruption" report[96] issued by the Institute for Economics and Peace also provides empirical evidence that beyond a certain threshold, there is a correlation between increasing levels of corruption and conflict, measured by political instability, violence, terrorism, organized crime, arms trafficking, and homicide rates. By contrast, as corruption decreases, prospects for peace improve. It thus comes as no surprise that five of the 10 countries ranked as most corrupt today are also ranked among the 10 least peaceful places in the world[97].

Into this mix come challenges also posed by exclusion. World Bank data note that 1.5 billion people currently have no form of state-recognized identification[98], which includes an estimated 230 million children under five whose births have not been registered[99]. The lack of legal identity renders all of them *invisible* to the law, deprives them access to basic services and opportunities, excludes them from public processes where decisions affecting their lives are made, and exposes them to victimization such as human trafficking.

Accountable and inclusive institutions are key in addressing these challenges and in making real the peaceful and just societies we aspire for. But trust in public institutions has been declining at a time when their effectiveness for delivering on the ambitious *2030 Agenda* is crucial[100]. Much is therefore required of all development actors, Member States in the first place, and partners to ensure even progress towards 2030 and, in turn, all will require much, including greater investments, strong partnerships, and bold strategies that can match the ambitions of SDG 16.

2. The Potential of ICTs to Advance Goal 16

ICTs offer enormous potential for meeting the targets of SDG 16, particularly in helping address the governance and development deficits that fuel conflict, feed mistrust of government, and weaken social cohesion. ICTs are helping build inclusive and accountable institutions specifically by enhancing the transparency of public institutions' actions through open data, by improving citizens' access to public information and services through online platforms, as well by enabling engagement through virtual dialogues and dynamic channels.

Governments across regions have embraced the digital revolution, so much so that, by 2014, all 193 Member States of the UN now have national websites, many of which enable citizens to conduct official business online, and most now have digital core administrative systems[101]. These have helped address risks of corruption and have enhanced transparency and accountability in many official processes.

UNDP has been privileged to be part of many of these efforts in a wide variety of development settings, working closely with other UN entities and a variety of development partners including national and local governments, telecommunication companies and mobile phone operators, small enterprises, youth and women's organizations, academia and local communities. For example:

- In Papua New Guinea, a simple SMS-based system is empowering citizens to report corruption in public institutions ("Phones against Corruption").

- In Ukraine, the National Assembly's open data portal (Verkhovna Rada) enables access to information on the legislative framework, draft laws, progress of plenary sessions, and expenses of the National Assembly and its members[102].

- In Bhutan, parliamentarians and their constituents connect through a videoconference programme called the Virtual Zomdu ("Zomdu" = a meeting of residents of villages or communities). The facility provides real-time face to face interactions and discussions between MPs and their constituents on new bills, national issues and community based issues[103].

- In Bangladesh, the Digital Centres have raised the effectiveness and efficiency of public services, the accessibility of services and information, and government transparency.

- In Rwanda, YouthConnekt is engaging youth across society in dialogues with government on development challenges through ICT platforms, deepening social cohesion through the open dialogues online and offline, and providing channels for empowerment through mobile app entrepreneurship.

From our work, we have learned that governance and development deficits are among the main causes of the violence and conflict witnessed across regions. Our development efforts therefore aim to address the underlying causes of conflict and violence, and ICTs are amplifying their reach and impact. For example, in North-East Nigeria, where violence has destroyed lives and communities, displaced 1.4 million people, and rendered 4.5 million at risk of starvation, ICT-enabled programmes will help communities in Adamawa, Borno and Yobe States to start new livelihoods (including in computer and cell phone repair), and establish new networks to promote dialogue and prevent conflict. Efforts also involve re-establishing systems for public institutions to function[104].

The use of ICTs in voter registration is expanding inclusive governance in numerous countries. In 2015, approximately 35 countries were using some form of digital voter registration systems with biometric data analysis functionality. These biometric voter registration systems can increase transparency and credibility of voter registration processes by helping detect multiple registrants. In fragile contexts, trust in voting registrations systems is crucial for protecting democratic gains, and ICTs have helped particularly by ensuring efficiency and by making processes transparent and trustworthy. For example, in the Democratic Republic of Congo in 2011, UNDP helped register 30 million people to vote[105]. In some of the countries with underdeveloped population registration systems, UNDP is being approached by an increasing number of requests to support registration and national ID efforts (including Malawi, Moldova, Sierra Leone, Tajikistan, Tanzania, and Zambia).

Simplification of civil registration and improvement of delivery of public services by state agencies has also been a hallmark of successful reforms in Georgia. UNDP has been supporting such reform there since 2005, including by helping to establish the modern Civil Registration Agency. This institution is a best-practice example in Europe and in the Commonwealth of Independent States (CIS) regions as well as globally, providing citizens with a prompt and user-friendly service for issuing essential documents such as birth, death, and marriage certificates, IDs, and passports.

SDG 16 may not have a target specific to ICTs, but Target 16.10 on access to information is understood as difficult to achieve in the Information Age and Digital Age without ICTs. Coupled with the increasing demand for open government, the trend is expected to only grow. The Open Government Partnership (OGP), for instance, which UNDP supports as an official partner, has grown to 75 countries and is transforming governance at all levels. Along with the pillar on transparency, civic participation and accountability, OGP's other pillar emphasizes the use of ICTs to advance openness and accountability[106]. ICTs will play a crucial role in an effort in OGP that UNDP and partners developed, which will harness data to monitor progress on SDG 16 implementation.

But the most transformative potential of ICTs lies perhaps in their ability to empower people and foster trust between government and the people, which are central to inclusive governance needed to sustain peace and shared prosperity.

3. Conclusions

The *2030 Agenda's* vision of a world transformed responds to urgencies that include serious threats to global peace and to our shared prosperity. UNDP is committed to helping address these urgencies and, from its work particularly since the launch of HDR 2011 that framed the potential of ICTs for development, to help frame the strategic use of ICTs in development efforts where they can have the most impact.

Governments will face enormous challenges in the next years as they implement the *2030 Agenda*. Part of these challenges is the need to shape a "government designed for new times"[107], which require a *government equipped* to meet quickly evolving challenges as well as *governance* arrangements that match the demands of the times. No government doing "business as usual" can respond effectively to this call. Based on lessons we learned from using ICTs in our development work around the world and on insights from other development actors, civil society, academia and the private sector, we note the following as key issues for further reflection:

Development anchor: ICT-enabled solutions can reduce costs of public services, enhance access to and quality of these services, enhance regulatory compliance, and help enhance the transparency and accountability of public agencies. Such solutions however are not automatic; they require strategic thinking about ICTs, governance, and development. To ensure even progress towards 2030, governments will need to embrace the use of ICTs not as state-of-the-art tools but as essential means to advance the building of peaceful, just and inclusive societies and to accelerate progress on the entire sustainable development agenda overall.

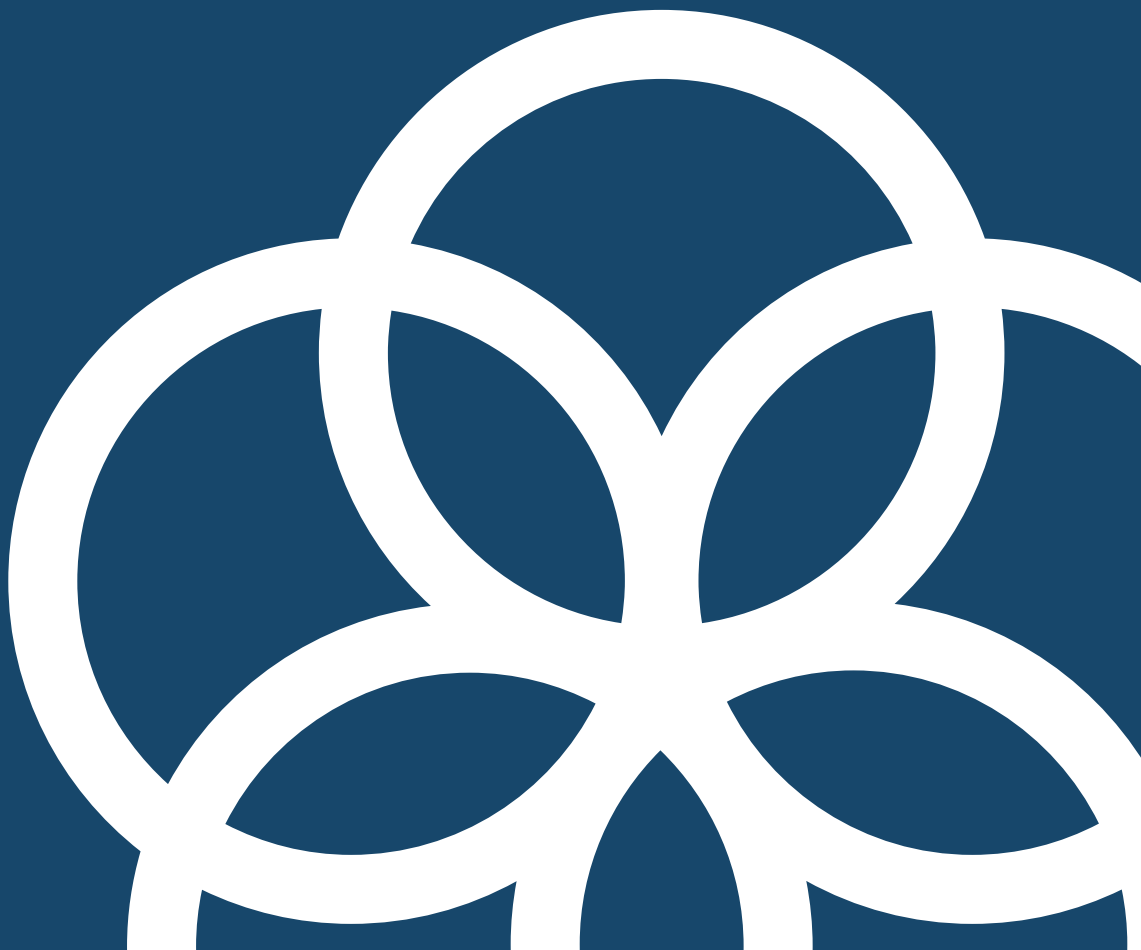
Online and offline barriers: "Connectivity" is a key feature of the digital revolution. Given that those likely to remain un-connected are the poor and marginalized[108], leaving no-one behind also means that we should be mindful of the risks posed by a *fully* digital approach and thus make sure that our efforts do not exacerbate inequality. This requires, among others, giving special attention to "digital gender divides" and to online and offline barriers to digital inclusion that women and girls face[109].

Revitalized partnerships: Meeting the targets of SDG 16 and of the entire *2030 Agenda* require increased and aligned efforts from all partners. The engagement of the cross-section of society had always been crucial in development efforts; in ICT-assisted efforts, the engagement of the ICT industry and civil society are particularly important. From our past efforts cited above, partners from telecommunications industry, civil society organizations and local communities, research institutions and donor community, as well as youth entrepreneurs had been particularly significant in identifying the most appropriate and ensuring the most strategic use of tools and approaches for specific development challenges, as well as in the effective implementation of efforts on the ground. More needs to be done to enhance the engagement of the ICT industry as partners as well as stakeholders in development.

Strategic policies: Technology alone will not achieve the goals of sustainable development. Access to information, services, and opportunities are not an automatic result of access to technology. Strategic policies are crucial, and through the MAPS (Mainstreaming, Acceleration, Policy Support) approach[110], the UN Development system stands ready to assist countries in developing the strategic policies that help accelerate progress in achieving specific SDGs through ICTs (such as SDG 3 on education, SDG 4 on health, or SDG 8 on productive employment), as well as improving the enabling environment necessary to achieve all SDGs.

SDG 16 is not only a valuable and important aspiration in its own right; it is also an important enabling goal for the entire sustainable development agenda. The sustainable development agenda is indivisible meaning that all goals need to be prioritized and that progress in one goal does have an impact on progress in other goals. Certainly, without action on SDG 16, we will not see the major transformations needed to achieve the world we want by 2030. ICTs can be a powerful tool to make that happen.

Partnerships



ICTs, Big Data and Partnerships for SDG 17

By The late Dr. Babatunde Osotimehin,
Executive Director, United Nations Population Fund (UNFPA)

There is growing enthusiasm for leveraging big data to inform and accelerate development, by strengthening the evidence base for more effective, responsible, and inclusive development investments. In a world where data often lags the pace of human progress, big data offers extraordinary potential to provide near real-time estimations of the number and locations of people. Big data can support national development efforts during or after humanitarian crises, in the midst of mass movements of people or when governments need to estimate the size, location and composition of their population during or after conflict, when official data collection systems may be undermined.

The central focus of the 2030 Agenda for Sustainable Development is to leave no one behind. This places a great demand on national data systems, as well as our collective ability to identify and locate the vulnerable. Improved understanding of subnational variations and inequalities in health, educational attainment, wealth, and access to resources is essential to achieving sustainable development. Data from existing sources (such as the census, civil registration and vital statistics, administrative records and surveys) is the core foundation for these analyses. Strong national statistical systems are needed in every country, connecting data producers and users, and linked to agile and innovative public institutions with the capacity to use and integrate diverse types and sources of data for development.

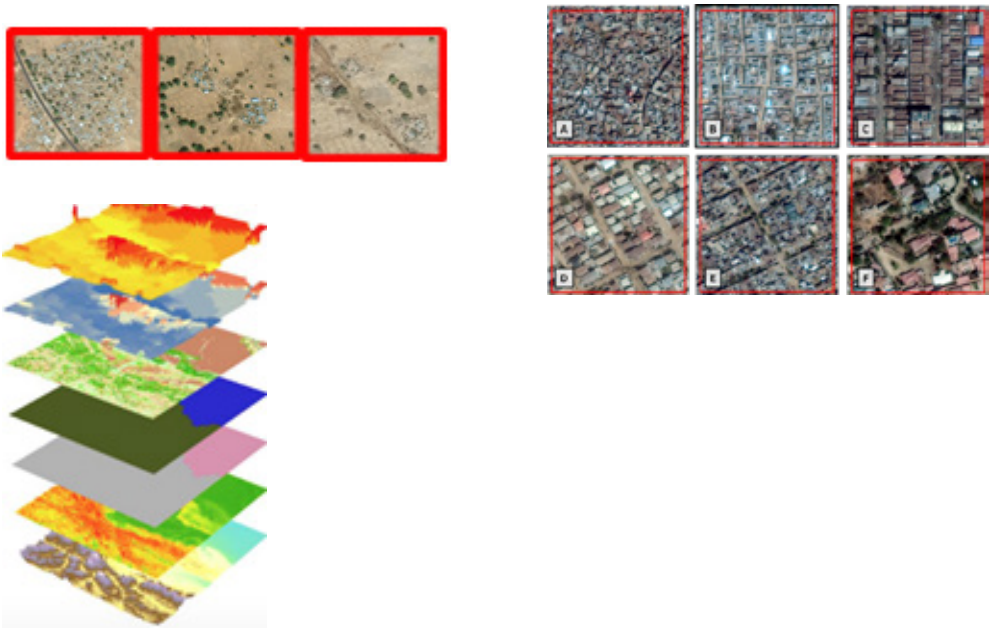
Even in fragile circumstances, and in the poorest countries, big data offers genuine potential to contribute meaningful information, and to inform and improve decision-making, and should be embraced and integrated into the world's growing data ecosystems. No rapid and accurate method exists to track population movements after disasters, when morbidity and mortality often increase considerably. For example, a geospatial study after the earthquake in Haiti, conducted by the organization Flowminder, improved disaster and risk response by tracking population movements with mobile phone network data. Without knowledge of the locations of affected people, relief assistance would have been compromised.

Digital technologies have lowered the costs of producing, sharing, distributing and visualizing knowledge. The Internet and mobile communications have massively accelerated the pace and volume of information available, and increasingly reach into even the most remote parts of the world. Such advances have already paved the way for greater political participation, transparency and public action in many places. And the big data that these systems generate offer potential to improve the gathering of data on topics formerly invisible to traditional data collection exercises. For example, UNFPA has collaborated with UN Global Pulse to use real-time digital data posted by young Ugandans to understand the types of debates they are having about contraception and teenage pregnancy.

Combining the higher frequency and greater granularity of big data with traditional sources provides important population data that would otherwise elude us. For example, UNFPA currently leads an effort to map Afghanistan's population using socio-demographic surveys, satellite imagery, remote sensing data, urban data and GIS statistical modelling. Using accurate data will be essential to Afghanistan's development (Figure 6).

Figure 6: Integration of different data sources

Ongoing socio-demographic survey, satellite imagery, remote sensing Data, urban Data and GIS statistical modeling (left chart); settlement typologies mapped from satellite imagery (right chart).



Source: WorldPop-Flowminder.

UNFPA has also partnered with USAID, the Reproductive Health Supplies Coalition and the Bill & Melinda Gates Foundation in the Global Visibility and Analytics Network (Global VAN), to ensure end-to-end visibility in the global supply chain of reproductive health commodities. A shared data platform enables all agencies, partners, countries, suppliers and freight forwarders to connect, enabling health commodities to be visible from the moment they leave the manufacturer to the distribution point, where they ultimately reach recipients. This will enable agencies to analyze and plan the distribution of reproductive health commodities, avoid shortfalls and stock-outs, highlight results in saving lives to donors, and estimate funding needs.

ICTs provide rapid analytics, accurate and up-to-date information, accessible for decision-making globally and locally. ICTs can allow optimal resource usage, bring together planning at the district, country and global levels, and make supply gaps visible in advance. An ICT system can send alerts, find options to re-route supplies to meet urgent needs, eliminate inefficiencies and identify the needs for funding and resources. And ultimately, the use of ICTs in modern supply chain management of reproductive health commodities will save lives.

The international development community and the UN system can play a critical role in advancing the use of all data sources for development by supporting countries' efforts to create an evidence base for informed decision- and policy-making and to monitor progress towards global development objectives. Over recent decades, there have been major improvements in national capacities, in public sector institutions such as National Statistics Offices (NSOs), and in collecting and managing large surveys and census exercises. These efforts must continue, riding the upsurge of interest generated by the SDGs.

Going forward, due attention must be paid to the potential of big data for the public good. Harnessing this potential will require new partnerships and new commitments. A true data revolution will draw on existing and new sources of data to fully integrate statistics into decision-making, promote open access to, and use of, data and ensure increased support for statistical systems – indeed, this is how we will ensure no one is left behind.

ICTs Require Coordinated Partnerships to Achieve the SDGs

On behalf of the World Food Programme (WFP)

As the world rang in a new year, it also brought with it an estimated 85 million children, women and men in urgent need of life-saving assistance. The world continues to face conflict, disease and natural disaster, and the onus is on us, the humanitarian and development community, to drive the agenda forward, working with a wider network of more diverse partners to deliver a better future for millions of people. WFP is the world's largest humanitarian and development organization, fighting hunger worldwide. WFP is a solution provider in the struggle to end acute hunger and malnutrition, focusing on reaching the furthest behind first. As a 100% voluntarily funded organization, WFP relies on its partners and donors across the world to support and implement its life-saving work across the globe.

As the UN frontline agency in the fight against hunger, WFP contributes to a number of SDGs, depending on country contexts and national priorities, while prioritizing two:

- **SDG 2: Zero Hunger** – end hunger, achieve food security and improved nutrition and promote sustainable agriculture.

- **SDG 17: Partnerships for the Goals** – strengthen the means of implementation (MoI) and revitalize the global partnership for sustainable development.

At the humanitarian-development nexus, WFP is delivering more digital-enabled assistance to its beneficiaries. From its position on the global stage, it has seen first-hand how access to ICTs is critical in both emergencies and peacetime. ICTs are changing the way communities are affected by, and can respond to, disasters as well as development opportunities. Communications and the ability to communicate are now recognized as a basic human need, alongside food, water and shelter.

With regards to SDG 17, the implementation and use of ICTs require coordinated partnerships in order to deliver the most appropriate and timely solutions to beneficiaries. With populations in the millions needing reliable access to communications networks and ICTs, the scalability and integration of services remain a challenge for humanitarian organizations – acting alone, no single organization can extend ICT services to entire communities. Increasing connectivity and access to ICTs by the world's poorest people will provide educational and economic opportunities and changes in behavior and culture, as well as contribute to achieving the mission of the 2030 SDG Agenda of "Leaving No One Behind". The time is ripe to forge productive partnerships in order to create synergies for the most innovative and effective ICTs to address global humanitarian and development needs.

Trends and Implications in Partnerships for ICTs

The last decade has witnessed unprecedented growth in ICTs, in terms of both technology and services provided in the field. Cash-based assistance, unmanned aerial vehicles (UAVs) and other cutting-edge technologies have emerged, influencing greater expectations of how technology can deliver assistance to beneficiaries. While advances in these areas have enabled new solutions in response operations, they have also placed greater demands on the humanitarian sector to provide more robust services and tools than previously available. However, these emerging technologies must be explored for their true potential and managed to ensure that their risks are mitigated and the safety of people receiving assistance is protected.

Disasters underline the need to provide connectivity to affected communities, enabling them to communicate with their loved ones, request much needed support, access vital information and services, and have a say in the response and recovery of their own community. Operating in 80 countries, with the support of over a thousand NGOs, and a growing network of governmental and private sector partners, WFP recognizes the vital role of partnerships in achieving the SDGs. With the shift to delivering digital assistance, ICTs play a key role in enabling WFP and the broader humanitarian sector to deliver on their mandates and help fight hunger.

The Emergency Telecommunications Cluster (ETC) is a global partnership of humanitarian, government and private sector organizations, led by WFP, and working to ensure that all those responding to emergencies – including people affected by disaster – have access to vital communication services. The ETC aims to strengthen system-wide preparedness, technical and human capacity, thus ensuring a more coherent and effective response to emergencies by mobilizing humanitarian, private sector and government organizations. By working with national governments, communities and industry partners in disaster-prone areas, the ETC is improving and decentralizing response-readiness, and strengthening the ability of national actors to respond to multiple large-scale disasters.

Corporate organizations, in particular those within the ICT field, are increasingly participating in the development of new solutions as part of their CSR initiatives. Ericsson Response, for example, has been working closely with the ETC in the design and development of 'WIDER' (Wireless LAN in Disaster and Emergency Response), a mechanism designed to enable humanitarian workers to access the Internet from any suitable device in any emergency-affected area. Functioning similar to Wi-Fi registration a hotel, for example, WIDER will allow the ETC to better manage access to the network, addressing the challenge of increased bandwidth requirements, and ensuring users are provided with the best communication services possible.

Governments are also strong partners of humanitarian organizations, supporting the development of traditional, as well as more innovative, solutions to fight hunger. In 2016, WFP and the Government of Belgium further strengthened cooperation, collaborating on a pilot project to develop and implement an UAV (or drone) coordination model for humanitarian emergency preparedness and response. There are different local laws and policies on the use of UAVs and various security concerns may make it difficult to leverage UAVs for humanitarian and development operations. A coordinated approach is vital to defining and leveraging the use of UAVs globally to further the *2030 Agenda*.

Cash-based transfers and mobile money to beneficiaries are also growing at very rapid rates. Mobile money requires recipients to interact with technology. Equipping beneficiaries with SIM cards or mobile phones supports their financial inclusion and increases the uptake of ICTs in the poorest parts of the world. To ensure the world's inhabitants have access to ICTs and make use of them, support is needed from governments, regulators and international actors to expand the reach of a competitive mobile sector. Activities by regulators are needed to facilitate financial transactions and basic financial inclusion via mobile phones. Advocacy and support are also needed from international actors to bring about legislation to produce these outcomes. Only by continuously working towards identifying the best coordination models can we ensure mutually beneficial outcomes of a wider network of partners in offering a broader scope of relevant solutions, technologies and capabilities.

ICT Humanitarian-Private Sector Partnerships – Advocating Shared Principles

Before, during and after crises, local communities must be at the centre of humanitarian response efforts. The onus is on the entire response community – humanitarians, governments and the private sector alike – to strengthen their capacity to respond, recover and redevelop from disaster. To achieve this, the humanitarian and private sectors must collaborate well under clear operating frameworks. Intervention design and choice of solutions must also reflect the need to hand them over to local governments within the short- to medium-term. It is important to make sure the solutions are sufficiently context-specific and do not crowd out suitable local solutions.

International conventions such as the Tampere Convention[111], governance frameworks and accountability mechanisms are an integral part of humanitarian partnerships. These mechanisms provide a principled operating framework aimed at pre-establishing standardized agreements and common procedures among partners. With international charters clearly articulating the rules of engagement in partnership arrangements and principled governance frameworks in place, humanitarian-private sector partnerships should be able to operate in a climate of shared outcomes. ICTs act as a connecting force, linking those across the globe, and will continue to underpin development and the reliable, effective and transparent partnerships needed to achieve the SDGs.

The Government of Luxembourg and the ETC recently convened a World Humanitarian Summit Business Consultation for the satellite industry to identify issues and make commitments to improve engagement in humanitarian emergency response. The meeting generated a 'Crisis Connectivity Charter' with a set of principles, including: strengthening partnerships between satellite industry, government and humanitarian sector; enhancing coordination to enable prioritization of humanitarian Internet traffic during disaster operations; prepositioning satellite equipment; providing training and capacity-building.

This Charter is a prime example of a new generation of life-saving alliances, with companies overcoming commercial competition to partner with the humanitarian community on the basis of shared goals. Innovative, dynamic and results-focused, ETC and the Government of Luxembourg share decision-making roles in this partnership. WFP has the practical experience of humanitarian emergencies, while the private sector partners have the technical expertise in developing unique satellite infrastructure, under the framework built by the Government of Luxembourg. The result is a collaborative relationship with each partner learning from one another to develop comprehensive solutions for the entire humanitarian community.

Before, during and after crises, local communities must be at the centre of ICT-driven humanitarian response and sustainable development efforts. The entire response community must strengthen their capacity to prepare for, respond to, and recover from disaster. To achieve this, humanitarians, governments and private sector must collaborate, cooperate and coordinate adequate and suitable technology-driven solutions. No single organization can extend ICT services to entire communities – scalable and integrated solutions can only be achieved through coordinated partnerships.

Measuring Sustainable Development: a Global Postal Data Revolution in the Digital Era

By Bishar Hussein, Director-General of the Universal Postal Union (UPU)

Did you know that your online order produces valuable data every time it is delivered by the Post, the most physically connected network in the world? This is because e-commerce has become truly global, and the postal network, with its 690,000 post offices and 5.2 million staff, has become one of the most prominent delivery channels – if not the most prominent – for hundreds of millions of cross-border online orders. As an unexpected by-product, the billions of tracking records for these international transactions can be used to help achieve the UN SDGs by providing reliable indicators on social and economic development. Conscious of this opportunity, the Universal Postal Union (UPU) leverages disruptive ICTs to collect, share and analyze data that can support a wide range of development policies. Our collaboration with UN Global Pulse is the most noteworthy example in this regard.

UPU–UN Global Pulse collaboration: using global postal flows to measure social and economic development

When the development of the Internet became a global phenomenon, many pundits predicted an acceleration of Posts' decline, as substitution from letters to e-mail gathered pace. However, although ICTs posed a significant threat to Posts, they also carried exciting opportunities, thanks to e-commerce and to the pervasive digitalization of various inclusive services delivered to citizens everywhere. In the age of the IoT, the postal sector very much remains an enabler of inclusive development and an essential component of the global economy.

The digital transformation experienced by postal operators means that they can track the electronic connections between millions of devices and sensors attached to the critical physical and human components of the global postal supply chain, whether they be buildings, vehicles or delivery staff. Resulting from this connectivity between postal "things", the automated transmission of data between millions of nodes in the global postal network enables an ever-smoother and predictive tracking and tracing of postal shipments across the world.

What is more, governments and policy-makers are realizing that the growing application of a wide array of modern ICTs in the postal sector will soon lead to the real-time capture of several trillions of digital footprints every year, which could, through appropriate data-sharing arrangements, be leveraged to monitor progress in achieving the *2030 Agenda for Sustainable Development*.

In particular, target 17.18 of the SDGs stresses the urgent need for the international community to enhance, by 2020, capacity-building support to developing countries in order to significantly increase the availability of high-quality, timely and reliable data at various levels of granularity. In response to this immediate challenge, the UPU, in partnership with the UN Global Pulse, has been researching how to unleash the potential of postal big data to measure and monitor development[112].

The UPU and UN Global Pulse have published a recent joint study[113] in which they analyzed a data source that is undoubtedly "big", and that also represents one of the most established and pervasive long-distance communication networks in the history of mankind – data on the postal network. Every time a letter or a parcel is sent, many digital traces are left, including where it was sent from (in the origin country) and where it was delivered (in the destination country) – see Figure 7. The UPU has been collecting electronic data on the traces left by these international transactions for over twenty years. In many cases, the data comes from post offices disconnected from any digital or mobile network.

The joint UPU–UN Global Pulse study addressed the question whether the network patterns of different flow networks between countries could be used to estimate indicators for the socio-economic profile of a country. To test this hypothesis, the study produced aggregate measures of each country's connectivity based on the postal network structure and international flows, and then correlated different measures of global connectivity with 14 commonly used socio-economic indicators – including a country's GDP per capita, Human Development Index (HDI), Gini coefficient, Corruption Perception Index (CPI) and poverty rate.

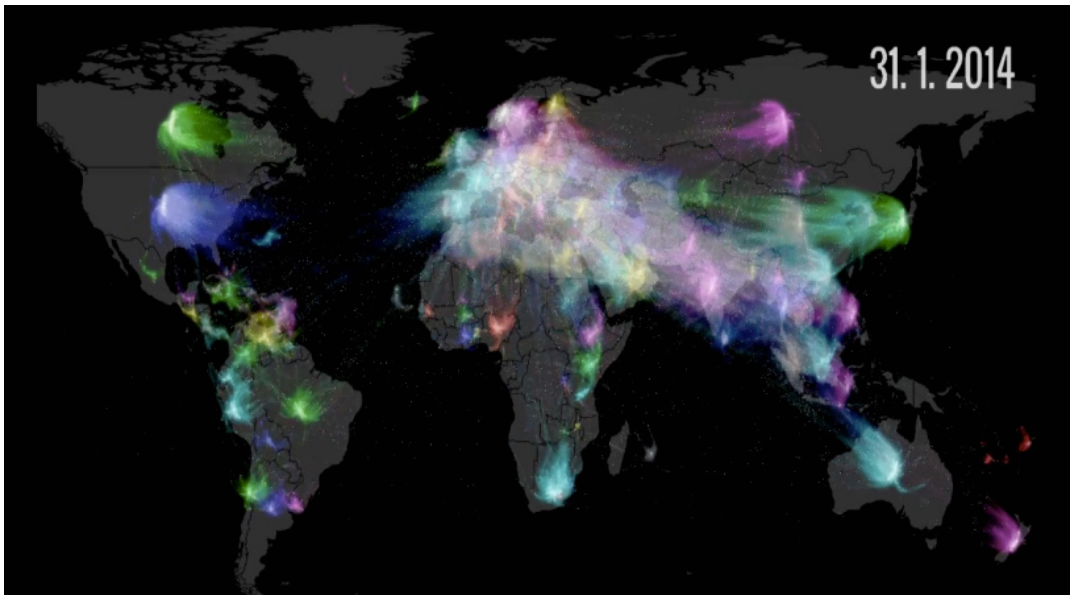
GDP per capita and life expectancy were found to be the most closely correlated with the degree of global network connectivity (as a combined measure of all global networks), followed by postal, trade and Internet levels of connectivity, taken separately. In other words, a very close link was identified between national wealth and the cross-border flow of goods and information facilitated through the use of ICTs.

The UPU–UN Global Pulse study concluded with four principal findings. Firstly, it is clear that global postal flows can reveal fundamental aspects of international dynamics and act as a proxy for many socio-economic indicators, such as GDP, poverty rate and HDI. Secondly, combining global postal data with data from other global networks can produce even better proxies for measuring development at national level. Thirdly, measures of postal connectivity at the community level can provide a view of local well-being in real-time, thanks to the continuous tracking of postal shipments. Finally, the exponential growth of e-commerce strongly suggests that postal flows will remain a key indicator of economic activity.

By leveraging ICTs, the study showed that UPU's big data was able to generate reliable indicators on social and economic development, even in cases where macroeconomic data is patchy (e.g. due to weak local statistical capabilities). And this big data is truly invaluable for policy-makers, donors, fundraisers, project managers and all key stakeholders in the technical cooperation arena, who are eager to measure the potential and the actual impact of projects in the field.

In conclusion, while many were predicting that the advent of new ICTs would spell the end of the Post, the postal sector has in fact reached a tipping point, where the opportunities opened up by ICTs far outweigh the initial threats of electronic substitution. With the postal sector already at the forefront of innovative SDG measurement initiatives around the world, and with postal operators worldwide fully committed to delivering on numerous SDG targets, the international development community can definitely rely on this important and inclusive delivery channel – available to and accessed by several billion citizens every year, including the most vulnerable. It is now up to national statistical offices and other international organizations to fully seize this unique opportunity for collecting data and monitoring key global development patterns by further integrating postal big data indicators into their SDG measurement toolbox. This and other studies show that, far from being an outdated technology, postal services remain a key foundation infrastructure in our modern societies, and one which continues to throw up surprises about how and why we live the way we do.

Figure 7: A Snapshot of Global Postal Flows from 31 January 2014



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List of Acronyms and Abbreviations

CAD Computer-Aided Design

CAE Computer-Aided Engineering

CDRs Call Data Records

CPI Corruption Perception Index

CSIS Climate Service Information System

eDNA environmental DNA

EHRs Electronic Health Records

ETC WFP's Emergency Telecommunications Cluster

GFCS Global Framework for Climate Services

GPS Global Positioning System

FAS IMF's Financial Access Survey

FDI Foreign Direct Investment

FIUs Financial Intelligence Units

GIS Geographical Information System

GOOS Global Ocean Observing System

HDI Human Development Index

HHC IAEA's Human Health Campus

HINARI Health InterNetwork Access to Research Initiative

HIT Health Information Technology

IAEA International Atomic Energy Agency

ICTs Information and Communications Technology

IFAD International Fund for Agricultural Development

IFIs International Financial Institutions

ILO International Labour Organization

IOC Intergovernmental Oceanographic Commission of UNESCO

IODE IOC's International Ocean Data and information Exchange program

ISID Inclusive and Sustainable Industrial Development

IT Information Technology

ITA WTO's Information Technology Agreement

KOS Knowledge Organization System

LDCs Least Developed Countries

LMICs Low- and Middle-Income Countries

LPI WWF's Living Planet Index

MARiS IAEA's Marine Information System

MDGs Millennium Development Goals

MoI Means of Implementation

MSMEs Micro-, Small- and Medium-sized Enterprises

MTCC Maritime Technology Communication Centres

NGO Non-Governmental Organization

NKM Nuclear Knowledge Management

NODCs IOC's National Oceanographic Data Centres

NPPs Nuclear Power Plants

NWP Numerical Weather Prediction

OECD Organisation for Economic Cooperation and Development

OSCE Organization for Security and Cooperation in Europe

OSS Open Source Software

PIM Plant Information Model

PSSA Particularly Sensitive Sea Areas

RFID Radio-Frequency Identification

SDGs Sustainable Development Goals

SIDS Small Island Developing States

SMEs Small- and Medium-sized Enterprises

STEM Science, Technology, Engineering and Mathematics

TFA WTO's Trade Facilitation Agreement

TVET Technical and Vocational Education and Training

UAVs Unmanned Aerial Vehicles

UHC Universal Health Coverage

UNCTAD United Nations Conference on Trade and Development

UNESCO United Nations Educational, Scientific and Cultural Organization

UNFPA United Nations Population Fund

UNHCR Office of the UN High Commissioner for Refugees

UNIDO United Nations Industrial Development Organization

UNODC UN Office on Drugs and Crime (UNODC)

UPU United Postal Union

USD United States Dollar

VUCC net IAEA's Virtual University for Cancer Control

WFP World Food Programme

WHO World Health Organization

WIDER Wireless LAN in Disaster and Emergency Response

WIGOS WMO Integrated Global Observing System

WIS WMO Information System

WMO World Meteorological Organization

WTO World Trade Organization

Footnotes

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