

Population estimation and projection

Summera Kainat

Meaning of Population Projections Estimation vs Projection

	Population Estimation	Population Projection
Same	<ul style="list-style-type: none"> ▪ Methods of preparing are same. ▪ Methods are same. 	
Differences	<ul style="list-style-type: none"> ▪ Focus on the present or recent past. 	<ul style="list-style-type: none"> ▪ Focus on the future
	<ul style="list-style-type: none"> ▪ the years between censuses, or intercensal estimates ▪ –the current year following the latest complete census, or postcensal estimates 	<ul style="list-style-type: none"> ▪ the years in the future, or population projection
	<ul style="list-style-type: none"> ▪ Based on observed population data. 	<ul style="list-style-type: none"> ▪ No observed population data

Purposes of Population Projection

As a basis for planning: both government and non-government

- Population projection serves as the starting point for most projections of future need.
 - expected number of retirements from labour force
 - required number of teachers, classrooms, schools,
 - required number of medical personnel and facilities
 - number of housing unit
 - etc.

General Issues and Principles

Population projections are essentially concerned with future growth

May be prepared for the total population of

- Nations
- Principal geographic subdivision
- Residence classes: urban / rural

Principal characteristics are age and sex

Length of Projection Period

Projection period depends on:

- Type of area in question
- The needs to be served
- The conception of the problem by the analyst
- The available resources

Assumptions

- Projection is uncertainty!
- Assumptions is needed!
 - Basic assumptions
 - Fertility assumptions
 - Mortality assumptions
 - Migration assumptions
- Number of series and combination of assumptions

Basic Assumptions

- ❑ Assumption on general society:
 - There is **no natural disaster** or
 - No suddenly changes in the social and economic** situation during the estimates or projection periods

- ❑ Assumption on demographic change:
 - The results of population estimates or projection are depend on population changes conditions.

Fertility Assumptions

- TFR / ASFRs
 - Constant / change throughout the projection period
 - Set target period and target level/pattern of TFR
- Sex ratio at birth
 - Constant / change

Mortality Assumptions

- **ASDRs**
 - Maintaining the latest observed death rates
 - Study from past trend, then extrapolate by linear / logistic or other possibly trends
 - Set target by using rates from analyzing data of past trend & other countries

- **Life Expectancy (LE)**
 - LE from own country data or
 - LE from model life tables: United Nations, Coale & Demeny
 - LE increase / decrease: linear, logistic or other possibly trends

Migration Assumptions

National level

Having / **no migration**: depend on existing / available data

Sub-national level

Internal migration affect to population composition

Series and Combination of Assumptions

- ❖ Evident uncertainties regarding future population changes: **more than one series of projections are desired.**

Generally 3 series (variants) of projection are presented :
high, medium, and low

-The range of highest to lowest “reasonable” series: **rough indicator of the degree of uncertainty regarding future population change.**

Series and Combination of Assumptions

High variant :

-The combination of fertility, mortality and migration assumption that give the maximum future population.

Medium variant:

-The most likely (but not certain) projection that recommended to use base on the most likely fertility, mortality and migration assumptions.

Low variant:

-The combination of fertility, mortality and migration assumption that give the minimum future population

Frequency and Nature of Revision

Factors affect to the revision of population projections:

- **Primary factors:**

- The extent to which the present projections are out of line with current estimates.
- The mere passage of time during which at least some of the series of projections must deviate from the current estimation.
- The availability of additional data
- Advances of methodology

- **Secondary factors:**

- Availability of resources
- The need to establish publication

Methods of Estimation and Projection

The 2 most frequently used methods :

Mathematical methods	Component methods
Using arithmetic or geometric inter & extrapolation - Estimate for short period of time, - Result: just total number of population	Component of population changes (fertility, mortality and migration) - Result: population by age and sex
Focus on growth rate	Cohort component method: Focus on 2 characteristics: age & sex

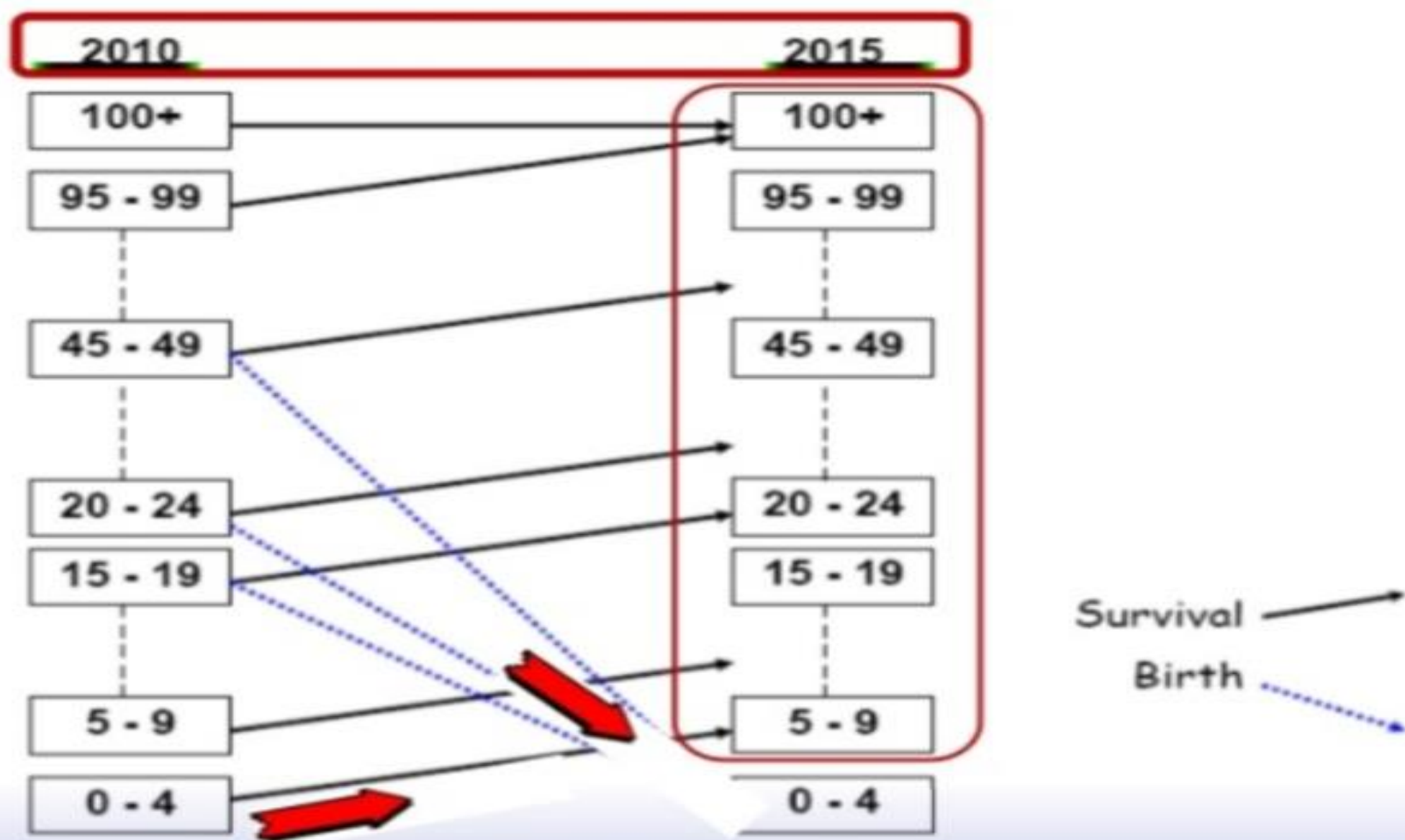
COHORT COMPONENT METHOD

Data Required for the Component Method

Based population by age and sex

- **Mortality**
 - Age-specific death rates (ASDRs)
 - Life expectancy at birth, survival ratios
- **Fertility**
 - TFR
 - Age-specific fertility rates (or Age distribution of ASFRs)
 - Sex ratio at birth
- **Migration: international or internal migration**
 - Net migration rates by age and sex

An illustration of one time step of the cohort component method for a female population.



If no migration

MYP concept

Survival Ratio at birth

Sex Ratio at birth

Age	2010	2015
Male		
0 - 4	317,121	460,708
5 - 9	483,774	314,165
10 - 14	583,653	482,109
15 - 19	564,813	581,570
20 - 24	489,351	561,655
25 - 29	434,478	485,836
30 - 34	406,302	430,843
35 - 39	445,101	401,961
40 - 44	447,975	438,376
45 - 49	325,515	437,909
50 - 54	222,888	314,194
55 - 59	143,463	210,781
60 - 64	229,095	131,331
65 - 69	167,733	199,405
70 - 74	151,152	135,444
75 - 79	53,673	109,443
80 - 84	18,087	33,146
85+	16,449	14,639
Total	5,500,623	5,743,516

$$= \frac{(\text{Births}_{2010} + \text{Births}_{2015})}{2} \times 5 \times S_{\text{at birth}} \times 105/205$$

$$= 317,121 \times S_{0-4}$$

$$= 445,101 \times S_{35-39}$$

$$= (18,087 + 16,449) \times S_{80+}$$

Survival Ratio at Specific 5 year age group

Calculation

Calculating cohort component projections (1)

- **Projected survivors**

– P_x at year y = P_{x-n} at year $y-n$ \times S_{x-n}
at year $y-n$

Ex. P_{5-9} at year 2015 = P_{0-4} at year 2010 \times S_{0-4}
at year 2010

– P_{x+} at year y = $(P_{x-n} + P_{x+})$ at year $y-n$ \times
 S_{x-n} at year $y-n$

Ex. P_{85+} at year 2015 = $(P_{80-84} + P_{85+})$ at year 2010 \times
 S_{80+} at year 2010

Calculating cohort component projections (2)

- **Projected total births:** will be projected population aged 0 - 4 (male & female)

$$\text{Births} = \sum_{x=15-19}^{45-49} ASFR_x \times P_x^f$$

Male 0-4:

= Male births during year x to $x+n$ \times Survival ratio at birth

= $[(\text{Births in year } x + \text{Births in year } x+n) / 2 \times 5 \times 105/205] \times S_{\text{birth}}$

Female 0-4 :

= Female births during year x to $x+n$ \times Survival ratio at birth

= $[(\text{Births in year } x + \text{Births in year } x+n) / 2 \times 5 \times 100/205] \times S_{\text{birth}}$

(Let sex ratio at birth = 105:100)

	Women		
Age	2010	2015	2020
15 - 19	541,536	552,682	451,610
20 - 24	471,732	539,847	551,097
25 - 29	424,725	469,787	537,796
30 - 34	422,205	422,464	467,473
35 - 39	502,881	419,197	419,663
40 - 44	507,264	497,813	415,233
45 - 49	381,483	499,771	490,855
	ASFRs		
Age	2010	2015	2020
15 - 19	0.0710	0.0698	0.0687
20 - 24	0.1175	0.1156	0.1136
25 - 29	0.1080	0.1062	0.1045
30 - 34	0.0650	0.0639	0.0629
35 - 39	0.0265	0.0261	0.0256
40 - 44	0.0068	0.0067	0.0066
45 - 49	0.0012	0.0012	0.0012
	Births		
Age	2010	2015	2020
15 - 19	38,449	38,596	31,012
20 - 24	55,429	62,391	62,628
25 - 29	45,870	49,904	56,175
30 - 34	27,443	27,009	29,388
35 - 39	13,326	10,926	10,756
40 - 44	3,449	3,330	2,731
45 - 49	458	590	570
Total births	184,425	192,747	193,260
Avg. births	188,586	193,003	184,052
Births in 5 years	942,928	965,016	920,258

2015 Male population aged 0-4

$$\begin{aligned}
 &= \frac{(\text{Births}_{2010} + \text{Births}_{2015})}{2} \times 5 \times S_{\text{at birth}} \times 105/205 \\
 &= \frac{(184,425 + 192,747)}{2} \times 5 \times 0.95392 \times 105/205 \\
 &= 942,928 \times 0.95392 \times 105/205 \\
 &= 460,708
 \end{aligned}$$

Projection Outputs

▪ Population Characteristics

- Total population size
- Defined age group
- Population aged 0-4
- Population aged 5-14
- Population aged 15-64
- Population aged 65+
- Sex ratio
- Dependency ratio
- Median age

▪ Growth Rate

- Rate of natural increase (RNI)
- Annual growth rate (GR)
- Doubling time

▪ Fertility Indicators

- Births
- Child-woman ratio
- Crude birth rate (CBR)
- Total fertility rate (TFR)
- Gross reproduction rate (GRR)
- Mean age of childbearing
- Net reproduction rate (NRR)

▪ Mortality Indicators

- Deaths
- Crude death rate (CDR)
- Infant mortality rate (IMR)
- Life expectancy at birth (e_0)
- Under five mortality rate (U5MR)

▪ Migration Indicators

- Total net international migration