APPENDICES

Investing in Tomorrow's Labour Force

Socioeconomic implications of the demographic transition in Zanzibar

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Appendices to *Investing in Tomorrow's Labour Force: Socioeconomic implications of the demographic transition in Zanzibar*

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Appendix 1: Methodologies of the four sectoral sub-models

The two population growth scenarios are estimated for four specific sectors: education, health, infrastructure and social development. For each, a specific methodology is devised in order to quantify the fiscal implication that a trajectory would have for the RGoZ. The projections across all four sub-models are provided up to the year 2060. For those projecting costs, values are presented both in absolute terms (TSh and US$), and as a percentage of GDP and total government expenditure. Here it must be noted that GDP and government expenditure are computed for the years 2022 to 2060. This is done based on the 2021 values and their assumed targets, i.e., nominal average GDP growth rate, government expenditure as a share of GDP and the inflation rate over time, as shown in Table 2 (main report).

1. *Education sub-model*

For education, the devised sub-model projects the number of students at the pre-primary, primary and secondary levels of education,[1] and subsequently calculates the number of teachers, inspectors, schools, classrooms and textbooks that will be required. Combined, these estimates, along with the inflation-adjusted, baseline unit costs estimated from the development, wage recurrent and non-wage recurrent education budget,[2] allow for the calculation of the projected education budget.

While the modelling applied under the **low levels of public investment** estimates the implications of population growth on the assumption that current proxies for educational access and quality are maintained over time, that of the **high levels of public investment** estimates the implications of population growth on the assumption that gradual improvements in the current proxies for educational access and quality will take place over time.

The modelling exercise assumes that the first improvements will be realized by 2030 in line with the targets outlined under the Zanzibar Education Development Plan III as well as the 2030 Sustainable Development Framework. The second set of improvements are modelled to be introduced gradually until 2050 and then sustained until 2060 in line with Zanzibar's Development Vision 2050 targets (*see* Table 2, main report). Improvements are aimed at bringing access to universal primary and secondary education, as well as significant improvements in quality, which is in line with the aforementioned policies.

2. *Health sub-model*

For health, the sub-model centres around Zanzibar's public expenditure for the delivery of essential health services. These consist of expenditure on reproductive, maternal, newborn and child health and infectious and non-communicable diseases – be it promotive, preventive, curative, rehabilitative or palliative. To project the costs of this into the future, the sub-model initially calculates the number of medical staff, beds and public hospitals required given the projected trajectory of Zanzibar's population. Following this, the baseline per capita health expenditure is determined using the most recently released national health budget. Combined, the relevant outcomes of these calculations will allow for the projection of the national health budget. It needs to be noted that costs under this sub-model are adjusted for inflation, where relevant.

For the budget projections assuming **low levels of public investment**, *the model estimates the implications of population growth on the assumption that current proxies for essential health-care access and quality are maintained over time.* In other words, the trajectory quantifies how much it will cost the RGoZ to finance essential health-care services in

1 The tertiary education sector was not considered given that free education financed by government is largely provided for pre-primary, primary and secondary education. In total these three education components compose 66.5 per cent of the annual education budget, while tertiary education only takes up 4.6 per cent.

2 These are the three components of the education budget. The development budget reflects government investments into projects, school infrastructure and construction, as well as teacher training. The wage recurrent budget reflects regular expenses related to public staff in the education sector (e.g., public teachers, public inspectors, etc.). The non-wage recurrent budget reflects regular expenses by the government into education that do not consist of wages. These include expenses on textbooks, capitation grants, etc. This information has been collected based on the RGoZ's most recent budget speeches on education.

the future, if current levels of access and quality were to remain unchanged between 2020 and 2060. This would mean that Zanzibar would remain at the current Universal Health Coverage Index of 43, yet would still require a sizeable increase in health-care investment in order to maintain its coverage given the rising population of Zanzibar.[3] In contrast, for the budget projections assuming **high levels of public investment**, estimations derive the implications of population growth on the assumption that *gradual improvements in the current proxies for essential health-care access and quality will take place over time*. The modelling exercise assumes that the first improvements will be realized by 2030 in line with the targets outlined under the Health Sector Strategic Plan and the 2030 Sustainable Development Framework. It is assumed that Zanzibar attains a universal health service coverage index of 90 per cent by 2030, in line with the SDGs. This is sustained until 2060 (*see* Table 2, main report). For both outcomes, no changes in the model of service delivery, social transitions or epidemiological transitions are assumed.

3. *Infrastructure sub-model*

For infrastructure, the analysis of the sub-model focuses on capital investments and the fiscal impact these will have considering Zanzibar's growing population in the next 40 years in relation to the areas requiring access to electricity and its distribution, as well as to water supply and sanitation. The methodology estimates cost figures based on relevant targets and baseline values as identified in Table 2 (main report). These cost figures include assumptions regarding the per capita cost of extending piped water to household premises in both rural and urban areas; the per capita costs of extending improved water technologies to rural and urban households; and the per capita costs of connecting households to the grid as well as to off-grid sources.

The respective cost estimates for all trajectories are based on pre-existing Africa-specific literature from the World Bank (2019) as well as from Hutton and Varughese (2016). It needs to be noted that these cost estimates aim solely to provide a simplistic overview of the investments needed by the RGoZ to extend access universally. These are meant to be compared by population growth scenarios and are not meant to capture variations in contextual circumstances such as population density, type of power generation, distance to water source, type of water source, terrain, etc. The costs of extension are assumed to be as follows:

- The urban and rural population will have access to either electricity through the grid or through solar energy.[4] This equates to approximately TSh88,888 (US$38) per individual residing in the rural areas, and TSh61,551 (US$26) per urban individual.
- The growing urban population will have access to piped water, while rural residents will have access to improved water.[5] This equates to a per capita cost of TSh279,070 (US$120) and TSh93,023 (US$40), respectively.
- The expansion of access to improved sanitation consists of a minimum of one latrine with a septic tank for urban households and improved sanitation structures[6] for rural households. This equates to TSh534,884 (US$230) for an urban resident, and TSh186,047 (US$80) per rural resident.

These costs are assumed to grow by inflation over time, and do not include operation and management costs. Furthermore, the infrastructural assets are assumed to depreciate at an annual rate of 4 per cent. This would imply that infrastructural assets

3 'The UHC [universal health coverage] service coverage index measures progress towards SDG 3.8.1 and its component tracer indicators, based on the most recently available data and agreed-upon methods' (World Bank, 2020). This assumption is based on the UHC Index of Tanzania given that data were insufficient to calculate the index for Zanzibar specifically (WHO, 2021a).

4 Access to electricity is measured by households using electricity or solar energy as their main source of lighting in both rural and urban areas. The cost estimates are based on a World Bank project that estimates that it would cost US$142 million to extend universal access to electricity (both through the grid and solar power) to the Zanzibari population by 2032. It is assumed that 85 per cent of this cost would be required for rural areas, and the remainder would be needed for urban expansion. To achieve a per capita cost, an average household size of 5.6 is assumed.

5 Having access to water relies on the definition provided by the SDGs: improved water sources are those that are protected and within 30 minutes walking distance from the household. The cost estimates are derived from a study conducted by Hutton and Varughese (2016) which gathered costing information for water, sanitation, and hygiene interventions for 40 countries.

6 Improved sanitation services are defined as the use of an improved latrine technology that is not shared with another household. The costs are derived from the Hutton and Varughese (2016) study described in the previous footnote.

would need to be completely replaced after a total of 25 years. Subsequently, the cost of extending the infrastructure to the increasing number of Zanzibar's population is estimated, taking into consideration the access rates to electricity, water and sanitation; the depreciation of assets; as well as rural-to-urban migration rates.

Again, for low levels of public investment, the modelling estimates the implications of population growth on the assumption that current access rates to electricity, water supply and sanitation services are maintained over the projection period. In other words, the modelling quantifies how much it will cost the RGoZ to finance these three essential infrastructure services in the future to cater for the growing population, without making changes to the current sectoral access rates and quality between 2020 and 2060. On the other hand, under the assumption of high levels of public investment, the model estimates the implications of population growth on the assumption that gradual improvements in the current electricity, water supply and sanitation service access rates will take place over time. The modelling exercise assumes that the improvements will be realized by 2030 in line with the targets outlined under the 2030 Sustainable Development Framework. Therefore, it is assumed that Zanzibar attains universal access to these three areas of infrastructure by 2032. These are then sustained until 2060 (*see* Table 2, main report).

4. Social development sub-model

This sub-model aims to quantify the magnitude of Zanzibar's employment challenge by exploring the implications of population growth over the next four decades in terms of pre-identified labour market indicators. In particular, it illustrates how the growth of the working-age population over the coming years poses a major challenge for the labour market in Zanzibar. In addition, it illustrates policy options that allow for an increase in GDP per capita over time and whether Zanzibar's goal of becoming an upper-middle-income country by 2050 can be achieved.

To do so, the sub-model contains two analyses – one focused on the labour market and the other on poverty. The former makes use of the original the United States Agency for International Development (USAID) demographic dividend (DemDiv) model – an open-access, customizable projection model developed by USAID through the Health Policy Project. The model is structured in two parts, composed of the demographic sub-model and economic sub-model. The demographic calculations feed into the economic sub-model, which consists of equations projecting capital formation, employment growth and total factor productivity as a function of age structure and other social and economic variables. The two sub-models interact over the projection period to describe the combined effects of changes in both sub-models, ultimately projecting GDP and GDP per capita until 2060.

As a consequence, the model reflects the nature of how demographic change can contribute to the economic prosperity of Zanzibar. In the case of the poverty model, impacts are estimated using the historical correlation between GDP per capita and the headcount ratio for Tanzania Mainland given the lack of such information and data for Zanzibar. This is in line with the literature that commonly asserts that increases in economic growth are significantly correlated to reductions in poverty.[7] Hence, by using the projected GDP per capita and the associated correlation, the impact on poverty can be projected for the coming four decades.

As with the aforementioned three sub-models, the social development model also distinguishes per public investment level. While the results for low levels of public investment assume that current demographic and economic indicators are maintained over the projection period, the modelling of high levels of public investment estimates the implications of population growth on the assumption that current demographic and economic indicators improve over time. For the latter, a sensitivity analysis is undertaken whereby the economic variables are assumed to solely reach the average indicators of African countries characterized as lower-middle-income countries instead of the average of African upper-middle-income countries – as assumed under the most-favourable trajectory.

7 Examples include Adams, 2003; Blank, 2000; Blank et al., 1993; Bruno et al., 1998; Dollar and Kraay, 2001; Enders and Hoover, 2003; Squire, 1993; Stevans and Sessions, 2005; Thornton et al., 1978; Wallace and Blank, 1999.

Appendix 2: Sectoral background information

1. Education

Zanzibar follows an education system that is characterized by a 2-7-4-2 structure (*see* Figure 2.1). The first two years are comprised of pre-primary education, followed by seven years of primary education. After the first nine years of schooling, a child needs to write the Standard 7 examination in order to transition into lower secondary school (Forms 1 to 4). After passing her/his Form 4 examination, education can continue along two paths –enrolment into upper secondary education (two years) or enrolment into technical and vocational education and training (TVET) courses (two years). Once students have passed their Form 6 or Vocational Education and Training Authority (VETA) examinations, they can transition to higher education and further TVET courses.

In 2019/20, the RGoZ implemented decentralization measures in the education sector. Pre-primary and primary education is now managed by the Department of Pre- and Primary Education under the local government authorities. However, the Ministry of Education and Vocational Training (MoEVT) retains its responsibility for curriculum development, policy, review and monitoring.

The planning and budgeting for each of the educational levels is guided by the 2017–2022 ZEDP II. This plan provides sector specific targets with respect to net enrolment, passing rates, as well as the number of schools that have access to electricity, water, sanitation services and computers (UNICEF and RGoZ, 2021a).

In 2019/20, TSh196.2 billion were approved to progress on reaching the outlined targets in the ZEDP II. This equated to 13.8 per cent of the total government budget and 4.2 per cent of GDP – both of which had declined since 2017/18. This decline was alarming given that, over the same time period, the

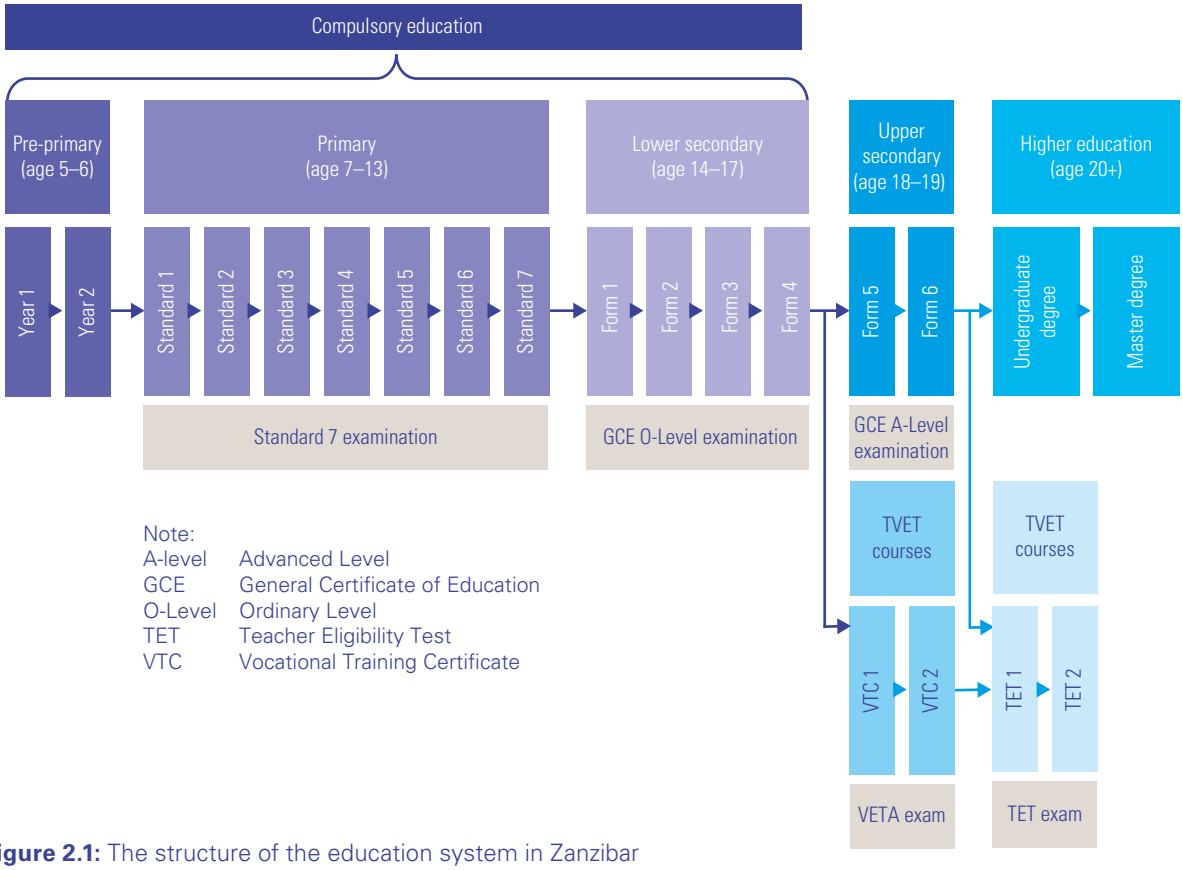

Figure 2.1: The structure of the education system in Zanzibar
Source: Author's own illustration based on Juma, 2018.

number of registered pre-primary, primary and lower secondary students rose. Currently, such a decline in the education budget, when compared to the total national budget, may potentially inhibit the RGoZ from achieving its commitment to universal education and from reaping the maximum gains resulting from the demographic dividend. Furthermore, it will also prevent the government from meeting the international target set for education budgets by the Abuja Declaration as well that by as the Education for All Movement (a target of 20 per cent).

While primary education has been free since 1964, the government extended this policy to include lower and upper secondary schooling in 2019. This has strained the education budget, given the influx of students into the schooling system. By 2022, the gross enrolment rates for pre-primary, primary and secondary education was 85.1 per cent, 122.5 per cent and 55.7 per cent, respectively.[8]

Of those who enrol, few drop out during primary school. In fact, on average, the dropout rates across the Standard 1 to 7 cycle equals 16 per cent. The survival rates are therefore high. In contrast, a high proportion of secondary students leave the education system. Across the lower secondary cycle, dropout rates equate to 50 per cent, while they become even higher for upper-secondary education at 97 per cent (MoEVT, n.d.).

Grants and loans have formed the essential investments that have enabled continued and expanded access to public education and improvements in infrastructure. In 2019/20, the government financed a total of 62.2 per cent of the education budget, while the remaining 37.8 per cent were financed by grants and loans provided by the African Development Bank, Arab Bank for Economic Development in Africa, Good Neighbours, Global Partnership for Education, Korea International Co-operation Agency, OPEC Fund for International Development, Swedish International Development Cooperation Agency, Table for Two, UNESCO, UNICEF, USAID and the World Bank.

2. Health

Zanzibar's health-care system is organized into three levels: primary level, including primary health-care units and centres; secondary level, including regional and district hospitals; and tertiary level, including the national referral and specialized hospitals (*see* Figure 2.2). Primary health-care units provide curative and preventative services and are characterized as the lowest level in Zanzibar's health-care system. These usually provide the first point of contact and serve on average between 3,000 and 20,000 individuals.

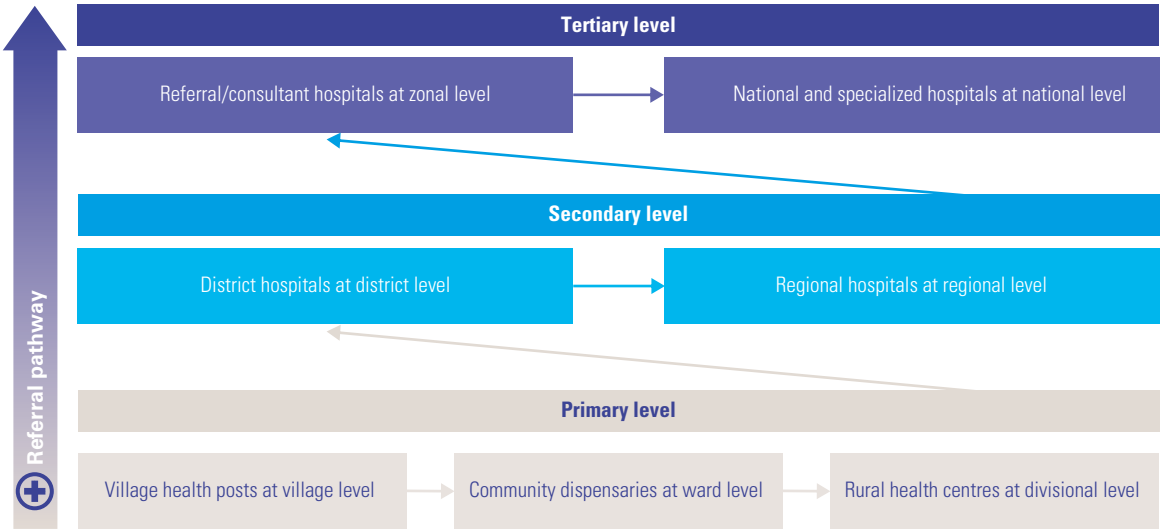

Figure 2.2: The structure of the health system in Zanzibar
Source: Author

8 Government of Zanzibar and UNICEF (July 2022). Education Budget Issue Paper. Available at https://www.unicef.org/esa/media/11301/file/UNICEF-Tanzania-Zanzibar-2022-Education-Budget-Brief.pdf.

Primary health-care centres provide all services offered by the primary health-care units, but do so on a larger scale (serving between 30,000 and 150,000 individuals on average), and for longer hours (usually 24 hours per day). While the primary health-care centres provide first-line referral facilities, the district hospitals provide second-line services. However, given the importance of essential health care and the relative challenges that each facility faces, all health facilities, irrespective of their level, provide essential services to ensure that individuals receive the care they need.

The exception to this is the national referral hospital. To ease coordination of health-care services and ensure adequate linkages to secondary- and tertiary-level services, the RGoZ has appointed a District Health Management Team in each district (UNICEF and RGoZ, 2021a).

In the 2019/20 financial year, a total of TSh109.9 billion was allocated to these three levels of public health care. This constituted 7.7 per cent of the national budget – a decline from the 8.3 per cent in 2018/19, and also significantly below the 15 per cent target outlined in the Abuja Declaration as well as below the proportion allocated by countries that have successfully achieved universal health coverage. Furthermore, as a percentage of GDP, the 2019/20 value of 2.4 per cent is also below the WHO recommended share of 5–6 per cent of GDP to achieve universal health coverage (UNICEF and RGoZ, 2021b). This would currently equate to US$29 per capita.

3. Infrastructure

The Zanzibar Strategy for Growth and Reduction of Poverty 2016–2020 (ZSGRP III) prioritized the generation of enabling infrastructure, such as energy, water and transport, as a key driver of economic growth and poverty reduction. It is this strategy, as well as the draft version of the Medium-Term Plan 2021–2026, that provide the overarching umbrella for the country's high-level objectives for development of energy, water and sanitation infrastructure. These objectives include:

1. The provision of "accessibility, affordability and sustainability of water resources, sanitation services and hygiene practices, ensuring all households and public institutions have access to safely managed water and sanitation"; and
2. The attainment of "greater power system independence and reliability through the diversification of energy sources, especially renewable energy" (RGoZ, 2020).

The aspirations of each objective are provided in Table 2.1.

In terms of electricity, there is no independent producer of power on Zanzibar. Instead, Zanzibar's power sector is composed of three main public institutions:

1. The Department for Energy and Minerals within the Ministry of Land, Housing, Water and Energy, which is responsible for the overall coordination, planning and policy of the sector.
2. ZURA, which is responsible for the economic and technical regulation of the electricity, water and petroleum sectors.
3. ZECO, which is responsible for the generation, transmission, distribution and sale of electricity.

In terms of water and sanitation, the RGoZ aims to improve the social well-being of its people, while also enhancing the performance of the economy by ensuring the equitable and adequate provision of water and sanitation services. Furthermore, it places emphasis on cost recovery, the environmental protection of existing resources, as well as the sustainability of investments into this sector. In order to ensure that these goals are achieved, the RGoZ formed ZAWA, which is responsible for the identification, conservation and protection of water sources, as well as for the production, distribution, protection and sustainability of safe and clean water throughout the country (ZAWA, 2020).

4. Social development

The information previously provided on this sector can be disaggregated further into sectors of employment, industry, as well as level of education.

Of the employed Zanzibaris in 2021, the majority were found in the service sector (47.4 per cent), followed by agriculture (35.5 per cent) and manufacturing (17.1 per cent). Historically, a slight difference emerged when further disaggregating these numbers by geographic region. While individuals in rural areas were predominantly employed in agriculture, those in urban areas

Table 2.1: Key aspirations regarding the electricity, water and sanitation infrastructure in Zanzibar

	Key aspirations	Key legislation
Water	1. Sustainable access to safe and clean drinking water facilitated by an effective water resource management master plan and associated strategies, focusing on integrated water resources management to protect the water ecosystem; 2. Diversified potable water sources reinforced by the exploration of undersea freshwater, rainwater harvesting and reuse technologies, as well as seawater desalination; and 3. Optimal water supply management for agriculture, tourism, industry and other economic activities supported by continuous research and development on sustainable sources.	The Zanzibar Water Sector Policy (2004)
Sanitation	1. Sustainable sanitation service provision through effective sanitation-focused interventions, including the enforcement of the 'polluter pays' principle and the construction of sewage treatment systems for households and industry; and 2. Strong institutional framework for the sustainable and responsible collection, processing and disposal of solid, liquid and hazardous waste that focuses on empowering local government authorities and other relevant institutions.	The Zanzibar Water Sector Policy (2004)
Energy	1. Sustainable and diversified energy sources through the exploration and adoption of domestically generated energy, including potential renewable and non-renewable energy sources; 2. A reliable power system backed by improvements to the current submarine cable network; 3. High public and private sector investment in renewable energy initiatives, including engagement with renewable energy-focused non-governmental organizations; and 4. Modern and innovative renewable energy and non-renewable energy technologies supported by research and development, innovation and training programmes.	The Zanzibar Electricity Corporation Act (2006) The Energy Policy (2009) The ZURA Act (2013) The ZURA Strategic Plan (2017–2022) The Zanzibar Investment Guide (2019–2020)

Source: RGoZ, 2020

were mainly engaged in wholesale retail trade and the repair of vehicles, with only a fraction of the employed in the agriculture sector. Yet, although more than 35 per cent of the population was employed in agriculture, the sector has historically only accounted for close to 25 per cent of Zanzibar's GDP. This is unlike the service and manufacturing sectors, which accounted for 56 per cent and 19.6 per cent of Zanzibar's GDP, respectively.[9]

Furthermore, by skill level, it was found that less-educated workers were predominantly concentrated in the agriculture sector in 2014, while those with more skills were employed in services (including trade and public administration), the private service sector, as well as manufacturing. Of these individuals, those with upper-secondary and university degrees, were predominantly employed in wage employment, mainly in public administration (World Bank, 2017). Overall, however, wage employment in 2021 remained rather limited in Zanzibar (roughly 28 per cent), illustrating the high dependence of Zanzibaris on agricultural and non-agricultural business income. This is additionally reflected by the presence of a relatively large informal sector. In 2021, approximately 42 per cent of all those employed were engaged in the informal sector, the majority of which were female (NBS and OCGS, 2021).

9 The data on value added by industries were retrieved from the United Nations Statistics Division.

Appendix 3: Remaining trajectories

This appendix outlines the two trajectories not discussed in the main report, and their results.

1. A trajectory characterized by high population growth rates and high public investment

The results of this trajectory assume that the population growth rate will continue to grow along its most likely path as identified for the population projections shown in Chapter 3, Section 3.1, of the main report. In addition to this, it is assumed that access and quality is improved across all four sectors. The consequent results of this trajectory are illustrated in Table 3.1.

Table 3.1: Projected results, by sector

	2021	2030	2040	2050	2060
Education sector					
Enrolled public pre-primary students	18,670	22,634	27,939	27,409	26,009
Enrolled public primary students	285,210	317,678	295,583	297,417	280,544
Enrolled public secondary students	127,742	189,795	201,300	210,336	205,769
Total public classrooms	5,873	8,415	9,909	12,380	11,847
Total public teachers	13,083	17,975	19,808	22,219	21,339
Total public schools	538	633	621	661	552
Total public textbooks	122,780	235,441	502,471	513,234	491,515
Total nominal costs (in million US$)	84.4	143.7	313.6	599.1	989.6
Total real costs (in million US$)	84.4	99.2	143.5	181.7	198.9
As a percentage of GDP	4.2	4.2	5.0	5.8	6.5
As a percentage of government expenditure	13.8	15.4	16.7	17.9	18.6
Health sector					
Number of primary health facilities	162	329	296	274	256
Number of secondary and tertiary hospitals	8	16	15	14	13
Total public beds	1,282	3,809	4,626	5,394	6,080
Total public medical staff	1,755	9,416	11,437	13,334	15,030
Total nominal costs (in million US$)	47.3	177.5	315.3	583.9	906.8
Total real costs (in million US$)	47.3	122.6	144.3	177.1	182.3
As a percentage of GDP	2.4	5.2	5.0	5.7	6.0
As a percentage of government expenditure	7.7	19.0	16.8	17.5	17.1
Infrastructure sector					
Total population with access to electricity/solar power	979,234	1,954,319	2,570,194	2,996,468	3,377,595
Urban	614,892	949,029	1,246,544	1,516,213	1,776,615
Rural	364,342	1,005,290	1,323,650	1,480,255	1,600,980
Total population with access to piped/improved water	672,332	2,052,562	2,570,194	2,996,468	3,377,595
Urban	575,554	954,441	1,246,544	1,516,213	1,776,615
Rural	96,778	1,098,121	1,323,650	1,480,255	1,600,980
Total population with access to improved sanitation	810,108	2,116,043	2,570,194	2,996,468	3,377,595
Urban	486,185	983,960	1,246,544	1,516,213	1,776,615
Rural	323,923	1,132,083	1,323,650	1,480,255	1,600,980
Total nominal costs (in million US$)	–	40.8	14.7	15.0	16.4
Total real costs (in million US$)	–	28.1	6.8	4.6	3.3
As a percentage of GDP	–	1.2	0.24	0.15	0.11
As a percentage of government expenditure	–	4.36	0.79	0.45	0.31

	2021	2030	2040	2050	2060
Social development sector					
African upper-middle-income assumption					
Number of employed	600,009	744,373	992,481	1,259,138	1,497,107
Number of unemployed	147,543	247,263	337,232	395,850	472,974
GDP per capita (US$)	1,099	1,482	3,142	6,434	10,860
Poverty rate (%)	25.7	22.4	15.7	11.13	8.7
Number of poor	440,150	473,807	402,258	333,585	294,369
African lower-middle-income assumption (sensitivity analysis)					
Number of employed	600,009	743,630	950,397	1,165,632	1,371,638
Number of unemployed	147,543	248,006	379,316	489,356	598,442
GDP per capita (US$)	1,099	1,463	2,369	3,977	6,390
Poverty rate (%)	25.7	22.5	18.0	14.1	11.3
Number of poor	440,150	476,602	462,342	423,097	382,367

Source: Author's calculations based on assumptions in NBS and OCGS, 2018 and 2021; education and health budget briefs in UNICEF and RGoZ, 2018a and 2021a; information retrieved from the World Economic Forum, 2017; and MoHCDGEC et al., 2016. Assumptions regarding extension costs retrieved from World Bank, 2019; and Hutton and Varughese, 2016.

2. A trajectory characterized by low population growth rates and low public investment

The results of this potential trajectory (i.e., low population growth rates and low public investment) assume that the population growth rate will decline given reductions in the total fertility rate of the country, as explained in Chapter 3, Section 3.2.1, of the main report. In addition to this, it is assumed that access and quality across all four sectors are maintained at their 2021 level. The results are given in Table 3.2.

Table 3.2: Projected results, by sector

	2021	2030	2040	2050	2060
Education sector					
Enrolled public pre-primary students	18,670	15,944	16,041	14,115	11,705
Enrolled public primary students	285,210	321,509	291,712	270,717	221,708
Enrolled public secondary students	127,742	175,070	148,581	148,063	129,055
Total public classrooms	5,873	7,027	6,240	5,940	4,991
Total public teachers	13,083	15,779	13,970	13,349	11,264
Total public schools	538	648	574	548	462
Total public textbooks	122,780	153,431	134,237	129,586	110,040
Total nominal costs (in million US$)	84.4	84.2	127.6	200.1	295.9
Total real costs (in million US$)	84.4	58.2	58.4	60.7	59.5
As a percentage of GDP	4.2	2.5	2.0	1.9	1.9
As a percentage of government expenditure	13.8	9.0	6.8	6.0	5.6

	2021	2030	2040	2050	2060
Health sector					
Number of primary health facilities	162	201	236	264	284
Number of secondary and tertiary hospitals	8	10	12	13	14
Total public beds	1,282	1,591	1,869	2,092	2,249
Total public medical staff	1,755	2,101	2,469	2,764	2,970
Total nominal costs (in million US$)	47.3	42.6	55.9	77.1	116.6
Total real costs (in million US$)	47.3	29.4	25.6	23.4	23.4
As a percentage of GDP	2.4	1.3	0.9	0.7	0.8
As a percentage of government expenditure	7.7	4.6	3.0	2.3	2.2
Infrastructure sector					
Total population with access to electricity/solar power	979,234	1,188,759	1,416,911	1,609,680	1,754,371
Urban	614,892	767,522	940,516	1,098,228	1,226,952
Rural	364,342	421,237	476,395	511,452	527,419
Total population with access to piped/improved water	672,332	830,310	1,006,888	1,163,823	1,288,554
Urban	575,554	718,419	880,346	1,027,969	1,148,458
Rural	96,778	111,891	126,542	135,854	140,096
Total population with access to improved sanitation	810,108	981,372	1,167,195	1,323,064	1,439,038
Urban	486,185	606,866	743,650	868,351	970,130
Rural	323,923	374,506	423,545	454,713	468,908
Total nominal costs (in million US$)	–	6.8	6.8	5.9	5.7
Total real costs (in million US$)	–	4.7	3.1	1.8	1.1
As a percentage of GDP	–	0.20	0.11	0.06	0.04
As a percentage of government expenditure	–	0.73	0.36	0.18	0.10
Social development sector					
African upper-middle-income assumption					
Number of employed	600,009	737,608	921,642	1,090,173	1,247,357
Number of unemployed	147,543	254,028	387,490	482,722	553,469
GDP per capita (US$)	1,099	1,448	2,206	3,506	5,708
Poverty rate (%)	25.7	22.6	18.6	15.0	12.0
Number of poor	440,150	464,132	448,491	404,557	346,387
African lower-middle-income assumption (sensitivity analysis)					
Number of employed	600,009	737,608	921,642	1,090,173	1,247,357
Number of unemployed	147,543	254,028	387,490	482,722	553,469
GDP per capita (US$)	1,099	1,448	2,206	3,506	5,708
Poverty rate (%)	25.7	22.6	18.6	15.0	12.0
Number of poor	440,150	464,132	448,491	404,557	346,387

Source: Author's calculations based on assumptions in NBS and OCGS, 2018 and 2021; education and health budget briefs in UNICEF and RGoZ, 2018a and 2021a; information retrieved from the World Economic Forum; and MoHCDGEC et al., 2016. Assumptions regarding extension costs retrieved from World Bank, 2019; and Hutton and Varughese, 2016.

Appendix 4: Methodological appendix

This appendix provides a step-by-step overview of the analysis undertaken in this report. This includes instructions and the underlying assumptions of two Excel-based models. The first aims to identify the financial investment required to improve the access and quality of three identified sectors (education, health and infrastructure) of the economy, while the second illustrates the impact that population growth and an improvement in demographic and economic indicators will have on the employed and unemployed population, GDP, GDP per capita, and poverty (social development sub-model).

1. Population growth scenarios

The demographic transition in Zanzibar can take one of two paths – one where population growth resembles the most likely 'status-quo' path that the country will take in the future (i.e., high population growth scenario), and one in which the RGoZ makes deliberate choices to reduce the total fertility rate in the country (i.e., low population growth scenario), thereby lowering future population growth rates (*see* Figure 4.1). The assumptions that underlie each of the calculations for the two population growth scenarios are explained in the next section.

Each of these two scenarios can yield two possible policy outcomes that are driven by government public investment choices. The first is characterised by low levels of public investment, and models the implications of population growth assuming that the current (2021) access and quality of identified components within the sector remain constant over time (see the baseline column under the worksheet title 'control panel' in the Excel file titled 'FinancialInvestmentModel'). In other words, this level of public investment identifies how much a government would need to invest to finance the system if the current level of sectoral indicators were to be maintained between 2021 and 2060 in light of a rising population.

For a second choice characterized by high levels of public investment, the methodology models the implications for government given a gradual improvement in key sectoral parameters that are related to access and quality (see the remaining columns under the worksheet titled 'control panel' in the Excel file titled 'FinancialInvestmentModel'). These improvements are in line with targets set in policy documents – the Zanzibar Development Vision 2050, as well as other sectoral plans (e.g., the Zanzibar Education Development Plan II 2017–2022, the Zanzibar Health Sector Strategic Plan III 2014–18, the Zanzibar Investment Guide 2019/20, etc.).

2. Population projections

2.1 Step 1: Relevant software

In order to project the population of Zanzibar, you must first download the following software: Spectrum 5, Version 5.441. To do this, go to the following website (https://www.avenirhealth.org/software-spectrum.php) and press the words 'Historical Versions' on the right of the screen. From the pop-up screen that appears, select '5.441 (29 Jun 2016) (AIM 2016)' and follow the download instructions. Please note that this is for Windows operating systems. If you use another system, you need to take special care that you download the software meant for your system.

Once downloaded, open the software and click on the icon termed 'Run Spectrum'. This brings you to the user interface site of the programme. The next step is now to save a project. To do this, click on 'New'. A pop-up box appears on the screen. Under the projection file name, enter a name that will refer to this analysis. Next, you will set the year boundaries for the projection. This consists of a first year and a final year. For the model in this report, the first year was set to 2012 and the final year was 2060. Once this has been chosen, you can activate certain modules. For the methodology at hand, you will only need to ensure that the 'Demographic Projection' (DemProj) module is ticked. Finally, before clicking 'ok', choose a country or global region. For this, click on 'default data' and double click on 'The United Republic of Tanzania' in the list. Once chosen, click 'ok' at the bottom of the dialogue box. You have now created your first project.

However, any projections that you would undertake at this moment, are based on data for Tanzania as a whole. In order to adjust this, click on 'Modules' in the top left. Then click on 'DemProj'. You will see that the interface now has three

main tabs: projection parameters, demographic data, and results. Under the first tab (projection parameters), you can identify certain parameters for his/her population projections. For the purpose of this modelling, only tick the 'Include urban/rural population' and then click 'ok'.

Having done this, it is now time to change the underlying assumptions of the projections in order to adjust them to Zanzibar. For this, click on 'Demographic data'. A window will pop out, which includes eight tabs: 'First year population', 'Total fertility rate', 'ASFR' (age-specific fertility rate), 'Sex ratio at birth', 'Life expectancy', 'Model life table', 'International migration', and 'Regional assumptions'. These must be filled in according to the instructions provided under Step 2 below. Once done, click 'ok'. The user can now generate projections for Zanzibar.

2.2 Step 2: Underlying assumptions

In order to project the population for Zanzibar, a number of underlying data and assumptions need to be gathered. These are found under the 'AssumptionsPopulationProjectionMostLikely' Excel file and consist of: a base population by age, the total fertility rate, the age-specific fertility rate, the sex ratio at birth, the life expectancy, the model life table, as well as assumptions on international migration and the future share of the urban population.

On the first worksheet, 'First year population (2012)', you can change the data if needed based on a more recent census or household survey. In this worksheet, single age-disaggregated data are needed by gender and area of residence. Here you must note that the program used to project the population can only do so for up to 50 years in advance.

The second worksheet, 'Total fertility rate', requires you to start plotting data from the year that you used on the first worksheet. As such, if the first-year population was plotted for 2016, then the total fertility rate must start at 2016. This also holds for all the remaining worksheets in the Excel file. Consequently, you plot the rates that are exhibited currently and in the past, while making assumptions about the future. In the case of the modelling at hand, the future assumptions are made based on past fertility rates retrieved from the demographic and health surveys, projections outlined in the National Projection Report and targets set under the Zanzibar Development Vision 2050. Based on this information, any projected fertility rates are proportionally in line with those outlined under the National Projection Report, yet are also adjusted by a constant in order to attain the targets outlined in the Zanzibar Development Vision 2050.

The third worksheet, 'Age-specific fertility rate', is based on two components. The first includes an estimation of the age-specific fertility rates for the first-year population. This was achieved by using the underlying microdata and calculating the rates with Stata. The do-file for this process is also provided and can be used to replicate the analysis. Based on these calculated rates, further years are extrapolated using the projected age-specific rates for Tanzania as a whole. The latter are obtained from Spectrum under the 'Demographic data' tab (see where this is found from Step 1 above). This is done by using the difference across the age-specific fertility rates and applying this difference to the first-year age specific rates for Zanzibar.

The fourth and fifth worksheets require the past, present and future values of the sex ratio at birth as well as male and female life expectancy. This can be obtained from previous national reports, demographic and health surveys, as well as policy targets.

The fifth worksheet concerns the 'model life table'. This can be left blank as you can select the option needed in Spectrum under the 'Demographic data' tab. As a quick introduction, a model life table outlines survival ratios, which indicate how many individuals of a specific five-year age group will survive to make it into the next five-year age group. For many countries, information to generate a country-specific life table are scarce or incomplete. Spectrum thus provides a number of different options. For the modelling at hand, the CD-North life table is utilized as it derives mortality indicators based on the characteristics of mortality in nineteenth century Europe. While this might sound strange, it is of importance to realize that these patterns of mortality are used for estimations across the globe despite the fact that their source data are retrieved from Europe. For modelling, it is more important to have reliable sources of data rather than geographically specific patterns that are based on less reliable data. However, if you believe another model life table would be more suitable, this

can be adjusted under the 'Demographic data' tab in Spectrum (see Step 1 above).

The sixth worksheet forecasts net migration per year. Given that such data for Zanzibar are unavailable, the numbers are based on those retrieved from Spectrum for Tanzania as a whole. These numbers are based on the 2019 World Population Prospects from the United Nations. In order to adjust them to Zanzibar, the net migration rates per year were divided by the whole population of Tanzania. With the resulting unit rate, the estimates for Zanzibar are obtained by multiplying this unit rate by the first-year population of Zanzibar. It is assumed that the calculated net migration rate will remain constant over the projection period.

The final worksheet projects the share of Zanzibar's population living in urban areas. To do so, historical data is filled in and linearly extrapolated where required. Then, the annual differences among the historical shares are calculated. The subsequent projections for years in the future are then based on the average of the historical differences. For example, in 2020, the urban share of Zanzibar was 44.4 per cent. The average annual difference in the urban share was 0.2 per cent. Consequently, to compute the shares from 2021 onwards, the 0.2 per cent is added to 44.4 per cent, and so forth.

2.3 Step 3: Generating results

Once the assumptions have been adjusted as identified under Step 2, you can generate results by clicking on the 'Results' tab. This allows for a variety of outputs ranging from population projections, to fertility/mortality projections and to the estimation of the demographic dividend. For the modelling at hand, we require the projection of the population by single years of age. To do this, click on the 'Results' tab, then on 'Age groups' and 'Defined age group'. A pop-up box will appear. Depending on which information is needed, you can change the options selected in the box. For the purpose of this modelling, we would need the following results in table format:

- Single age-disaggregated total population per projection year
- Single age-disaggregated male population per projection year
- Single age-disaggregated female population per projection year
- Total urban population per projection year
- Total rural population per projection year.

For this, click the respective options (region, sex, first and final year, low and high age) and under 'Chart type' select 'Table'. Once this has been selected, you can now tick 'Disaggregate by age'. You can also change the range of the age group to be displayed under the 'Low Age' and the 'High Age' cells. For example, if you want to have the total population between the ages of 0 and 8 years old, then the 'Low Age' cell value would be 0 and the 'High Age' cell value would be 8. After this has been

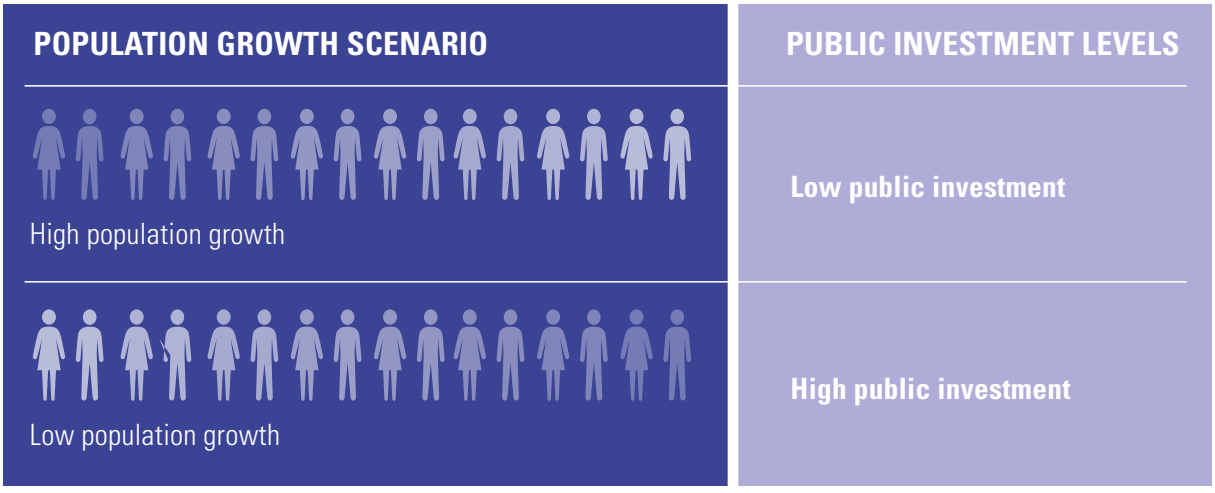

Figure 4.1: Modelled scenarios and public investment levels
Source: Author

entered, press 'ok'. This will provide the projected results in tabular form, which can now be selected by clicking on the blank cell in the left upper corner of the results table. This will select the entire table. With a right click, select 'copy' and paste the data to where you need them (*see* Section 2.2, Step 2).

2.4 Step 4: Creation of a low population growth scenario

Having undertaken Steps 1 to 3 to generate the high population growth scenario, it is now time to generate a low population growth scenario. In order to do this, Steps 1 to 3 need to be repeated. The only difference is that under Step 2, changes to the total fertility rate are made (see description of second worksheet above). For the modelling at hand, total fertility under the low population growth scenario is assumed to be 0.5 births below the rates utilized under the high population growth scenario. This rate is based on the assumptions made by the population projections of United Nations Department of Economics and Social Affairs' (UNDESA's) World Population Prospects, which assume that the low fertility variant is 0.5 births below the total fertility rates utilized under its medium fertility variant. However, you may generate a low population growth scenario of your choice. The only thing that is of importance is that the total fertility rates for any future years are lower than those exhibited under the high population growth scenario.

3. Education, health and infrastructure sub-models

3.1 Step 1: The identification of baseline and target variables for each sector

This step entails opening the Excel-based model named 'FinancialInvestmentModel' and saving a new version of it. Following this, click on the 'control panel' worksheet. This worksheet serves as input into the calculations on the remaining worksheets in the Excel file.

1. **Selection of baseline year:** To start, identify a baseline year from a dropdown menu in cell B2. In the case of the model at hand, this is 2021. Any changes to this cell will also change the years in rows 5, 13, 27, 57 and 79. Please note that the intervals between the time periods will remain the same. For example, currently, the baseline year equals 2021, with the target years identified as 2025, 2030, 2035, 2040, 2045, 2050, 2055 and 2060. If you were to change the baseline year to, for example, 2026, the target years will change to 2030, 2035, 2040, 2045, 30250, 2055, 2060 and 2065. Do not change the years manually as these are linked to equations throughout the Excel file. Consequently, you may only change cell B2. Please also note that if the baseline year is changed, the new projection timeline also needs to be reflected in the population projections. As such, you would need to go back to Section 2 (page 12), and repeat the steps for the newly established projection period.
2. **Inputting data for the baseline indicators:** Following this, you must adjust the baseline indicators to showcase the situation in Zanzibar during the baseline year chosen. This holds for all indicators listed under the sections titled: general assumptions, education sub-model, health sub-model and infrastructure sub-model. For the model at hand, these indicators were obtained from a number of sources and verified by the relevant ministries of Zanzibar, as well as through key informant interviews and a working group session with relevant stakeholders (*see* Table 4.1).

Table 4.1: The sources for baseline indicators

Indicator	Source of baseline indicators (year 2021)
	Pre-primary education
Gross enrolment rate	The 2018 Education Budget Brief; the 2019/2020 Education Budget Brief; the Education Development Plan II (2017–2022); the Annual Joint Education Sector Review Report 2019; the Education Statistical Abstracts; and the Zanzibar in Figures reports.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school ratio	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	Annual financial statements from the education sector and direct inputs from the MoEVT through UNICEF's education section.
	Primary education
Gross enrolment rate	The 2018 Education Budget Brief; the 2019/2020 Education Budget Brief; the Education Development Plan II (2017–2022); the Annual Joint Education Sector Review Report 2019; the Education Statistical Abstracts; and the Zanzibar in Figures reports.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school ratio	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	Annual financial statements from the education sector and direct inputs from the MoEVT through UNICEF's education section.
	Secondary education
Gross enrolment rate	The 2018 Education Budget Brief; the 2019/2020 Education Budget Brief; the Education Development Plan II (2017–2022); the Annual Joint Education Sector Review Report 2019; the Education Statistical Abstracts; and the Zanzibar in Figures reports.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school ratio	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	Annual financial statements from the education sector and direct inputs from the MoEVT through UNICEF's education section.
	Health sub-model
Number of public hospital beds per 10,000 people	The SDGs, and the publication by the World Bank, *Tackling the Demographic Challenge in Uganda*.
Number of public medical staff (doctors and nurses) per 10,000 people	The SDGs, and the publication by the World Bank, *Tackling the Demographic Challenge in Uganda*.
Share of public health budget that is for development (%)	The 2018/2019 Health Budget Brief; the 2019/2020 Health Budget Brief; the 2017/2018 National Health Account; and direct inputs from the Ministry of Health through UNICEF's health section.
Share of public health budget that is spent on hospital services, prevention and education (%)	
People with access to electricity from national grid or solar power in urban areas (%)	Calculations undertaken on microdata retrieved from the most recent Demographic and Health Survey and the Household Budget Survey.
People with access to electricity from national grid or solar power in rural areas (%)	
People with access to piped water within 30 minutes of premises in urban areas (%)	
People with access to improved water within 30 minutes of premises in urban areas (%)	

Indicator	Source of baseline indicators (year 2021)
	Infrastructure sub-model
People with access to piped water within 30 minutes of premises in rural areas (%)	
People with access to improved water within 30 minutes of premises in rural areas (%)	
People using basic improved and not shared sanitation services in urban areas (%)	
People using basic improved and not shared sanitation services in rural areas (%)	
	Cross-cutting indicators
Nominal average GDP growth rate (%)	Zanzibar's socioeconomic survey reports.
Government expenditure as a share of GDP (%)	Zanzibar's socioeconomic survey reports.
Inflation rate (%)	The website of the Office of the Chief Government Statistician.

Source: Author

3. **Identifying relevant targets for each baseline indicator:** Once this has been completed, the relevant targets need to be identified for the coming 39 years. These should be based on international and national policy targets set by the RGoZ. For the model at hand, these targets originate from Zanzibar's 2050 Development Vision, its sectoral strategies and action plans, the 2030 SDG targets, as well as from direct input from relevant ministries. See Table 4.2 for a list of sources for the targets of each indicator.

   It may, however, be the case that a target is only available for a single year in the future. In order to fill in the remaining target years, you can linearly extrapolate the values in between those provided in documents. For example, if the average growth of GDP is 2.0 per cent in 2021 and policy documents want to attain a growth rate of 7.0 per cent by 2050, then the values can be subtracted from one another (7.0 – 2.0 = 5.0) and divided by the target years between them (5.0 ÷ 29 years = 0.17) in order to get a value that showcases the unit increase per year that would need to be attained in order to reach the target by 2050. As a result, the 2025 target growth rate would be 2.68 (2.0 + (0.17 × 4)), while the 2040 growth rate would be 5.23 (2.0 + (0.17 × 19)).

   If, however, specific targets are already present for the years, then these can simply be changed in the appropriate cells.

   Any information that is filled into the cells in the control panel will automatically generate changes to the underlying equations in the other worksheets. Also note that some of the cells or worksheets of the Excel file are protected, meaning you cannot make changes to them. This is only done to cells or worksheets that do not require input from the user of the model.

Table 4.2: The sources of targets for each indicator

Indicator	Source of targets
	Pre-primary education
Gross enrolment rate	Direct inputs on targets from the MoEVT through UNICEF's education section. These consist of a pre-primary gross enrolment of 100 per cent by 2040, a public pre-primary pupil-to-teacher ratio of 13 by 2050, a public pre-primary pupil-to-textbook ratio of 5 by 2040, and a public pre-primary pupil-to-classroom ratio of 25 by 2050. Any targets before these dates are linearly extrapolated based on the value of the baseline indicator.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	This indicator is assumed to remain constant given the lack of available data on how it has developed historically.
	Primary education
Gross enrolment rate	Direct inputs on targets from the MoEVT through UNICEF's education section. These consist of a primary gross enrolment of 100 per cent by 2040, a public primary pupil-to-teacher ratio of 31 by 2050, a public primary pupil-to-textbook ratio of 1 by 2040, and a public primary pupil-to-classroom ratio of 45 by 2050. Any targets before these dates are linearly extrapolated based on the value of the baseline indicator.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	This indicator is assumed to remain constant given the lack of available data on how it has developed historically.
	Secondary education
Gross enrolment rate	Direct inputs on targets from the MoEVT through UNICEF's education section. These consist of a secondary gross enrolment of 100 per cent by 2040, a public secondary pupil-to-teacher ratio of 20 by 2050, a public secondary pupil-to-textbook ratio of 1 by 2040, and a public secondary pupil-to-classroom ratio of 45 by 2050. Any targets before these dates are linearly extrapolated based on the value of the baseline indicator.
Public pupil-to-teacher ratio	
Public pupil-to-textbook ratio	
Public pupil-to-classroom ratio	
Inspectors per school	Direct inputs from the MoEVT through UNICEF's education section.
Public share of enrolment (%)	This indicator is assumed to remain constant given the lack of available data on how it has developed historically.
	Health sub-model
Number of public hospital beds per 10,000 people	The target indicators of 44.5 medical doctors, nurses and midwives per 10,000 people; and around 18 hospital beds per 10,000 people by 2030 are obtained from the SDG targets as well as the WHO report *Global Strategy on Human Resources for Health: Workforce 2030*. Any targets before this date (2030) are linearly extrapolated based on the value of the baseline indicator.
Number of public medical staff (doctors and nurses) per 10,000 people	
Share of public health budget that is for development (%)	The 2018/2019 Health Budget Brief, the 2019/2020 Health Budget Brief, the 2017/2018 National Health Account, the Health Strategic Plan III 2014–2018, and direct inputs from the Ministry of Health through UNICEF's health section. Based on this, the indicators are assumed to remain constant over time given little available data on how these indicators developed historically.
Share of public health budget that is spent on hospital services, prevention and education (%)	
	Infrastructure sub-model
People with access to electricity from national grid or solar power in urban areas (%)	Zanzibar's Development Vision 2050, Zanzibar's Investment Guide 2019/2020, ZURA's Strategic Plan 2017–2022 and ZECO's Zanzibar Energy Sector Transformation and Access Project document. The documents stipulate universal access to sanitation by 2030 (according to the SDGs) and to electricity and water by 2032. Any targets before these dates are linearly extrapolated based on the value of the baseline indicator.
People with access to electricity from national grid or solar power in rural areas (%)	
People with access to piped water within 30 minutes of premises in urban areas (%)	

Indicator	Source of targets
	Infrastructure sub-model
People with access to improved water within 30 minutes of premises in urban areas (%)	
People with access to piped water within 30 minutes of premises in rural areas (%)	
People with access to improved water within 30 minutes of premises in rural areas (%)	
People using basic improved and not shared sanitation services in urban areas (%)	
People using basic improved and not shared sanitation services in rural areas (%)	
	Cross-cutting indicators
Nominal average GDP growth rate (%)	Based on the average growth rate of upper-middle-income African countries in 2021. The value obtained is assumed to be Zanzibar's 2060 target. The remaining targets are linearly extrapolated based on the value of the baseline indicator.
Government expenditure as a share of GDP (%)	Based on the average share of expenditure of upper-middle-income African countries in 2021. The value obtained is assumed to be Zanzibar's 2060 target. The remaining targets are linearly extrapolated based on the value of the baseline indicator.
Inflation rate (%)	The indicator is assumed to remain constant over the projection period. Its value is calculated based on the historical average of Zanzibar's inflation rate.

Source: Author

3.2 Step 2: Inserting the projected population

The population projections that have been generated under the steps outlined in Section 2 (page 12) will be copy-and-pasted into the worksheet named 'Population projections'. Here, be sure to paste single age-disaggregated data as this is important for the calculations for the education, health and infrastructure sub-models. This is done for both the high population growth scenario and the low population growth scenario:

- For the high population growth scenario, the total population (cell range DL4:GN52); the total male population (cell range DL54:GN102); and the total female population (cell range DL104:GN152).
- For the low population growth scenario, the total population (cell range B4:CW52); the total male population (cell range B54:CW102); and the total female population (cell range B104:CW152).

Based on the data entered, all other columns in the 'Population projections' worksheet will undertake the underlying calculations by themselves. These have been protected, meaning you cannot change the underlying calculations.

3.3 Step 3: Inserting urban and rural population projections

After the above step is completed, also copy-and-paste the total urban and rural population projections into the worksheet named 'UrbanRuralProjections'. These data are not age-disaggregated. They solely represent the total projected urban and rural population of Zanzibar for the projection period. In the case of the modelling, this is from 2012 to 2060. Again, this is done for both the high and low population growth scenarios. The data to fill this worksheet have been calculated by the user in Spectrum (see the steps under Section 2 if necessary).

3.4 Step 4: The sub-models

When considering the worksheets related to the education, health and infrastructure sub-models, no changes are required. These worksheets have been protected. The sole changes that are required are undertaken in the control panel of the model.

However, it is of importance that you understand each worksheet of the model. To start, for each

sectoral sub-model, there is a worksheet that reflects the high population growth scenario (EducationHighPopGrowth, HealthHighPopGrowth, InfrastructureHighPopGrowth), and one that reflects the low population growth scenario (EducationLowPopGrowth, HealthLowPopGrowth, InfrastuctureLowPopGrowth).

Additionally, in each of these worksheets, the Excel file calculates the financial investments required from the RGoZ for each of the two outcomes outlined in Section 1 (page 12). On the left side of the yellow column in each worksheet, you will see the underlying calculations for low levels of public investment, while on the right side of the yellow column you have the calculations for high levels of public investment. For both investment choices, all cells are linked to information in the 'control panel' worksheet. Calculations will be automatically updated if the indicators under the education, health and infrastructure sections in the control panel are updated. The same applies when considering the worksheets reflecting the low population growth scenario.

3.4.1 The education sub-model

The sub-model calculates the gross enrolment of students at each level of education based on the population projections provided, as well as the baseline gross enrolment rate entered under the control panel. With low levels of public investment, this rate is assumed to remain constant across the coming 39 years, while for high levels of public investment, the rate is linearly extrapolated between each target year based on the targets identified under the control panel.

For example, the pre-primary gross enrolment was 69.2 per cent in 2021 and has a target of 77.5 per cent in 2025. There is a total of four years between these two gross enrolment values. Consequently, to obtain the gross enrolment rate per year (for 2022, 2023 and 2024), the values are subtracted from one another and divided by the duration. The unit increase is then added to the previous year's value. The difference between the two values is 8.3 percentage points (77.5 minus 69.2). Per year, this would result in a 2.075 percentage point rise between 2021 and 2025: from 69.2 to 71.3 to 73.4 to 75.4 to 77.5.

As such, in each of the respective years, the number of children of pre-primary age are multiplied by the respective gross enrolment rate. In order to obtain the public share of these enrolled students, the resulting number is multiplied by the proportion of pre-primary students that are enrolled in public institutions – this is also found under the control panel.

Once the public enrolled students have been calculated per year, the model calculates the number of teachers, textbooks, classrooms, schools and inspectors that would be needed. For this to take place, you need to have entered values for the following indicators under the control panel: the public pupil-to-teacher ratio, the public pupil-to-textbook ratio, the public pupil-to-classroom ratio and the number of schools per inspector. While these indicators remain constant over time with low levels of public investment, they are linearly extrapolated as illustrated in the example above with high levels of public investment. Consequently, the following calculations are undertaken for each year up to 2060:

- The total number of teachers per education level per year = the total number of public enrolled students per education level per year divided by the public pupil-to-teacher ratio per education level.
- The total number of textbooks per education level per year = the total number of public enrolled students per education level per year divided by the public pupil-to-textbook ratio per education level.
- The total number of classrooms per education level per year = the total number of public enrolled students per education level per year divided by the public pupil-to-classroom ratio per education level.
- The total number of schools per education level per year = the total classrooms in a year divided by the previous year's ratio of classrooms per school. With low levels of public investment, this ratio is assumed to remain constant across the projection period, while with high levels of public investment, the ratio is assumed to double by 2060. Again, there is a linear extrapolation of the increase in the ratio across time.

- The total number of inspectors per education level per year = the total number of schools per education level per year divided by the number of schools per inspector for each education level.

Following this, the education sub-model calculates the total cost of any additional schools that need to be built over time. For this, the model includes the price of a fully furnished classroom in the control panel. This price is grown by inflation over time. Based on this, the cost of a new school at each education level is calculated by multiplying the price by the average number of classrooms per school per education level. This will feed into the education development budget later on (*see* Table 4.3).

Following this, the total nominal value of the education budget is divided into the recurrent budget and the development budget. Their calculations, projections and the underlying assumptions are explained in Table 4.3. These calculations are the same for both low and high levels of public investment. The only difference is that targets for the former are held constant over time, while for the latter they are linearly extrapolated.

Once the total education budget and its components have been projected across time, the model then converts the nominal values into nominal US$values and real US$values. This requires the exchange rate as well as the average annual inflation rate. Both of these are identified in the control panel: cell B6 and cell B9. In addition, the total annual budget values are expressed as a share of GDP and government expenditure.

It should also be noted that the calculations explained in this subsection are undertaken for both the high population growth scenario and the low population growth scenario. The only difference is that the latter is based on a lower number of projected children of school age. As a result, the model also calculates the real fiscal savings that the RGoZ can achieve by lowering future population growth rates. This is calculated in row 80 of the 'EducationHighPopGrowth' worksheet. The annual real fiscal savings are essentially the difference between the total annual projected real education budget of the high and low population growth scenarios.

3.4.2 The health sub-model

This sub-model begins by calculating the projected number of public health facilities and beds required per level, as well as the total number of public medical staff. This calculation is dependent on the projected total population as well as the baseline value and targets identified for the number of public medical staff per 10,000 people and the number of public hospital beds per 10,000 people (cells B63:J63 and B69:J69 in the control panel).

- The total number of public beds per year = the population per year multiplied by the number of public hospital beds available per individual. This is further disaggregated by primary public beds, as well as secondary and tertiary public beds. To do this, the growth rate of the overall public beds per year is applied to the baseline number of beds available in primary and secondary/tertiary health facilities.
- The total number of public medical staff per year = the population per year multiplied by the number of public medical staff available per individual.

In order to calculate the number of facilities required by level, assumptions are made regarding the average number of public beds in primary health facilities, as well as the average number of beds in secondary and tertiary health facilities. For low levels of public investment, these are assumed to remain constant over time at an average of 1 bed per primary health facility and an average of 132 beds in secondary and tertiary facilities. In the case of high levels of public investment, these numbers are assumed to triple in size by 2060. This takes into consideration the argument that hospitals increase in size in the future to reap economies of scale and overcome finite land resources in light of a growing population. Again, this growth in the number of beds per health facility over time is linearly extrapolated.

Table 4.3: Projecting the education budget and its components

	Baseline year (2021)	Projection period (2022–2060)
Total education budget	Identified in the control panel (cell B16).	Adding the projected recurrent and development budget per year.
Recurrent education budget	**As a share of total education budget identified in the control panel (cell B17).**	**Adding the projected wage recurrent and non-wage recurrent budget per year.**
Wage recurrent	As a share of the total education budget identified in the control panel (cell B18).	Summing the total number of teachers and inspectors per year and multiplying it by the average wage per teacher and inspector. The average wage in the baseline year is calculated by dividing the wage recurrent budget in 2021 by the total number of teachers and inspectors in 2021. The wage increases by a nominal wage growth rate over time (also identified in the control panel (cell B10)).
Non-wage recurrent	Calculated by subtracting the wage recurrent value from the total recurrent education budget value.	This first requires calculating the total cost of new textbooks needed. Per year, the total number of new textbooks is multiplied by the unit price of a textbook (identified in the control panel (cell B22). The unit price increases across time with inflation. The total price of all new textbooks per year is then added to the non-wage recurrent budget per year. To calculate the non-wage recurrent budget per year, the model grows the non-wage recurrent budget in the previous year by the annual nominal education budget growth rate, as identified in the control panel (cells B21:J21).
Development education budget	**Implicitly calculates the value based on the share of the recurrent education budget identified in the control panel.**	**Adding the projected operating activities and investment activities per year.**
Operating activities	Calculated by subtracting the investment activities value from the total development budget value.	The value of projected operating activities was calculated by multiplying the projected investment activities value by the proportion of the value of operating activities to that of investment activities in the baseline year.
Investment activities	Identified in the control panel (cell B19).	The projected investment activities are assumed to be the price of the new schools. Consequently, to calculate the amount, the total number of new schools per year is calculated and multiplied by the cost of constructing a new school. This is done for each education level.

Source: Author

Next, the model calculates the average price of constructing public health facilities. Per level, the price has been identified in the control panel (cells B70 and B71) and is subsequently grown by inflation across time. This later feeds into the projections of the development budget.

Following this step, the total nominal public health budget is identified for the baseline year. However, notably, the sub-model also centres around Zanzibar's public expenditure for the delivery of essential health services. These consist of expenditure on reproductive, maternal, newborn and

Table 4.4: Projecting the health budget and its components

	Baseline year (2021)	Projection period (2022–2060)
Total health budget	Identified in the control panel (cell B58).	Dividing the projected total essential nominal health-care budget by the latter's share of the total health budget (cells B61:J61 in the control panel).
Total health budget on essential services	**As a share of total health budget identified in the control panel (cell B61).**	**Adding the projected recurrent and development budget for essential services per year.**
Recurrent component of essential health-care budget	**Implicitly calculates the value based on the share of the development component of the essential health-care budget identified in the control panel.**	**Adding the projected wage recurrent and non-wage recurrent budget for essential services per year.**
Wage recurrent	Calculated by multiplying the value of the wage-recurrent health budget by the share of the public health budget that is used for essential services. Both of these are identified in the control panel (cells B59 and B61).	Summing the total number of medical staff required per year and multiplying it times the average annual salary per medical worker. The latter is identified in the control panel under cell B64 and is grown by the nominal wage growth rate over time (also identified in the control panel (cell B10)).
Non-wage recurrent	Calculated by subtracting the wage recurrent value from the total recurrent essential health budget value.	To calculate the non-wage recurrent budget per year, the model grows the non-wage recurrent budget in the previous year by the annual nominal health budget growth rate, as identified in the control panel (cells B62:J62)
Development component of essential health-care budget	**Given a lack of available data, it was assumed that its share can be approximated by the share of the total health budget directed towards development, as identified in the control panel (cell B60).**	**Calculating the total costs of all new health facilities per year. This means multiplying the average price of constructing primary, secondary and tertiary health facilities per year and multiplying this by the number of new health facilities required per year.**

Source: Author

child health, infectious diseases, non-communicable diseases – be it promotive, preventive, curative, rehabilitative or palliative. The essential health budget is divided into two categories: the recurrent health budget and the development health budget. Their calculations, projections and the underlying assumptions are explained in Table 4.4. These calculations are the same for both low and high levels of public investment, the only difference is that targets under the former are held constant across time, while under the latter, they are linearly extrapolated.

Once the total health budget, the essential health budget and their components have been projected across time, the model then converts the nominal values into nominal US$values and real US$values. This requires the exchange rate as well as the average annual inflation rate. Both of which are identified in the control panel: cell B6 and cell B9. In addition, the total annual budget values are expressed as a share of GDP and government expenditure.

It should also be noted that the calculations explained in this subsection are undertaken for both the high population growth scenario and the low population growth scenario. The only difference is that the latter is based on a lower total population across time. As a result, the model also calculates the real fiscal savings that the RGoZ can achieve by lowering future population growth rates. This is calculated in rows 58 and 59 of the 'HealthHighPopGrowth' worksheet – the former for the total health budget, and the latter solely for the essential health budget. The annual real fiscal savings are essentially the difference between the total annual projected real (essential) health budget of the high and low population growth scenarios.

3.4.3 The infrastructure sub-model

For the infrastructure sub-model, the calculations focus on estimating the costs of extending access to electricity, water and sanitation to all individuals in Zanzibar. To do so, the sub-model commences by detailing both the total urban and rural population for

the entire projection period (2021–2060). Following this, the model calculates the number of individuals that have access to the above-identified services in each year. This is based on access assumptions made in the control panel – see cell range B80:K85. With low levels of public investment, the number of individuals that have access to these services remains constant over the projection period, while with high levels of public investment the access rates increase, attaining universality by 2030 for sanitation and by 2032 for electricity and water.

Following the calculation of the rural and urban populations that have access to services, the sub-model calculates the prices of extending each service to the population. This is first done in the nominal local currency and then converted into nominal US$. Subsequently, the values of both currencies are adjusted for inflation. The following assumptions on pricing are assumed based on Africa-specific literature and utility documents and policies from Zanzibar – each of which are identified in the control panel:

- Price of extending access to the grid/solar power in urban areas: TSh59,386 (cell B89)
- Price of extending access to the grid/solar power in rural areas: TSh85,761 (cell B88)
- Price of extending access to piped water in urban areas: TSh279,070 (cell B90)
- Price of extending access improved water in rural areas: TSh93,023 (cell B91)
- Price of extending access to improved sanitation in urban areas: TSh534,884 (cell B92)
- Price of extending access to improved sanitation in rural areas: TSh186,047 (cell B93).

Across the projection period, each of the above-mentioned prices increase by the annual rate of inflation.

Following this, the model calculates the total cost of extension for each of the three utilities. In order to do so, the annual price of extension is multiplied by the number of individuals that newly gain access per year. This is done separately for rural and urban residents. By summing the total cost of extension for rural and urban areas, one receives the total cost of extension to the population per year per utility.

However, the model also considers the costs associated with the depreciation of infrastructure. It is assumed that any infrastructure built will need to be fully replaced in 25 years. As such, the annual cost of depreciation would equal to 4 per cent of the total cost of extension (as identified in cell B86 in the control panel). As a result, if, for example, the total cost of extension of piped water cost TSh2,000,000,000 in 2022, then the cost of depreciation that needs to be accounted for would equate to TSh80,000,000 (0.04 × 2,000,000,000). In total, the cost of extension for 2022 would then be TSh2,080,000,000.

Once the total annual costs of extending access to electricity, water and sanitation in urban and rural areas have been projected across time, the model converts the nominal values into nominal US$ values and real US$ values. This requires the exchange rate as well as the average annual inflation rate, both of which are identified in the control panel: cell B6 and cell B9. In addition, the total annual costs are expressed as a share of GDP and government expenditure.

It should be noted that the calculations explained in this subsection are undertaken for both the high and low population growth scenarios. The only difference is that the latter is based on a lower total population across time. As a result, the model also calculates the real fiscal savings that the RGoZ can achieve by lowering future population growth rates. This is calculated in row 95 of the 'InfrastructureHighPopGrowth' worksheet. The annual real fiscal savings are essentially the difference in the total annual projected costs of extension between the high and the low population growth scenarios.

4. The social development sub-model

The social development sub-model is undertaken in a different Excel file, named 'MacroeconomicModel'. It aims to quantify the magnitude of Zanzibar's employment challenge by exploring the implications of population growth over the next four decades in terms of pre-identified labour market indicators. In particular, it illustrates how the growth of the working-age population over the coming years poses a major challenge for the labour market in Zanzibar. In addition, it illustrates policy options that allow for an increase in GDP per capita over time and whether Zanzibar's goal of becoming an upper-middle-income country by 2050 can be achieved.

To do so, the sub-model contains two analyses – one focused on the labour market and the other on poverty. The former makes use of the original USAID DemDiv model – an open-access, customizable projection model developed by USAID through the Health Policy Project. The model is structured as a two-part model, composed of the demographic component and the economic component. The demographic calculations feed into the economic component, which consists of equations projecting capital formation, employment growth and total factor productivity as a function of age structure and other social and economic variables. The two components interact over the projection period to describe the combined effects of changes in both components, ultimately projecting GDP and GDP per capita until 2060.

In the case of the poverty analysis, impacts are estimated using the historical correlation between GDP per capita and the headcount ratio for Tanzania Mainland given the lack of such information and data for Zanzibar. This is in line with the literature, which commonly asserts that increases in economic growth are significantly correlated to reductions in poverty. Hence, by using the projected GDP per capita and the associated correlation, the impact on poverty could be projected for the coming four decades.

4.1 The control panel

The control panel of the social development sub-model identifies the variables that are required for the calculations in the remaining worksheets of the Excel file. As can be seen, there are a number of topics for which baseline data as well as targets need to be identified: education, family planning, economic policies, health and economy. The first step for all the underlying indicators for these topics is to validate the data for the baseline year. In the current model the sources for the underlying data can be seen in Table 4.5.

Table 4.5: The sources for the baseline indicators under the social development sub-model

Indicator	Source of baseline indicators (year 2021)
	Demographic variables
Expected years of education (female)	The latest available data on Tanzania as a whole retrieved from the UNESCO Institute for Statistics Database.
Expected years of education (male)	
Mean years of education (female)	The Demographic and Health Survey 2015–16 report. For indicators that could not be found in the report, the value for Tanzania as a whole is used.
Mean years of education (male)	
Mean years of education (both)	
Modern contraceptive prevalence rate (married women)	
Traditional contraceptive prevalence rate (married women)	
Postpartum insusceptibility (months)	
Sterility (per cent of all women aged 45–49)	
Percentage married (female 15 years and above)	The Demographic and Health Survey 2015–16 report, the Mortality and Health Monograph and the Population and Household Census of 2012.
Total fertility rate (female)	
Percentage births at risk	
Infant mortality rate (age 0–1)	
Under-five mortality rate (ages 0–4)	
Maternal mortality ratio (deaths per 100,000 live births)	The Mortality and Health Monograph
Contraceptive effectiveness, modern methods	These are underlying assumptions that the USAID DemDiv model has made for Tanzania as a whole.
Contraceptive effectiveness, traditional methods	

Indicator	Source of baseline indicators (year 2021)
Female life expectancy at birth	The Population and Household Census of 2012 report.
Female–male life expectancy difference	The government's 2019 Women and Men in Zanzibar: Facts and Figures report.
Primary education costs (percentage of GDP per capita)	The World Bank, World Development Indicators. This number is assumed to be that for Tanzania as a whole as reliable sources for Zanzibar could not be found.
Poverty rate	Directly validated by the Office of the Chief Government Statistician.
	Economic variables
Public institutions	The World Economic Forum's Global Competitive Index data in Tanzania as a whole are for imports as a percentage of GDP given that its data are obtained from OCGS's data on the composition of the GDP in 2015.
Imports as a percentage of GDP	
Labour market flexibility	
Financial market efficiency	
ICT use	
Capital formation per capita	Retrieved from the United Nations Database. Yet, the most recent available figure is for 2013.
Initial employment (ages 15 and above)	The 2020/21 Integrated Labour Force Survey report.
Initial employment growth rate (ages 15 and above)	The model assumes the value for Tanzania as a whole, which is based on the International Labour Organization's *Key Indicators of the Labour Market, 8th edition.*
GDP per capita	The 2020 Economic Survey of Zanzibar.
Ratio of capital stock to population aged 15 and above	Given a lack of reliable data on this indicator for Zanzibar, the underlying assumption made by the USAID DemDiv model is maintained. The source for this indicator originates from research undertaken by Berlemann and Wesselhöft (2012), as well as from data retrieved from the United Nations Population Division.
Initial GDP growth rate	The National Budget Brief 2019/2020.
Capital stock growth rate	This indicator is implicitly calculated based on the capital formation per capita indicator and the ratio of the capital stock to the population aged 15 and above.
Capital stock depreciation rate	The source for this indicator originates from research undertaken by Berlemann and Wesselhöft (2012) as it is a constant and not a country-specific indicator.
Labour force participation rate	The 2020/21 Integrated Labour Force Survey report.

Source: Author

Having finalized this step and validated/updated all the underlying indicators, you can now move on to the second step – defining the targets for the low levels and the high levels of public investment. These can be set as you see fit. For this model, the following assumptions are made:

- **Baseline indicators:** For the economic component, the underlying indicators cannot be calculated for Zanzibar given a lack of adequate data. Consequently, the sub-model assumes these to have the value of that exhibited by Tanzania as a whole. The exception to this is the variable representing imports as a percentage of exports, which could be determined based on data retrieved by the OCGS. Concerning the demographic component, the baseline values were identified through the sources as outlined in Table 4.5.
- **Low public investment level:** For both the demographic and the economic components, the target indicators are assumed to remain constant over time as is the case in the education, health and infrastructure sub-models. Here, again, it is important to note that this does not mean that no investments will be undertaken in these sectors. Given the growing population over time, the RGoZ will need to invest substantially to keep the underlying indicators at their current level.
- **High public investment level:** While the indicators under the demographic component

achieve levels as outlined under the 2030 SDGs, the target indicators for the economic component under this outcome are dependent on a sensitivity analysis – as described below. The user can choose the Sensitivity Scenario under Step 3 in the control panel (cell B1).

A sensitivity analysis can be defined as one that determines how outcome variables are affected by changes in the underlying input variables. In the case of this analysis, the sensitivity analysis is based on different inputs into the economic component of the USAID DemDiv model. For this, two different assumptions were undertaken:

- **African upper-middle-income assumption:** Over the projection period, the economic variables are assumed to reach the average indicators of African countries characterized as upper-middle-income countries according to the World Bank classification. More specifically, the World Economic Forum's Global Competitive Index indicators for Botswana, Namibia and South Africa are averaged to obtain the required targets. This assumption is applied to all estimations considering a high level of public investment.
- **African lower-middle-income assumption:** Over the projection period, the economic variables are assumed to reach the average indicators of African countries characterized as lower-middle-income countries according to the World Bank classification. More specifically, the World Economic Forum's Global Competitive Index indicators for Benin, Cameroon, Congo, Egypt, Ghana, Kenya, Lesotho, Mauritania, Morocco, Nigeria, Senegal, Tunisia, Zambia and Zimbabwe were averaged to obtain the required targets. This assumption is applied as a sensitivity analysis to the results obtained under a high level of public investment.

The composition of the demographic and economic components, as well as the assumed baseline and target values for each are explained in Table 4.6. These values feed into the underlying calculations in the remaining worksheets of the model. For more information on this see Moreland et al. (2014).

Table 4.6: Baseline and target values for the demographic and economic components

Economic variables	Baseline value	Low public investment level	Accelerated progress	
			High level of public investment	Sensitivity analysis
Demographic component				
Expected years of education (female)	8.20	11.89	14.8	14.8
Expected years of education (male)	8.00	11.48	14.2	14.2
Mean years of education (female)	6.48	8.51	10.0	10.0
Mean years of education (male)	8.10	9.25	10.0	10.0
Mean years of education (total)	7.29	8.88	10.0	10.0
CPR modern (married women)	10.0	35.5	75.0	75.0
CPR traditional (married women)	4.3	0.0	0.0	0.0
Postpartum insusceptibility (months)	7.3	7.3	7.3	7.3
Sterility (percentage of all women aged 45–49)	1.72	1.72	1.72	1.72
Economic component				
Public institutions	3.40	3.9	4.1	4.1
Imports as a percentage of GDP	23.70	32.6	49.5	39.3
Labour market flexibility	4.46	4.4	4.5	4.3
Financial market efficiency	3.14	3.1	3.9	3.0
ICT use	1.09	1.7	3.4	2.1

Note: CPR = contraceptive prevalence rate

Source: Data was retrieved from the UNESCO Institute for Statistics Database; MoHCDGEC et al., 2016; WEF 2017; NBS and OCGS, 2013 and 2021; and Berlemann and Wesselhöft, 2012, among others.

4.2 The population projections

The next step for the user is to update the population projections tab based on the projections calculated under Section 2 (page 12). For this Excel model, the user does not need single age-disaggregated population projections, but rather the following:

- Total population per projection year
- Total population aged 15 years and above per projection year
- Total population aged 1–4 years per projection year
- Total population aged 0 years per projection year (born in the year)
- Dependency ratio per projection year.

The last bullet point can also be attained from the Spectrum program, whose operation is explained under Section 2. To do so, click on the 'Results' tab, then on the 'demographic dividend' tab, and finally on the 'demographic dividend – number' tab. In the pop-up box, select the specifications that you need. Under chart type, also select 'table' and then click 'ok'. This will provide the dependency ratio for the projection period.

4.3 The worksheets

The identified baseline values and targets as well as the updated population projections will feed into four specific worksheets of the Excel-based model: Low invest High pop growth; Low invest Low pop growth; High invest High pop growth; and High invest Low pop growth.

Once again, the differences between these worksheets are the target values for the projection period as well as the growth rate of the population across time. Based on this, these worksheets project demographic and economic indicators into the future. In this case to 2060. You do not need to change anything on these sheets; however, a quick overview will be provided in order for you to be able to understand the results.

In the modelling at hand, the demographic component projects fertility, child mortality, the dependency ratio, life expectancy, and population size and structure. These demographic calculations then feed into the economic component, consisting of three main equations. One describes capital formation, the other employment growth and, the final one, total factor productivity – all of which depend on the age structure as well as other social and economic variables. Combined, the demographic and economic components interact over the specified projection period to ultimately project GDP, GDP per capita and poverty.

A number of the most important indicators are listed in Table 4.7 and briefly explained.

Table 4.7: A list of important indicators for the modelling

Column	Indicator	Description
X	Capital formation per capita	This can be defined as a country's current outputs and imports that are not exported or consumed during a financial year. Rather, they are set aside and allow the stock of capital goods in a country to grow. As it is per capita, the indicator implies the amount of capital stock that is available per individual in the country. In the Excel file, its estimation and projection is dependent on the population projections, financial market efficiency, GDP per capita, and the current level of capital formation per capita as identified in the control panel.
Y	Employment	This is defined as the number of individuals in the country that are employed. In the Excel file, its estimation and projection is dependent on the population projections, GDP growth rate, labour market flexibility, the current number of employed, as well as the initial employment growth rate. The latter two are directly influenced by the values in the control panel.
Z	Capital stock	This is defined as the existing physical capital that is available in a country's economy. In the Excel file, its estimation and projection depend on capital formation per capita, population projections, as well as the ratio of capital stock to the working-age population (the ratio of capital stock is identified in the control panel).
AA	Human capital (H)	This is defined as the knowledge, skills and experience possessed by the country's population. In the Excel file, its estimation and projection depend on the mean years of education, population projections and employment.
AB	Total factor productivity (TFP)	This is defined as a measure of productive efficiency of the country. In other words, how much output can be produced given a certain amount of input. In the Excel file, its estimation and projection depend on the population projections, the capital stock and human capital available, the share of imports as a percentage of GDP, an index quantifying the public institutional environment of a country, and one that quantifies the infrastructural and digital environment. Lastly, it also depends on current levels of GDP per capita as identified in the control panel.

Column	Indicator	Description
AC	Total factor productivity squared (TFP^2)	This is the square of total factor productivity. In the Excel file, its estimation and projection depend on total factor productivity and its change, GDP growth, as well as capital stock growth as identified in the control panel.
AD	Gross domestic product (GDP)	This is defined as the total monetary value of all finished goods and services produced within a country's borders during a specific time period. In the Excel file, its estimation and projection depend on the amount of capital stock, the amount of human capital, as well as total factor productivity squared.
AE	GDP growth rate	This is defined as the change in GDP over time. In the Excel file, its estimation and projection depend on GDP over time.
AF	GDP per capita	This is defined as the amount of GDP available per person in a country. In the Excel file, its estimation and projection depend on GDP and the population projections.
AG	TFP growth rate	This is defined as the growth in productive efficiency of the country. In the Excel file, its estimation and projection depend on the change in TFP over time.
AH	GDP per capita growth rate	This is defined as the growth of GDP per capita over time. In the Excel file, its estimation and projection depend on the change in GDP per capita over time.
AI	Employment growth rate	This is defined as the growth in the number of employed across time. In the Excel file, its estimation and projection depend on the change in the number of employed over time.
AJ	Capital stock growth rate	This is defined as the growth in the capital stock over time. In the Excel file, its estimation and projection depend on the growth in capital stock over time.
AK	Annual change in employment	This is defined as the number of individuals that enter employment each year. In the Excel file, its estimation and projection depend on the difference in the number of employed from the current year to the previous year.
AL	Annual gap between working-age population and employed	This is defined as the number of working-age individuals and the current number of those employed, highlighting the potential number of individuals that are in the economy that could still be put to productive use. In the Excel file, its estimation and projection depend on population projections and the number of employed per year.
AM	Annual gap between labour force and employed (the unemployed)	This is defined as the number of individuals in the labour force that are currently not in employment – or in other words, that are unemployed. In the Excel file, its estimation and projection depend on population projections and the number of employed per year.
AN	Gap between population and employment growth	This is defined as the difference that is present between the growth in the population that is available to work and the growth in those that are in employment. As such, the indicator represents an overview on whether the economy is creating enough jobs to employ the growing working-age population. In the Excel file, its estimation and projection depend on population projections on the change in the working-age population, as well as on the change in the employed.
AO	Employment/population 15 and above	This is defined as the share of the working-age population that are employed. In the Excel file, its estimation and projection depend on the number of employed, as well as population projections for those aged 15 and above.
AY	Poverty rate change	This is defined as the change in poverty rates given changes in GDP per capita. In the Excel file, its estimation and projection depend on the growth rate of GDP per capita and a correlation between that and the change in poverty over time (i.e., the growth elasticity of poverty – the percentage reduction in poverty associated with a percentage change in GDP per capita in the country) the latter of which is identified in the control panel.
AW	Poverty rate	This is defined as the percentage of the total population that lives below a nationally or internationally defined poverty line. In the Excel file, its estimation and projection depend on the poverty rate in the previous year and the change in poverty given changes in GDP per capita.
AX	Number of poor individuals	This is defined as the number of individuals in a country that live below a nationally or internationally defined poverty line. In the Excel file, its estimation and projection depend on the poverty rate and the population projections.

Source: Author, and Moreland et al., 2014.