ICPD30 THINK PIECE

NAVIGATING MEGATRENDS:
The ICPD Programme of Action for a Sustainable Future

The Future of Population Data

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"Valid, reliable, timely, culturally relevant and internationally comparable data form the basis for policy and programme development, implementation, monitoring and evaluation" (Chapter XII of the ICPD Programme of Action)

In mid-2024, UNFPA issued five think pieces to mark the thirtieth anniversary of the landmark 1994 International Conference on Population and Development (ICPD). Under the framing of Navigating Megatrends: The ICPD Programme of Action for a Sustainable Future, the five think pieces are titled:

- Demographic Change and Sustainability
- The Future of Sexual and Reproductive Health and Rights
- **The Future of Population Data**
- ICPD and Climate Action
- A Safe Digital Future

Population data systems can increase value for development through better data integration by capitalizing on new geospatial and non-traditional data sources

The think pieces explore ways to sustain, refresh and accelerate ICPD commitments in a world of radical transformation. Designed for development actors and policymakers, they reflect on progress and highlight likely future scenarios. They offer starting points for discussion on what's next for population, development, and sexual and reproductive health and rights.

This think piece highlights key findings and recommended actions on the future of population data. It suggests that population data systems can increase value for development through more and better data integration, grounded in stronger registry-based solutions while capitalizing on new geospatial and non-traditional data sources. The growth of new digital technologies calls for urgent attention to data governance, and expanded national, regional and global investments to prepare the next generation of population data scientists to meet the information and data protection needs of the future.

1 | Introduction

"Valid, reliable, timely, culturally relevant and internationally comparable data form the basis for policy and programme development, implementation, monitoring and evaluation." The opening statement of Chapter XII of the ICPD Programme of Action stressed the fundamental requirement of population and development data for government planning and the need for targeted investment in population data ecosystems. Recommended actions included but were not limited to strengthening the national capacity to collect, analyse, disseminate and use comparable population and development data; promoting interactions between data producers and users; and designing and implementing training programmes in statistics, demography and population and development.

The Programme of Action placed specific emphasis on the importance of gender-disaggregation and the need for more accurate data on women's social and economic status and their current and potential contributions to economic development.

In the intervening 30 years, numerous development initiatives, global and regional, have echoed these recommendations.[1] Principal among these is the call of the Secretary-General of the United Nations for a "data revolution",[2] one that would integrate traditional and newer forms of data and equip national governments with requisite data systems to track and achieve the Sustainable Development Goals (SDGs). A core demand for SDG data is that every country should be able to identify and locate those furthest behind for any given SDG indicator, and thereby target interventions to those experiencing the greatest shortfalls and clearest needs. National data systems that "leave no one behind" had a unique target date of 2020 (not 2030), recognizing that major investment in data was needed not only to monitor development progress but also to provide requisite baseline disaggregated data to tailor SDG investments for the greatest impact. Population data constitute a major pillar of the SDG data infrastructure, providing denominators for up to 107 of 232 unique SDG indicators.

While the modernization of data systems has evolved substantially since 1994, accelerating the speed of data processing, broadening the types of data available (e.g., geospatial, biometric and digital trace data) and offering cost-cutting opportunities, the recommended actions of the Programme of Action for strengthening population data systems have proven a high bar for many national governments. Data too often have remained detached from interventions, rather than embedded within investments in health, education, humanitarian relief and the like.

Despite significant progress in the availability of development data, a North-South divide persists in both the infrastructure and human capacity to analyse, disseminate and transform data into public knowledge for development. At the end of the last decade, the scale of official development assistance (ODA) for statistics support accounted for only half the amount required to implement the Cape Town Global Action Plan for Sustainable Development Data.[3] A recent survey of 101 national statistical offices (NSOs) found that aspirations to fund the action plan were "yet to be realized"[4] in low- and middle-income countries. Around the same time, COVID-19 exposed gaps in population and health data, including civil registration and medically certified cause-of-death data, as many low- and middle-income countries were unable to estimate the death toll due to the pandemic. Many population data aspirations highlighted in 1994 remain unfulfilled.

The world we live in has been transformed by global megatrends and emerging threats, such as population ageing and decline, leading to demographic anxieties; the rise of anti-gender narratives and the rollback of reproductive rights; rapid urbanization; global pandemics; and the climate crisis, protracted conflicts and non-state violence, which are triggering mass population displacements. Technologies – including smart phones, social media, digitization, geospatial solutions, artificial intelligence (AI), the Internet of Things, cloud computing and advanced robotics – have not only transformed data systems and expanded the realm of human capabilities but have also enabled new forms of harm perpetrated in the digital space, including technology-facilitated gender based violence.

These megatrends demand new data and population knowledge on human and environmental interactions, new forms and patterns of mobility, changing social and gender norms and choices

around reproduction and family formation, the determinants of healthy ageing over the life course, and the impact of technology on the well-being and bodily autonomy of people, among many other issues.

As the world reaches the 30-year anniversary of the ICPD and the 2020 round of population and housing censuses draws to a close, this think piece takes stock of the progress and extant gaps in population and development data since 1994. It offers a critical outlook on the future of population data systems (see Box 1) and the potential for innovation. It does not attempt to foresee how population data systems will look in the future – an attempt that would be doomed to failure, given the diversity of data systems and architectures, and the unpredictable course and acceleration of innovation. The think piece will instead illustrate pathways towards national statistical systems that are fit-for-purpose for the post-2030 development agenda and that will help fulfil the promise of the Programme of Action.

Population data systems can increase value for development through more and better data integration, grounded in stronger registry-based solutions, and capitalizing on new geospatial and non-traditional data sources. The growth of new digital technologies calls for urgent attention to data governance and expanded national, regional and global investments to prepare the next generation of population data scientists to meet the information and data protection needs of the future.

BOX 1

What do we mean by population data systems?

Population data systems refer to integrated frameworks for the collection, management, analysis, dissemination and use of population-related data. These systems typically draw from diverse sources, including censuses, surveys, administrative records and geospatial data. They provide information on the size, geographic location and characteristics of the population – such as age, gender, marital status, household composition, ethnicity, socioeconomic status and health outcomes – at any point in time. They also record ongoing changes that shape a population, such as vital events (births, deaths, marriages and divorces) and internal and international migration. Population data systems are commonly used to generate population estimates, monitor population trends and generate future population projections, allowing users to assess current and future population needs, adopt changes in infrastructure and resource allocation, and evaluate the effectiveness of programmes and policies. In doing so, they play a crucial role in decision-making to improve the health and well-being of communities. In particular, population projections help decision-makers anticipate and prepare for future demographic trends.

Population projections help decision-makers anticipate and prepare for future demographic trends

While the realm of population data extends to other types of data (e.g., qualitative data and clinical studies), this paper focuses on national data systems that underpin the production of official demographic and social statistics and aspire to represent the entire population of a country. In line with the scope of the ICPD mandate, examples highlighted in this paper primarily refer to demographic, health and gender data.

2 Transformational Change in Population Data Systems Since 1994 and Prospects for the Future

Progress and modernization of population and housing censuses

Population and housing censuses are and continue to be the cornerstone of demographic data infrastructure in most low- and middle-income countries. Most countries have conducted or are planning to conduct at least one population census in the 2020 round (2015 to 2024).[5] The role of censuses is also central to the 2030 Agenda for Sustainable Development, both in providing population denominators for indicators as noted above and disaggregated data on vulnerable subpopulations. A specific SDG target (17.19.2) underscores the importance of censuses as a data source for monitoring inclusive development. Over the past 30 years, census approaches and methodologies have modernized in a variety of ways that portend the future. Key innovations in data collection, processing and analysis are outlined below.

Digitization: Consistent with the progressive digitization of data systems worldwide, virtually all countries conducting field enumerations for their censuses have digitized data collection through the adoption of handheld devices such as tablets and smartphones. Computer-assisted personal interviewing (CAPI) has become the most common method of enumeration, generating significant improvements in census processes and data quality, and specifically, a more timely release of census results. To reduce the scope and cost of field enumerations, some countries have adopted CAPI in combination with other methods, such as online self-enumeration. The uptake of alternative methods of data collection was accelerated by the need to limit face-to-face interviews during COVID-19.

Use of geospatial information, including satellite imagery data: The geospatial revolution has radically transformed census processes across the entire cycle, with significant efficiency gains. Mapping is generally recognized as one of the most crucial activities of a census, providing the geographic basis of enumeration. With the advent of geographic information systems (GIS), census agencies across the globe have transitioned from hand-drawn sketch maps to digital mapping, and begun using satellite imagery (see Box 2) and implementing a range of GIS solutions. Over time, increasingly sophisticated algorithms have been developed for building footprint extraction, analysis and enumeration area delineation, allowing the identification of new structures without extensive field canvassing.

The use of GIS in censuses has progressively extended beyond the pre-enumeration phase. During enumeration, digital maps in combination with global navigation satellite system-enabled devices inform the deployment of census enumerators and assets, and help enumerators navigate the field. Geospatial dashboards, especially when powered by Cloud solutions, allow real-time monitoring and quality assurance of census operations. In the post-enumeration phase, digital maps, including dynamic maps and visualizations and geospatially enabled web data portals, are increasingly used to analyse, present and disseminate census results.

Georeferenced statistics compiled from census data can generate tremendous insights into development outcomes at the local level, unmasking patterns of inequalities.[6] Gridded census

results are a key example of geocoded census outputs that significantly enhance the usefulness of census data for policy- and decision-making when overlaid with other geospatial data. For example, such integration has demonstrated considerable value in improving operational responses to disasters. Figure 1 illustrates a case where Malawi's gridded census data were used in combination with satellite-derived flood footprints to estimate the population affected by the catastrophic floods caused by Tropical Storm Ana in late January 2022. Globally, few countries so far have produced gridded data from a census. The practice was adopted for the dissemination of the 2021 European censuses,[7] however, paving the way for new approaches to measuring degrees of urbanization.[8]

Model-based population estimates: In countries where a universal enumeration is not possible due to inaccessibility or insecurity in some areas, advances in the availability of high-resolution satellite imagery, including geopositioning tools for field surveys, combined with statistical methods and computational power, have enabled the development of geospatial statistical models. These can estimate population distributions at fine spatial scales in hard-to-reach areas. In particular, this has been possible due to the advent of machine learning and geoartificial intelligence enabling the extraction of very high-resolution and 3D spatial information on building footprints from satellite imagery.[10]

BOX 2

The power of satellite imagery

Mapping and georeferencing of population, housing and agricultural censuses is only one of the many applications of satellite imageries in development and humanitarian interventions. From early warning on disaster risk, damage assessment and directing emergency response, supporting security or peacekeeping operations, monitoring or evaluating impact of development projects, aiding topographic maps updates for national mapping authorities, or improving food security through crop forecasting and land use monitoring, satellite imagery in both the optical (multispectral or hyperspectral) and radar range is today an indispensable tool used by governments, the private sector, and the United Nations and other international organizations.

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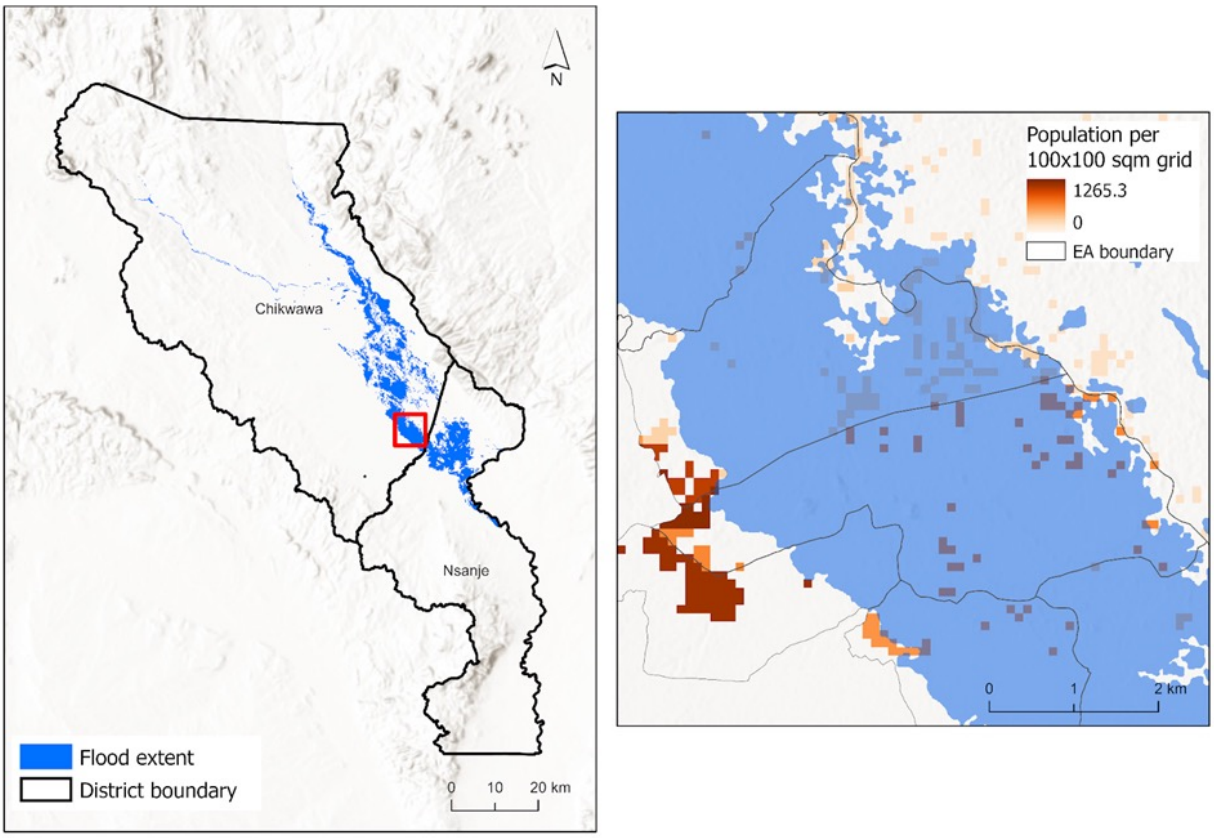
It has also been estimated that a number of climate-related indicators or variables required for the monitoring of the SDG targets and the implementation of the Sendai Framework for Disaster Risk Reduction can be directly measured in near real-time using satellite imagery alone, and at the lowest possible administrative unit level within any country.

While medium-resolution satellite imagery has gradually become more easily available and even free of charge, with various government-sponsored Earth observing satellite constellations ensuring long-term observations, the higher resolution imagery is still in the commercial domain and can be very costly, even as it is critical in census mapping as well as many of the operational areas mentioned above.

▶ FIGURE 1

Population in the flood zone caused by Tropical Storm Ana in the traditional authorities of Chikwawa and Nsanje, Malawi, late January 2022



Source: UNFPA analysis based on UNOSAT flood map[9] and Malawi 2018 census.
Note: EA refers to census enumeration areas.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Identifying vulnerable populations: The transformation of the census data cycle has been driven by technological advancements and emerging data needs as well as new statistical standards to meet these needs with more accurate and comparable data. The uptake of specific add-on questions has considerably enhanced the possibility of using national censuses to identify and locate vulnerable populations (e.g., migrants, persons with disabilities, Indigenous Peoples and people of African descent). As an example, about two thirds of countries have adopted functional difficulty questions to measure disability in censuses or surveys.[11] With an unprecedented number of people forcibly displaced by conflict, violence, human rights violations and climate-related events, countries have also started to adapt census protocols to collect data on refugees, internally displaced people and stateless persons, asking specific questions in addition to core migration variables. These good practices have not yet been systematically accompanied by the public dissemination of disaggregated data on the socioeconomic disadvantages of vulnerable subpopulations or by comprehensive data quality assessments.

The use of administrative data to generate census-like information: While traditional population and housing censuses involving the enumeration of the entire population continue to account for

the large majority of all censuses in the 2020 census round, more than 40 countries in Europe and parts of Asia have been using population registers, linked with other administrative records generated by government functions (education, health, employment, tax and social security, etc.) to produce census-like data. Some countries have conducted a fully register-based census (see Box 3); others have been using administrative data in combination with partial or full-field census enumeration. A "combined" approach has often been a stepping stone to a register-based census in the following round. Undoubtedly, as the quality of registers improves, the transition towards using administrative data for census purposes will be a defining feature of the next census round. Only 6 of 45 Members of the United Nations Economic Commission for Europe still expect to conduct a traditional census in the 2030 round (2025-2034).[12] Pilot initiatives to integrate administrative data in census processes are being developed in other regions.

BOX 3

Register-based censuses

A register-based census is a method of conducting a census where administrative registers and databases maintained by government agencies and other organizations are used as the primary source of data. As an alternative to conducting traditional door-to-door surveys or self-enumeration, a register-based census utilizes existing data such as population registers, tax records, health records and other administrative databases.

Outstanding and emerging challenges

Despite continued investment in census modernization and notable developments in census approaches and methodologies, emerging challenges in the current round of field-based censuses have prompted reflection on whether the traditional census is fit for serving as the foundation of population data systems in the future.

COVID-19 significantly disrupted census implementation in the majority of countries due to factors such as the diversion of funding, disruption of supply chains and the need to adapt data collection approaches to minimize in-person contact. While most delayed censuses have been or will take place within the time frame of the 2020 round, some are being postponed beyond the end of the round. About 20 countries, including some of the largest in Africa and Asia, were not planning a census at the time of writing.[13] It is possible that global census implementation may decline relative to the 2010 round (2005 to 2014), when 214 countries or areas (covering about 93 per cent of the world population) conducted a census.[14]

In addition, concerns about the accuracy, relevance and coverage of census data have emerged due to the increasing difficulties of conventional enumeration. These difficulties include decreasing response rates in some countries; challenges in capturing new types of living arrangements and patterns of mobility, such as multiple residences, single-person households and student mobility; and the omission by design or systematic underenumeration of some of the poorest and most marginalized population groups, such as the homeless, nomadic populations, and irregular migrants. To achieve high levels of coverage, some countries have been forced to extend field data collection for weeks or even months.[15] This is an unprecedented development that continues to affect field operations in the aftermath of the global pandemic, undermining one of the fundamental features of a population census – its simultaneity.

The integration of data collected with multiple methods, including online self-enumeration, field enumeration and self-response paper questionnaires, also poses some technical difficulties, most notably the fact that Internet-based data collection is feasible only in contexts with broad Internet penetration. Even in these contexts, it risks excluding some population groups, such as older people. The correction for non-response bias in online data collection is often difficult because differentials in digital adoption by gender, age and other demographic categories are not well understood or measured.

An outlook on the future of the census

Due to this variety of challenges, the cost-effectiveness, value-for-money and fitness of conventional population and housing censuses to meet evolving data needs are under scrutiny in many countries. In low-income countries, shrinking fiscal space, increasing public debt[16] and difficulties in mobilizing resources present obstacles compounded by the misguided public perception that census-type information can be easily generated through alternative data sources in real time and at a fraction of the cost.

Census data remain highly relevant for decision-making and retain a comparative advantage over other data sources as the only coherent basis for producing small area or local area statistics in most countries, including in the context of the 2030 Agenda and its focus on data disaggregation to leave no one behind. Yet the pressure on NSOs to use alternative data sources and devise more cost-effective strategies to generate inclusive population data will most likely continue to grow. The cost of conducting enumeration-based censuses will increase in countries with high population growth: Of the 700 million people who will be added to the world population by 2034, 637 million will live in low-income and lower-middle-income countries[17] where field-based enumerations are likely to remain the main method of data collection.

For countries with functioning administrative registers, there is little doubt that the trend of moving away from field-based enumeration and towards combined and full register-based censuses will continue in the 2030 census round as a strategy to reduce costs and improve the timeliness and efficiency of statistical production. This will certainly be the case in Europe and other high- and middle-income countries, where several countries have made significant progress in strengthening civil registration and vital statistics (CRVS) and have taken steps to establish population registers, as is already anticipated by a number of statistical agencies.[18]

The experiences of some of the most advanced statistical systems, however, show that establishing a functional set of registers that can replace enumeration-based censuses and surveys can take many years. This is due to the various political, legal, technical and operational preconditions and requirements for the successful adoption of administrative registers for the census. As these preconditions are unlikely to be met in the short term in low-income countries lacking fully fledged administrative data infrastructures, in these contexts, field-based population and housing censuses will likely continue to serve as a key pillar of population data systems until the 2030 census round.

The adoption of alternative methods of census enumeration may represent a viable solution to produce more accurate, timely and cost-effective census data, reducing the reliance on "door-to-door" data collection. Leveraging available administrative data sources to strengthen census processes may also enhance cost-efficiency. Yet technical solutions alone may not be sufficient as cultural, behavioural

and political shifts that are partly beyond the remit of national statistical systems may affect the viability of data collection systems as we know them today. De-politicizing censuses, at a time when so many issues are being hyperpoliticized, and ensuring that the benefits are well understood will be more important than ever to foster strong political will and a conducive environment for the 2030 round.

Household survey programmes: a major pillar of development data

A brief history and overview

For more than half a century, household surveys have played an instrumental role in generating more frequent data on a variety of population, health and development indicators than what censuses can provide. They fill critical data gaps especially in low- and middle-income countries with poor CRVS coverage. The **World Fertility Survey** (1972-1984) was the first global survey programme to provide comparative knowledge on fertility and its determinants in all participating countries. Amid concerns of a potential "population bomb"[19] as world population was reaching 4 billion, the survey was launched in preparation for the first World Population Conference in Bucharest in 1974 and the first designated World Population Year. As the largest social science data collection exercise of its time, it laid a solid technical foundation for subsequent global household survey programmes using an internationally comparable set of questions and coding.

The **Demographic and Health Surveys (DHS)** superseded the World Fertility Survey. DHS core questionnaires included more maternal health, child health and nutrition questions given the need to better understand the determinants of preventable maternal and child deaths in low- and middle-income countries at that time. Over the last 40 years, more than 400 surveys have been completed in over 90 countries.[20] Additional optional contents cover a range of topics, such as adult and maternal mortality, child well-being, disability, domestic violence, female genital mutilation and obstetric

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fistula, to name a few. The DHS has been instrumental in the collection of biomarkers of health, such as on HIV, anaemia and malaria. Its worldwide reputation for quality, nationally representative, user-friendly and cross-nationally comparable data has continued to grow. A broadened base of support for its country operations comprises UNFPA, the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), the Joint United Nations Programme on HIV/AIDS (UNAIDS) and other partners, in addition to the United States Agency for International Development (USAID).

The **Multiple Indicator Cluster Surveys (MICS)** launched by UNICEF in 1995 track progress on the survival, development and protection of children and youth and the well-being of women in low- and middle-income countries. The survey's scope has expanded periodically to respond to the Millennium Development Goals and cover approximately 40 SDG indicators. By its seventh round, the MICS programme had completed more than 360 surveys in about 120 countries.[21]

The **Generations and Gender Surveys** were launched in 2004 by the United Nations Economic Commission for Europe as a follow-on to the Fertility and Family Surveys implemented in the 1990s. The new surveys generated cross-nationally comparable longitudinal panel[22] data on gender roles, union formation and family life. Currently, a second round of data collection is taking place, including in new countries and territories in Asia and Latin America.[23]

The **Living Standards Measurement Study** is a programme of household surveys conducted since 1980 in less developed countries with the support of the World Bank.[24] While it puts a strong focus on the study of poverty, livelihoods and social sector outcomes, it contributes more broadly to generating population and development data, including on mobility, gender, population and health. The programme has made data from more than 150 surveys available to the research community, some linked together to form panel data sets.

In addition to these major global household survey programmes, many countries conduct routine national surveys generating nationally representative population statistics on various topics. Labour force and employment surveys and household budget surveys are among the most common examples. More than 200 time-use surveys, which measure how much time people spend doing various activities such as paid work, childcare and household chores, have been implemented worldwide, gaining momentum in the 1990s after the 1995 Beijing Conference on Women.[25] Some survey programmes focus on specific themes with a regional scope, such as the kNOwVAWdata initiative implemented by UNFPA to measure violence against women in Asia and the Pacific.[26] These are just selected examples.

Achievements, challenges and questions for the future

Since their early years, and with many evolving adaptations, global survey programmes have provided some of the most representative and comparable population data on maternal and child health, fertility norms, health-seeking behaviour, gender equality, harmful practices and other critical dimensions of development. They have improved the use of data and evidence in programme and policy decisions, and provided essential data for tracking and accomplishing the SDGs. Because these surveys have continued to meet data needs in countries with less-resourced national statistical systems, some middle-income countries currently have, somewhat paradoxically, more comparable development data[27] than higher-income countries, including on some indicators of women's empowerment and gender equality.[28] As the demand for data has

increased, international household surveys have continued to grow in popularity, including in the research community that enjoys public access to unit-level data sets.

Yet these surveys are costly, relying on international donor funding as well as substantial operating budgets from host governments for implementation. In fact, the pressure from governments and civil society is for more frequent data with expanded coverage so that indicators are representative at lower-level administrative units within countries and allow more data disaggregation at those levels. The implications of these demands include larger sample sizes and increasing fiscal and logistical costs. In addition, household surveys are experiencing some of the same technical challenges discussed above in the context of population and housing censuses. These include declining response rates due to privacy concerns and respondent fatigue, compounded by expanding questionnaire sizes and/or complexity.

Looking to the future, it is important to address some fundamental questions around the reliance on surveys for global development data. If the World Fertility Survey and DHS were initially conceived as stop-gap measures until governments established strong population and health data systems, why are we not further along in generating such data on a more continuous basis through routine CRVS and health information systems? Or as the Generations and Gender Survey implicitly suggests, should global survey programmes mainly focus on emerging, specific or sensitive questions about social change – such as shifting attitudes to marriage and family life, gender-based violence and reactions to the climate crisis – that may not be easily gleaned from administrative data or a census? As we move towards reducing dependence on household surveys to measure development indicators, how do we avoid a loss of data comparability and ensure alignment in the data architecture of the future global development agenda?

While there are no universal answers to these questions, we can be relatively certain that household surveys will retain an important role in the collection of self-reported data, particularly on issues such as gender roles (especially time use), social norms and cultural identity that cannot be adequately measured through administrative records. They will also support the validation of alternative sources and enhancement of data interoperability.[29]

Progress and challenges with CRVS and identity management systems

Administrative data systems, principally CRVS and identity management systems, are fundamental for real-time monitoring of population dynamics and for understanding the changing patterns of vital events across the life course. Yet approximately one in four births of children under 5 years is unregistered globally.[30] Almost 40 per cent of the world's deaths is not registered (with only 8 per cent of reported deaths in low-income countries having documented causes).[31] Addressing such pervasive problems of population invisibility is essential for leaving no one behind, as children and adults who lack proof of legal identity are often denied access to health care, education, housing, nutrition and other support through social protection programmes.[32] The completeness of marriage and divorce registration globally is unknown. The lack of investment in marriage/civil union and divorce/dissolution registration is a notable and persistent challenge in many countries, resulting in a failure to document pivotal life transitions. This gap also has major consequences for gender equality and women's empowerment as more complete registration offers protections against early marriage and promotes the equal rights of spouses within a union, including in terms of parental and child custody rights, asset distribution or inheritance when a union ends or a spouse dies.[33]

Over the last 30 years, there has been important progress in affirming political commitments to universal civil registration and representative vital statistics across regions.[34] Major efforts, such as the United Nations Legal Identity Agenda and the World Bank's Identification for Development Initiative, seek to align CRVS systems with national identity management systems. This supports universal legal identity across the life course, from birth to death, to improve the coverage of social protection programmes and access to economic opportunities, including banking and payments, particularly for women. These efforts track domestic investment in digital public infrastructure and international financing through mechanisms such as the Global Financing Facility for Women, Children and Adolescents and multilateral and regional development banks.

Significant obstacles still hinder the full functioning of CRVS systems, however, including legal gaps (e.g., outdated and inadequate legal frameworks governing civil registration), institutional and operational constraints (e.g., lack of coordination across governments, and direct and indirect costs associated with registration) and social barriers (e.g., a lack of awareness of the benefits of birth registration and legal identity and language differences). Data privacy risks are especially threatening for identity data. Widespread efforts to digitize registry platforms may actually exacerbate coverage inequalities in the short term, as they follow and reinforce inequalities in infrastructure (see Box 4).

Looking to the future, the pathway towards a register-based population data system is not exempt from technical, operational, political and capacity constraints. Crucial questions remain on how best

BOX 4

The risks of digital identity management systems

Digital identity systems are increasingly mediating people's access to basic government entitlements in health, education and social welfare as well as private sector opportunities via financial transaction systems. While the primary goal of such systems is to improve the efficiency and efficacy of service delivery, they provide significant opportunities for developing register-based population data. With unique identifiers for each individual, these systems can be integrated with other databases (e.g., health records, education systems and tax records), enabling the generation of multisectoral data to produce varied population statistics.

Such systems may exacerbate pre-existing forms of exclusion and discrimination in public and private services. For instance, community groups in India, Kenya, and Uganda have filed lawsuits against their respective national governments, claiming that the design and implementation of national identity management systems were conducted without sufficient protections against data privacy risks. Further, these systems now reduce access to health care, social services and other entitlements for older persons, women, people living in poverty and ethnic minorities. In Jamaica, the Supreme Court found that a proposed digital identity system was unconstitutional as the collection of extensive biographic and biometric information violated the right to privacy.[35]

Public concerns are also mounting that the misuse of biometric technologies can lead to new forms of harm, such as racial and gender bias and surveillance capitalism.[36]

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to expand and modernize civil registration coverage while advancing data protections and requiring a better understanding of patterns that exclude certain demographic groups from digitized services. Proper quality control procedures are required to avoid the risk of reduced quality in demographic statistics.[37]

Uneven progress in health sector data and measures of health and well-being

In 1993, the first Global Burden of Disease study estimates were published as part of the *World Development Report*, offering national estimates of the aggregate number of healthy years of life lost due to premature illness, death or disability.[38] While the data were welcomed for the advantage they provide in summing the full burden of a given health condition and allowing comparison of the burden of different illnesses, initial estimates were widely recognized as overly reliant on modelling and imputation, given the lack of national epidemiological data in many countries. The initial estimates also featured unexpected comparative results. For example, they highlighted the importance of road traffic accidents and mental health as among the leading causes of disability-adjusted life years lost in many countries. Over time, the study has expanded and matured. It is now widely used by WHO and many development actors in engaging with health data partners in 145 countries.

Since 1994, the digitization of health management information systems has generated new networks and commitments among United Nations Member States, with more than 120 now reporting a national e-health digital health policy or strategy. Telemedicine or telehealth systems have shown remarkable potential in extending care to remote populations, supporting rural health workers and accelerating progress towards universal health coverage. Examples of applying AI to address health challenges in high-income countries are increasingly being tested in low- and middle-income countries, including to supplement diagnoses, identify clusters of cases to alert health authorities about disease outbreaks and estimate the burden of rare conditions.

The pace and scale of progress varies greatly among countries, however, with fragmentation between sector-specific digital data systems and shortfalls in coordination and quality assurance. The well-spring of multilateral, donor and private sector actors contributing technical guidance has resulted in accelerated progress in select countries. It has also led to in-country misalignments among digital solutions for patient medical records, disease surveillance, financing, supply chains and the health workforce.

Long-neglected health conditions such as injury, disability and mental health have garnered increasing attention in the years since the ICPD. In the 2020 census round, about two in three countries included standardized Washington Group questions to identify persons with disabilities. Standardized measures of mental health conditions, which now account for one in five years lived with disability, continue to evolve. Yet despite approximately 20 per cent of the world's children and adolescents experiencing mental health conditions, mental health screening and case data remain underdeveloped in many low- and middle-income countries.

There has been growing recognition that health alone is an inadequate measure of well-being. New metrics are needed to track other dimensions of well-being that bolster resilience and happiness,

and enable people to thrive. The WHO Constitution notes that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity".[39] New metrics and approaches to well-being include the Happiness Index[40] and growing efforts to transform the work of Nussbaum and Sen,[41] who emphasize human capabilities, agency and freedoms, into health sector metrics. The Organisation for Economic Co-operation and Development and individual countries are using new metrics focused on capabilities and freedoms.[42] The Gates Foundation Exemplar programme has adapted the work of Nussbaum and Sen to generate and test new metrics of women's well-being.[43]

New and alternative data sources: digital traces and citizen-generated data

Defining digital trace data

Digitized information storage and processing have improved the accessibility and granularity of traditional population data sources such as censuses and vital registration data. They have also generated new types of data streams and opportunities for data collection.[44] The spread and use of digital technologies, such as the Internet and Internet-enabled platforms, social media, mobile phones, sensors and cameras, have themselves generated large volumes of data on human activities, interactions and behaviours. These are called "digital trace" data.

Digital trace data are generated by two processes. First, the adoption of digital technologies has resulted in the growing digitalization of social life. Web search engines, social media platforms and mobile apps mediate how we access information and services, and communicate and interact with each other. Using these technologies generates data streams that are often captured and stored by platforms that view these data as key to their business models. Second, an increasing amount of information, including about offline life, is captured digitally. For example, smart meters at home store electricity or energy consumption digitally.[45] Together, these processes have resulted in new data opportunities that have been applied to study population outcomes and processes, prompting the development of digital and computational demography.[46]

Promises of digital traces

Passively generated digital trace data provide unique opportunities for generating new knowledge but also involve methodological, conceptual and ethical challenges. These data enable more dynamic or continuous measurement and help capture events as they occur, unlike a survey or census model that involves asking questions at fixed time points, with significant planning and time lags for data processing and production. When calibrated to "ground truth" population data sources, real-time data have potential to help predict future changes and "nowcast" patterns before they appear in official statistics, fill gaps in the temporal or geographical resolution of more traditional data sources, or enable measurement when traditional forms of data collection are not feasible, such as during conflicts[47] or disasters.[48]

Of the three population processes, fertility, mortality and migration, the last has received the most attention in terms of the use of digital traces. A growing body of research has used different types of digital trace data from the web, mobile and social media to measure human mobility as well as internal or international migration. Some widely used examples include aggregated

social media audience counts from Facebook's marketing platform[49] and time-stamped call detail records from mobile phones that provide changing spatial-temporal distributions of mobile users.[50] Conventional data on migration are often irregular. Recent studies identify ways in which non-traditional data can help fill gaps and complement traditional sources of demographic statistics. Applications developed by or in partnership with national statistical institutions demonstrate the potential for using mobile phone data for official statistics, such as for the delineation of metropolitan areas in Indonesia[51] and the estimation of population mobility during COVID-19 in Ghana.[52]

Digital traces of behaviours, such as those from aggregate web search queries or social media posts, can further provide non-elicited forms of measurement of contexts, norms and behaviours relevant to understanding demographic shifts or tracking sentiments in response to these shifts. For example, aggregated web search queries have captured fertility intentions that are predictive of fertility rates.[53] Sensor-based digital traces can provide environmental cues linked to population indicators, such as by relying on utility consumption to extract information on housing occupancy and household composition, supporting field-based data collection. This approach was successfully adopted in China's 2020 Census, where smart meter data from the national electrical grid assisted in determining vacant housing units, and telecommunications data were used to map the distribution of the migrant population.[54]

Challenges of digital traces

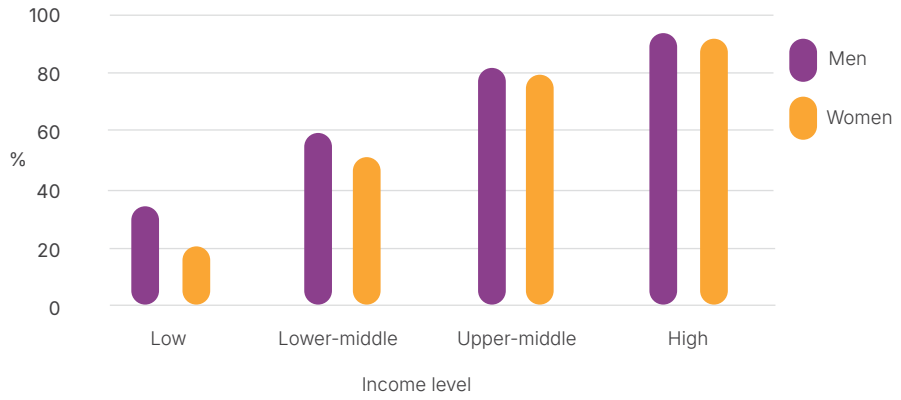
While a growing body of research highlights promising opportunities for digital trace data for population data systems, these data streams pose several challenges due to their properties. Unlike official demographic statistics based on long-established and harmonized statistical frameworks and computational methodologies, digital trace data pose significant challenges in terms of their bias and representativeness. Digital divides in Internet and mobile adoption persist across countries and demographic groups, such as by age and gender, so using these data for measurement may further exclude those who are most marginalized. For example, the proportion of individuals using the Internet significantly varies by the income group classification of a country, especially among women, with only one in five women in low-income countries using the Internet (Figure 2).

The Internet and mobile phones, furthermore, are not a singular technology; the landscape of these technologies is ever shifting. The diffusion of technologies is varied, uneven and often unpredictable. For example, social media platforms change over time as do their user populations, posing challenges to the coverage and stability of time series. Efforts at integrating digital traces for official statistical purposes have made a concerted attempt at assessing biases by validating digital traces with traditional data sources, but this may become ineffective if rapid shifts occur in the underlying use or engagement with the technology.

A second central challenge with the use of digital trace data sources for population data systems is linked to their ownership by private companies, which shapes access to them and the information available about them. The general availability of social media and mobile phone data for research and statistical purposes remains highly restricted and has not improved over time. This has been a limiting factor for use in official statistics. For example, few concrete examples exist of the application of digital data to the calculation of SDG indicators, and even fewer, if any, of their use by countries in voluntary national reviews.[55] Moreover, information about the underlying algorithms that shape

FIGURE 2

Proportion of individuals using the Internet, by sex and country income level, 2023



Source: Adapted from ITU World Telecommunication/ICT Indicators database, November 2023.

data can be insufficient. For example, social media platforms often provide aggregate information about their users to potential advertisers but offer little information on how the characteristics of their users are inferred, and how trends in usage have shifted over time. Ultimately, incentive structures and frameworks governing data generation, storage and sharing for these data are very different from conventional sources of population data.

The fact that passively generated digital traces provide a source for non-elicited information also implies that they often do not adhere to principles of informed consent on personal data reuse,[56] which are fundamental to self-reported information collected via censuses and surveys. Therefore, the nature of the data requires greater care and ethical foresight. Privacy expectations of users of social media platforms, for example, may shift over time, with implications for who is measured within these data and for public sentiment and support for the use of these data for different purposes. Legal or regulatory frameworks governing these data vary across countries/regions, making their broader, more generalized application across different settings challenging.[57]

A journey from pilot to production?

With multiple applications demonstrating the potential of using digital trace data to complement official statistics, the "use of Big Data is on the long evolutionary journey between pilots and production, between best practices and international recommendations and standards".[58] New digital data opportunities will continue to appear in different formats at an unprecedented pace, including as images, texts and time-stamped metadata records. A recent survey on the use of big data and data science for official statistics revealed that four in five NSOs have explicitly incorporated references to data science and the use of alternative data sources into their strategic agendas and have a roadmap to develop capacity in these new areas. Limited access, bias in representativeness and ethical concerns over the lack of consent and risks to privacy are unresolved issues, however.[59] Extracting meaningful measures from these data streams still requires an understanding of underlying social processes and mechanisms, issues of data quality, and frameworks for thinking about bias and uncertainty.

Citizen-generated data

Issues around the non-reactive nature and lack of informed consent can be addressed by citizen generated data (CGD), which people or civil society organizations actively produce to directly monitor, demand or drive change on issues that affect them. CGD are about more than just collecting data. They are a way to engage people in data processes that regard them as data agents and not just data subjects.

CGD can help close gaps in sectors where data currently do not exist. They can also complement existing data, giving them more nuance and uncovering patterns that may not be identifiable in averages. All sectors with an active civil society or citizen movement hold strong potential to produce and use CGD. In national demographic statistics, for example, CGD can help to highlight populations that are often left out of official population indicators due to their gender, age, disability or even geographical location. As such, CGD can help to improve methodologies to ensure these populations are captured in subsequent official statistical activities that provide statistical representativeness. Once population surveys or censuses are carried out, CGD can give more nuance and information on the findings, including through qualitative textual data expressing sentiments. CGD can also assist in collecting sensitive data on which governments may not be best placed to get the most accurate information, such as reproductive health preferences or gender-based violence. As an example, the Ghana Statistical Services worked with communities to produce more data on gender-based violence to give further insights on the drivers and capture dynamics outside the household.[60]

Over the last decade, significant efforts have been made to promote greater understanding of CGD among official statisticians as a pathway to leave no one behind and support the official statistical community to take more inclusive approaches to data and engaging citizens. National statistical systems could learn from this approach to ensure better response rates and more engaged populations in official statistics. CGD, however, are not bias-free in that they often reflect the "most active" population or those with the greatest social capital.

An artificial intelligence revolution?

AI has already broken into the workflows of NSOs, with promising applications in the processing of imagery data[61] and the automation of some manual processes. The potential for using AI for automating data processing and analysis, identifying patterns and correlations in – and linkages across – large data sets, generating synthetic data and providing predictive analytics is also on the horizon. For example, applications are being developed using natural language processing models for interrogation of data sets and data extraction from standardized variables. As AI technology continues to develop, even more innovative and effective ways to use it to improve the quality and availability of population data are likely. This is just the beginning of a bigger revolution, with an unprecedented pace that makes it difficult to anticipate the direction and scale of change.

A number of technical and ethical challenges to using AI to generate population data exist. One challenge is that algorithms in machine learning systems can only generate high-quality outputs if tested and trained using high-quality input data. If the input data are incomplete or inaccurate, the results of (any) model will be biased. Due to the dynamic nature of population processes (especially migration), AI models would also need continuous updates and retraining to adequately capture such changeable conditions and encapsulate the full complexity of human behaviour and societal dynamics. Algorithmic bias may not only lead to inefficient decision-making but also to

outcomes that infringe on people's fundamental rights, from racial discrimination in predictive policing algorithms to sexist AI hiring tools. This has become a growing social concern.[62]

At least in the short term, expectations have to be managed around the possible misperception that AI on its own can generate all the data we need. AI, like digital traces, will require extensive ground data for machine learning and model calibration. It should be seen as a complement rather than a silver bullet replacing traditional population data and demographic statistics.

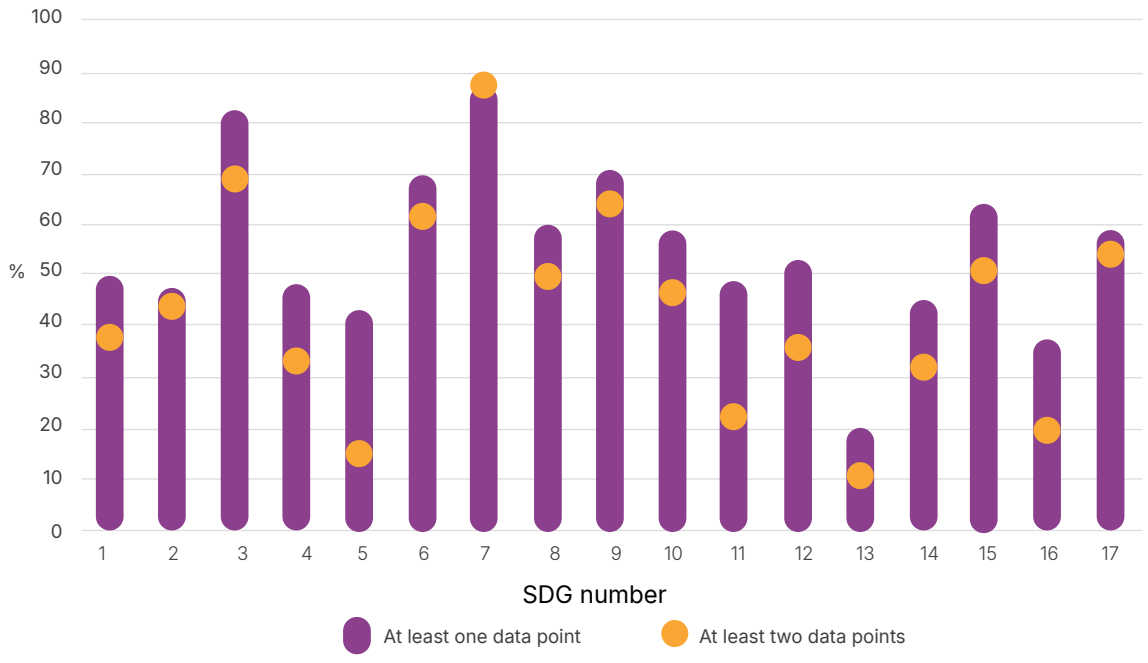
3 Persistent Shortfalls and Challenges of National Statistical Systems

Current gaps in data availability and quality

Significant content gaps persist in the availability, quality, accessibility and use of data, in particular in low- and middle-income countries. Less than 3 out of 10 United Nations Member States can monitor SDG progress from 2015 to the present (i.e., with two or more data points) for at least half of the SDG indicators.[63] Data availability significantly varies across the SDGs. For example, only half or fewer countries have data to monitor indicators on poverty, nutrition, education or gender at any point in time (see Figure 3).

▶ FIGURE 3

Proportion of countries with SDG indicator data since 2015, percentage



Source: Adapted from UNDESA, Global SDG Indicator Database (accessed February 2024).

Some countries lack recent basic population data disaggregated by age and sex that can be used as denominators of SDG indicators. This is especially the case for about 10 countries where it has not been possible to conduct a census for at least two decades. At the same time, not all countries that have regularly conducted censuses have been able to systematically produce updated population estimates and projections, especially at the subnational level. Even for countries with more developed population data systems, a consistent reconciliation of population stock (by age and sex) and flow (birth, death, migration) data from different sources may prove difficult.

The lack of basic population data is especially a challenge in humanitarian crises, where even recent censuses may become quickly outdated. With an almost threefold increase in the number of forcibly displaced people worldwide over the last decade,[64] tracking displacement flows and mapping displaced populations is essential to inform humanitarian responses and guide long-term solutions to protracted crises.

Significant efforts by UNFPA and other United Nations agencies, in partnership with national statistical authorities in 143 countries, have ensured the availability of fully usable population estimates by sex and age at small area resolution in the form of up-to-date common operational data sets on population statistics.[65] New international standards, recommendations and technical guidance on statistics on refugees, internally displaced populations and stateless persons[66] are also a major positive force in ensuring that people on the move are visible in population data systems, but are still in early stages of implementation.

With regard to specific thematic areas or population subgroups, examples of extant data gaps include the limited availability and quality of maternal mortality and other cause-of-death data in countries with incomplete CRVS systems; the limited comparability of urban/rural classifications across countries;[67] the lack of disaggregated data on adolescents and older people; the paucity of routine data on changing values and norms regarding marriage, fertility and family; the lack of more timely data on gender-based violence in both development and humanitarian settings; the non-identification of people with non-binary gender identities, persons with disabilities, people of African descent and Indigenous groups; and the statistical omission of some of the most marginalized groups (see Box 5), to name only a few.

Most data gaps refer to the most marginalized subpopulations, precluding a comprehensive assessment of social and economic inequalities. Inadequate data availability and timeliness often jeopardize decision-making where interventions are most needed. For example, in sub-Saharan Africa, where 57 per cent of all child deaths are concentrated, the most recent available child mortality data are more than five years old for two in three countries.[68] The possibility of locating those with the greatest needs is also limited by the lack of government-validated and harmonized administrative boundaries data.

Two domains of population data specifically highlighted in the ICPD Programme of Action, gender equality and international migration statistics, continue to have serious deficiencies, as discussed below.

Gender statistics

Gender statistics are vital quantitative data that shed light on gender inequalities and the challenges faced by women and girls in various domains of life, including access to education, health care, employment and participation in decision-making. Given the value of such data as a foundation for evidence-based

BOX 5

The statistical omission of marginalized subpopulations

Some of the most marginalized subpopulations are omitted or systematically underenumerated in national population data systems. These groups include undocumented migrants, the forcibly displaced, seasonal workers, the homeless, inhabitants of informal settlements, pastoralist and nomadic populations. A persistent problem in many national censuses, even in high-income countries, is the underenumeration of young children.[69]

Some of the most marginalized subpopulations are often omitted or systematically underenumerated in national population data systems

In some cases, these categories may be omitted by design, such as when the census population is defined based on the concept of residence and households are the units of enumeration. Other groups may be hard to count due to their high mobility or reluctance to participate in national data collection. The exclusion of populations living in institutions, such as prisons or nursing homes, or the collection of aggregate rather than individual information on these subpopulations are other common gaps.

The extent of undercounting is difficult to measure accurately. A 2013 study[70] estimated that over 250 million of the world's poorest were missing from population counts, accounting for at least one in five of the bottom income quintile, a serious bias. These omissions also affect the representativeness of household surveys that use census-based sampling frames.

policy formulation and effective programme implementation, remarkable progress has been made globally in strengthening the institutional, technical and operational capacity of national statistical systems to mainstream gender data across official statistics production. This includes an increase in the adoption of laws or regulations requiring national statistical systems to conduct specialized gender statistics surveys; the establishment of dedicated gender statistics focal points/units in the NSO and other relevant sectors of government; the inclusion of a dedicated budget for gender statistics; the implementation of time-use surveys/modules; and the recognition of non-traditional data, such as social media and CGD. Progress has also been made in devising methodological standards to measure technology-facilitated gender-based violence.[71]

Even so, SDG 5 on gender equality remains one of the global development goals with the lowest data availability, particularly to track progress over time. Gaps are conspicuous in some areas. Two in five countries do not have at least two data points allowing them to monitor trends in violence against women, while more than two thirds of countries lack any reported data on unpaid domestic and care labour, bodily autonomy and harmful practices such as female genital mutilation.[72] Only a few countries have attempted to collect data on sexual orientation or gender identity. Gaps in gender data are evident in both availability and representativeness. For example, censuses and global household surveys may have inherent gender-related biases associated with the selectiveness of missing responses, imbalanced or incomplete representation of population groups, and the collection of data on women from male proxy respondents.[73] The underrepresentation of women and ethnic minorities in clinical studies has also been noted, as it undermines the wider applicability of medical research.[74]

International migration statistics

With increasing life expectancy and declining fertility across most countries, migration is an increasingly important driver of demographic trends. As such, accurate and complete migration data are an essential input for population estimates and projections. International migrants are also overrepresented among the most vulnerable populations, making disaggregated data by migratory status crucial to locate those in need and fulfil the SDGs.

Despite this increasing demand, international migration statistics remain sparse. For instance, as of 2020, recent statistics on the migrant stock at the global level were available for only 93 countries. Data on migrant inflows and outflows are even less common.[75] The availability of migration-relevant SDG indicators remains deficient, and the disaggregation of other SDG indicators by migration status is among the least reported categories of disaggregated data.

Without comprehensive administrative records, censuses and surveys in many countries are the only sources of data on the foreign born and/or foreign national population. Absent information on the duration of stay, and with much mobility being transient and temporary in nature, it is often very difficult to reconcile any stock and flow information, leaving a critical gap in the evidence base. Underreporting and inadequate data coverage remain prevalent particularly in regions with irregular migration patterns or limited statistical infrastructure. The complexity of the drivers of contemporary migration and the increasing significance of displacement pose additional challenges.

A persistent data gap is that data gathered often remain underutilized. For example, although the uptake of core migration questions in censuses has been a widespread practice, most countries include only limited tabulated data on migrant populations in their census outputs. Some fail to release migration statistics from the census due to the lack of robust quality assurance mechanisms. Additionally, the lack of standardized definitions and harmonized statistics constrains comparative research and data reconciliation between migrant sending and receiving countries.

Systemic challenges of national statistical systems

This section briefly summarizes the main systemic factors underpinning the suboptimal availability of population data: namely, gaps in data financing, technical capacity, data accessibility and utilization, and governance.[76] It also considers global megatrends and new data needs.

Underinvestment in data

Underinvestment in public data systems continues to undermine the development of statistical activities. A lack of national funding for statistics is especially a challenge for low- and middle-income countries. Half of NSOs in these countries report facing severe shortages in financial resources required to meet user needs for statistical outputs; another 43 per cent indicate moderate shortages.[77] In 2021, no low-income country had a fully funded national statistical plan.[78]

Analyses of ODA flows suggest that international donor support for demographic and social statistics is also inadequate. Current ODA for data is less than half of what is needed to deliver SDG data requirements, leaving an annual financing gap for resourcing data and statistics estimated at $700 million. Accounting for only about 0.4 per cent of total ODA, this share reflects the low prioritization of investment in data from a limited pool of donors.[79] The partial exception has been the increase in funding to administrative data due to the contributions of private philanthropies.[80] The newest multilateral efforts to mobilize data financing, including the Bern Network on Financing Data for Development, the World Bank-hosted Global Data Facility and the United Nations-hosted Complex Risk Analytics Fund for humanitarian data,[81] offer new promise but remain in early stages.[82]

Technical skill and capacity gaps

Data gaps are also ascribable to insufficient institutional and technical capacity in lower-income countries. According to global surveys of national statistical institutions, the lack of skilled staff is reported as a major constraint on the performance of data producers. In addition to a shortage of statisticians across public institutions responsible for data collection and compilation, very few NSOs, mostly in high-income countries, have been able to recruit data scientists with new competencies in GIS, digital data and advanced processing and modelling techniques. A lack of digital infrastructure, data storage and processing capacity, and expensive imagery also undercuts local excellence in modern population data systems. This was evident, for example, in gaps in information technology infrastructure for remote data collection to meet new data demands during the COVID-19 pandemic.[83]

Limited data accessibility, openness and utilization

Limited data accessibility is a fundamental bottleneck underpinning current data gaps. According to the Open Data Inventory, which serves as an indicator of the availability (coverage) and accessibility (openness) of data published on NSO websites, overall data coverage and openness have improved between 2016 and 2022 but lower-income countries lag far behind. After COVID-19, the rate of progress slowed; 77 countries have lost ground. Social and gender data are significantly less accessible than economic and financial data. Subnational data at both the first and second administrative level remain by far the lowest scoring coverage components. The use of an open licence remains the greatest shortcoming among all elements of data openness, but limitations also still exist in basic practical aspects such as online dissemination. For example, only 37 per cent of low-income countries make at least some data available in machine readable formats.[84]

Allowing access to microdata or unit-level records obtained from censuses, sample surveys and administrative systems is an important component of data dissemination. This allows public, CSO and private researchers and analysts to generate in-depth understanding of socioeconomic issues and the relationships and interactions among phenomena. It also enables analysts to generate additional disaggregated secondary data that are not published as part of initial data releases. Since the end of the 1990s, the increased availability of individual-level and household-level data from censuses (such as through the Integrated Public Use Microdata Series) and international survey programmes (such as the DHS and MICS) has opened multiple opportunities for demographic research, such as multigenerational studies, the analyses of non-traditional family forms and large-scale comparative cross-national research projects.[85]

At the beginning of the 2000s, the exponential growth in census microdata availability was heralded as the "microdata revolution".[86] Twenty years later, however, access to census microdata remains far from universal.[87] Growing concerns about the protection of privacy and confidentiality, combined with limitations in the technical capacity to control the risk of disclosure, may have contributed to this gap.[88]

Data availability is not a goal on its own. It is only worth the investment when data are widely used for decision-making. On the other hand, deficiencies in data demand are often a constraining factor for investments in data projects and capacity, creating a vicious cycle of limited data production and use. Several barriers constrict data use, including low levels of data literacy among policymakers and the public, a lack of political commitment to evidence-based decision-making, low trust in the quality of official data, poor data communication and the unavailability of data in formats suitable to users.[89]

Fragmented data governance

Data governance refers to the exercise of authority and control over data management. While there is no universally agreed or unique definition, data governance can be thought of as a framework or set of mechanisms to transparently manage data privacy, access, use and re-use, quality and security, towards maintaining trust in data and the institutions producing and holding them and maximizing their net benefits. Data governance has evolved in a fragmented and uncoordinated manner, resulting in different approaches. At one extreme, there is the free flow of data, where data are seen as critical enablers of digital transformation, innovation, economic growth and social benefits. At the other extreme, there are concerns around data sovereignty related to privacy, taxation, competition, security and even democratic processes.

Deficiencies in data governance are a primary cause of the suboptimal exploitation of various sources of data. At the national level, the absence of clear mandates, responsibilities, incentives and protocols to effectively coordinate data production and data exchanges among government entities limits the use of administrative data for statistical purposes, obstructing collaboration and leading to duplicated data-gathering efforts. In general, outdated statistical laws can make it difficult for NSOs to take advantage of the proliferation of new data types, sources and producers.

A negative association has been found between the age of a country's statistical laws and its statistical performance and data openness.[90] Uncertainty about the legal responsibilities of NSOs also inhibits the dissemination of valuable microdata.[91] Deficiencies in data governance exacerbate the unhelpful separation between national population data systems (founded on censuses, civil

registration and household surveys) and the international humanitarian data ecosystem (informed by refugee registration, tracking systems for internally displaced people and humanitarian needs assessments).

Data governance is becoming increasingly important as data power the digital economy, feed algorithms and artificial intelligence, inform logistics, and shape markets, communications and politics. These data, personal or non-personal, public or private, yield not just economic benefits; they can have positive or negative impacts on individuals and societies, depending on whether they are used responsibly or irresponsibly. Fragmentation has produced asymmetric concentrations of data and capacities to use them, introducing the risks of abuse and manipulation. Striking the right balance between gaining insights from data to improve people's well-being and protecting their rights and privacy, and between proprietary and public goods data, will be essential to make the most of population data in the coming years.

Global megatrends and new data needs

While many data and information gaps are not new, the world is dramatically changing. It is more demographically diverse in terms of population dynamics and demographic structures, with most countries in Africa continuing to have high fertility and growing and rapidly urbanizing young populations, and much of the rest of the world now living in countries where fertility is below replacement and populations are rapidly ageing, and in some cases, already declining (see the related paper in this series on demographic change and sustainability). New or exacerbated threats to human prosperity include the rise of inequalities, the climate crisis, conflicts, widespread food insecurity and the risk of global pandemics. Technology is driving globalization, transforming labour markets and redefining social life and other aspects of human interactions.

These intersecting and mutually reinforcing global megatrends create new data needs, for example, on the impact of the climate crisis on livelihoods, reproductive health and population mobility; changing social norms in low-fertility contexts; shifting patterns of family formation and living arrangements; the determinants of healthy ageing; the social impact of pandemics; and the measurement of technology-facilitated gender-based violence. These defining features of future societies will require new data, evidence and research.

4 Key Recommendations for a Sustainable Data Future

Population data systems are in a state of flux. Shaped by demographic and social changes as well as resource constraints and the opportunities offered by digitization and other innovations, significant transformations in population data ecosystems are underway. Given different data histories and information systems, countries will adopt diverse modernization pathways to achieve a "maturity model" defined by key outputs and results: the generation of frequent, granular, inclusive and accessible population data that meet the future needs of users, and the protection of the rights of data providers, including by preventing possible harm caused by data misuse.

Global statistical frameworks and institutions should be inclusive and responsive to the needs of countries that may be prioritizing different approaches to developing their national data ecosystems. While there is no one-size-fits-all solution, key recommendations for modernizing population data systems are proposed around four broad areas, with further specifications to identify priority actions (Figure 4).

Accelerate the transition to integrated population data systems

Governments are encouraged to promote data integration across censuses, surveys, administrative sources and other types of data as a powerful means to improve the quality and cost-effectiveness of data generation and respond to population and health needs, including during crises. Integrated population data systems enable governments to locate and address inequalities towards achieving the goal of leaving no one behind. With the inclusion of gender statistics, these systems provide governments with important means to monitor and address gender equality, emerging needs in health and discrimination.

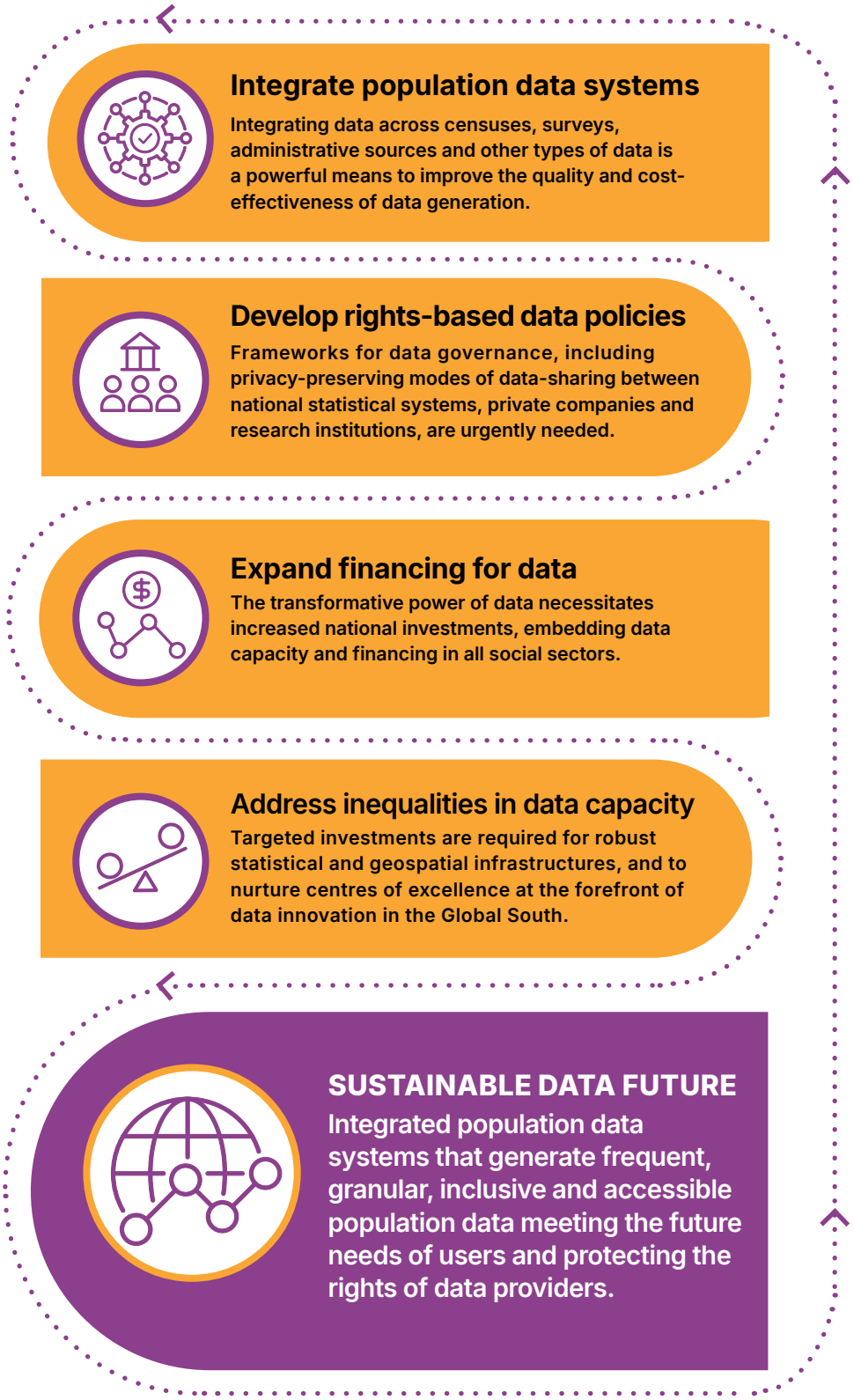
A step-wise transition to register-based population data systems, adapted to national specificities, has proved to be a viable path towards the availability of frequent (annual) population data at low cost. Gender-sensitive and inclusive CRVS systems that take a life course approach – from birth to death, including key life transitions such as marriage and divorce – are at the core of this transition, helping to ensure that no one is left behind. This requires complementary efforts on relevant legal frameworks, digitization and cross-government coordination, and the alignment of register systems with the health sector and social practices surrounding vital events. The process should build on the principle that modern data infrastructure is not only about better statistics but is a foundation of more efficient and effective governance.

A stronger culture of operations research and implementation science needs to inform and guide investments to strengthen CRVS and legal identity systems so that improvements can be progressively scaled up and adapted across diverse national contexts. Important synergies can be leveraged even in countries with incomplete registers through the integration of censuses, surveys, CRVS systems and other administrative data, harnessing the complementarities of different components of the data system. Key examples of good practices include the use of administrative records to support census and survey processes, and the use of censuses and surveys to determine the completeness of civil registrations. Sustained investments in census and survey capacity and the development of administrative data systems should be seen as mutually reinforcing.

Further **integration of geospatial and demographic data** is key to ensuring that population data meet information needs for a sustainable future. Adopting georeferenced data makes location a powerful locus for integrating data from different sources, revealing new insights and highlighting populations burdened by multiple concurring forms of disadvantage.[92] A prominent example is the integration of georeferenced population, health and climate data to highlight vulnerabilities. Key to unlocking the potential of geospatial data and techniques in population data systems is an effective strategy to enhance access to and the affordability of high-resolution satellite imagery, and to better and more cost-effectively leverage the increasing number of imagery providers and amounts of daily imagery data available. United Nations entities have a role in reducing costs for

FIGURE 4

Key recommendations for a sustainable, integrated and sufficiently financed data future



Member States through shared purchasing as well as by negotiating flexible multi-user imagery data licensing conditions.

National statistical systems are encouraged to **scale up the use of non-traditional data sources**, such as mobile phone records and social media, for capturing timely and granular information on migration and different patterns of mobility (including daily commuting), thereby addressing one of the major gaps in population data systems. Digital trace data are best conceptualized as complements rather than substitutes for traditional forms of population data within an expanded data ecosystem. New models of multistakeholder cooperation could facilitate data-sharing and access, which remains a major bottleneck, and validation research, including triangulation against high-quality traditional data, to better understand biases and gaps. Statistical methods should also be considered an integral part of AI system development, in the design of measurement frameworks and throughout the data value chain.[93]

Against the backdrop of frequent and protracted humanitarian crises, it is critical to **bridge the humanitarian and development data divide** by furthering the integration of censuses, civil registration systems, geospatial data, digital traces, displacement tracking systems and rapid field assessments. This will help to understand and address population movements, health needs and other impacts during crises. It is even more urgent as climate-related disasters, non-state violence and public health emergencies may disrupt government functions underpinning routine administrative data processes. Efforts to promote alignment and enhance interoperability are currently under way[94] and offer promising models for data integration during times of crisis.

Develop a rights-based data governance architecture

Frameworks for data governance, including privacy-preserving modes of data-sharing between national statistical systems, private companies and research institutions, are urgently needed. Countries and intergovernmental institutions should work towards establishing **data protection laws and regulations that balance open access, data confidentiality and ownership**. This process should be strongly anchored in rights-based principles to guarantee citizen interests and protect against data misuse, including the risk of "weaponization" of highly sensitive data if systems come under cyberattack. In particular, the potential risks of population data integration with biometric identity data and health sector data need more discussion and review.

Both "function creep" and a lack of informed consent point to the need for strong data governance frameworks that prevent the unregulated use and reuse of personal data by private firms and constrain their potential value as a public good. Inequalities arising from asymmetric access to and concentrations of data (the data divide) reinforce these concerns. As the increasing ease with which digital data can be stored, shared, exchanged and copied challenges the logic of national solutions, a global approach to data governance is needed to address growing concerns associated with surveillance capitalism, data sovereignty and the political economy of data as an economic asset.[95] More than anything else, strong governance and ethical protocols will be needed to unlock the potential of AI responsibly, recognizing its limitations, biases and ethical challenges, and addressing the risk of misuse or misinterpretation of AI-generated data.

With the advent of technology and rapid development of AI, robust data governance frameworks are also needed to **reconcile the widening gap between official statistics and the infinitely larger universe of data** produced by the public and private sectors for different purposes. This

requires revisiting the role and accountability of NSOs and other stakeholders, which may involve a decline in their traditional function as "data collectors" and an expanded role as reference custodians and stewards of the quality of data used by society.[96]

Expand financing for data and statistics

Governments will see long-term development benefits from upscaling data investments. Without adequate funding, the aspirations of a data-driven development agenda will be limited. To unlock the potential benefits of data, the United Nations recommends increasing domestic funding for data and statistics by 50 per cent from current levels by 2030.[97] Realizing the transformative power of data necessitates embedding data capacity and financing within all social sectors, with the potential for integrating and linking data across the different dimensions of health and well-being and demographic change.

Donors are encouraged to commit to raising the share of ODA for data to at least 0.7 per cent by 2030, in line with the Cape Town Global Action Plan for Sustainable Development Data (2017). Yet with stunted economic growth in high-income countries limiting international donor support, ODA for data and statistics should be considered a complement, rather than an alternative, to effective domestic financing mechanisms.

While increased financing should be channelled to registry data systems, there will be a continuing need for resource mobilization for population and housing censuses and household surveys in lower-income countries. With time, more registry sources will reduce demand for large surveys, but failure to sustain these data sources in countries without comprehensive administrative registers would result in widening the data divide between the Global North and Global South.

Address inequalities in statistical capacity and data use

Concerted efforts must focus on addressing both institutional and skills capacity gaps in low-income countries across the data value chain; building data competencies at the intersection of population, development and environmental issues; and cultivating national capacities to use and transform such data into meaningful knowledge for development. At the institutional level, targeted investments are required to develop and maintain robust statistical and geospatial infrastructures, and establish and nurture centres of excellence at the forefront of data innovation in the Global South. Further capacity-strengthening initiatives are required in "traditional" statistical competencies, such as effective data management, disaggregation and analysis; the production of gender statistics; record linkage methodologies for the use and integration of registry-based data; and statistical disclosure control techniques for the dissemination of granular data.

At the same time, investments should be scaled up to cultivate the new generation of data scientists and GIS analysts as well as interdisciplinary experts to unleash the potential of new data. In particular, strengthened national capacities to apply innovative geospatial solutions to meet the increasing need for data in humanitarian settings are likely to become even more critical, as will be the ability to produce gridded (census) data outputs based on common geographies and overlay them with remote sensing data for climate analysis.

To reinforce the virtuous cycle of demand and production, it will be paramount to integrate data literacy into education curricula at various levels. This will be an important step to enhance a culture of data-driven decision-making across sectors by empowering stakeholders to use data in policymaking, programme implementation and advocacy.

5 | Conclusion

- Shaped by global megatrends, resource and capacity constraints, and rapidly evolving technologies, population data systems are undergoing major transformations.
- This think piece has shown that future-ready population data systems, rather than converging towards a common architecture, are better characterized by the aspirational outcomes set out in the ICPD Programme of Action, namely, the generation of frequent, granular, inclusive and accessible population data that meet user needs and protect the rights of data providers.
- While countries with different data histories and information systems may take diverse paths in their journeys, developing a rights-based global data governance architecture, transitioning towards more integrated population data systems, expanding financing for data and statistics, and addressing inequalities in capacity will be essential for optimizing the future of data for a better world.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28 Note the distribution of countries reporting data on SDG 5.6, for example: Developing countries taking part in global survey programmes are prominent in reporting comparable data.
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