Methods for Producing 2016 Sub-County Population Projections for Jurisdictions in Pima County

By Pima Association of Governments

Three methods (models) — the time series model, the destination choice model and the land use model— have been employed to develop 2016 series of population projections. All three models have been implemented with the following two rules to develop population projections as in the attached Excel spreadsheet file.

- The projected population for all municipalities in Pima County, as well as unincorporated Pima County need to add up to the county total provided by Arizona Department of Administration (ADOA) for each projection year between 2016 and 2050; and,
- Sub-county Population projections are developed based on the current incorporated limits of the cities and towns in Pima County. In other words, future annexations/de-annexations are not considered.

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1. Time Series Model

This method focuses on the projection of the future growth rate of overall population or a specific population component (e.g. household population) for each projection object (i.e. city/town or incorporated Pima County) individually and separately. The historical growth trend usually weighs heavily in the projection of a future growth rate which may also account for a spectrum of known information pieces, to name but a few:

- Known development projects
- Employment growth trends
- Land use patterns

Finally, the individually and separately projected population for all cities and towns as well as unincorporated Pima County need to be adjusted proportionately so that their summation matches the provided total county population. A successful time series model will require minimal adjustment.

ADOA developed a preliminary sub-county population projections for Pima County in January 2016. The revised population projections included in the attached spreadsheet are largely based on this version of ADOA's effort. PAG staff applied additional benchmarking and smoothing techniques to fine-tune the population growth trend for each member agency.

The assumptions behind ADOA's trend assessment of future population growth in Pima County, however, are not entirely known.

2. Destination Choice Model

As its name suggests, the destination choice model simulates the choices that determine where population growth occurs. Specifically, the destination choice model that PAG staff developed is structured in the form of multinomial logit model. The model allocates the county level migration population growth into choice destinations based on a probability score it calculates for each.

Model formulation is as follows:

$$Probability_i = \frac{e^{Utility_i}}{\sum_{j=0}^{N} e^{Utility_i}}$$

$$Utility_i = JSC_i + 0.5 * \ln(GrowthCapacity_i) + \beta * Accessibility_i$$

Where *JSC* stands for *Jurisdiction Specific Constant*, a constant accounting for all other factors than those that are explicitly modeled, i.e. growth capacity and accessibility in this model formulation. These factors may include:

- Land price
- Civilian infrastructure qualities
- Parks and other amenities
- Natural resources
- Qualities of schools and other community aspects

Usually, these factors are very challenging to quantify.

The destination choice model has been estimated using the historical data collected for 2000 through 2015. The model estimation results are shown in the following table.

Jurisdictional Specific Constants														β
MAR	OV	SAH	STUC	TUC	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	
2.4	1.11	2.79	-10.2	0	-12.5	0.27	-9.36	-12.4	2.38	3.27	0.79	1.57	-12.5	1.84

In general, a larger JSC, greater growth capacity and better accessibility for a choice destination relative to other locations will give it a better chance to be selected as a population growth destination.

Separately estimated special population and natural population growth will be later added to represent overall population growth.

3. Land Use Model -SAM

SAM, short for *sub-area allocation model*, is the land use model used for this population projection development effort to spatially allocate population growth provided by ADOA to the Tucson

metropolitan region in five-year increments starting from 2015 until 2050. Population for other interim years are interpolated using the projected population of two nearest 5th years.

Specifically, SAM reviews an array of factors to estimate the growth suitability for each 0.5-acre land throughout the region, and then allocates the required regional population growth based on the probability calculated from the suitability score. However, the population growth that can be allocated to any 0.5-acre land parcel is capped at the population growth capacity designated by the future land use plans that jurisdictions developed. The inputs that SAM requires are as the following:

- Required county-level population growth

- Existing land use

- Future plans, including re-development plans

- State trust land

- Undevelopable lands

- Roadway networks and traffic

- Population/employment accessibility measures

More detailed information about SAM can be found from the following links:

- http://www.pagnet.org/documents/committees/poptac/2015/POPTAC-2015-01-12-RTP2045-LandUseModelingReportRevised.pdf

- http://www.pagnet.org/documents/committees/poptac/2015/POPTAC-2015-01-12-RTP2045-LandUseModelingReportExecutiveSummary.pdf

- http://www.pagnet.org/documents/committees/poptac/2015/POPTAC-2015-01-12-PresentationSAM-FinalResultsForApproval.pdf

4. Averaging Process

As an additional option, PAG developed a procedure to average results of the three methods for forecasting sub-county population growth. Since each method focused on different factors that impact future population growth (see the table below) and no tool exists to comprehensively account for all impacting factors, an averaging process blends the forecasts, balancing the impacts of all factors in the equation. The recommendation of final population projection results of using this averaging process were made at the PopTAC meeting on April 28, followed by the approval from The Regional Council on May 26, 2016.

Factors Considered	Time Series Model	Destination Choice Model	Land use Model
County Total Population Control	Yes	Yes	Yes
Growth Capacity Constraints	No	Yes; capacity is assessed comprehensively at a very disaggregate level	Yes; capacity is assessed comprehensively but at an aggregate level
Historical Growth Trend	Yes; historical trend is extrapolated out to assess future growth trend	Yes; model is estimated using historical data	Yes; model is estimated using historical data
Population/Employment Accessibility	No	Yes, explicitly	Yes; model considers accessibility explicitly but at a more aggregate level
Highway Network and Traffic	No	Yes	No
Redevelopment	No	Yes, explicitly	Yes, but not explicitly
State Trust Land	No	Yes, explicitly	Yes, explicitly but at more aggregate level
Other factors (e.g. community profile, crime rate, school quality, infrastructure condition, parks and other amenities, land pricing, natural resources, etc.)	No	No	Yes, through Jurisdiction Specific Constants that determine growth likelihood

Note: The averaged results in the provided Excel spreadsheet file are not weighted to favor any of the three methods.