Estimating temporary populations: a systematic review of the empirical literature

Appendix 4: Main characteristics of the studies

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1 Source, type, main data and methods

Author	Year of publication	Source	Type of publication	Main data type 1	Main data type 2	Main data type 3	Main data type 4	Method of estimating temporary population
Census of England and Wales 1921	1925	Manual	Report	Official statistics				Direct estimates from census (address of main employment)
Thornthwaite	1929	Manual	Thesis	Survey	Transport			Direct estimates from survey
Breese	1947	Systematic	Thesis	Transport	Survey	Official statistics		Combining counts from different sources
New York Regional Plan Association	1949	Manual	Report	Transport				Scaling estimates from surveys
Seattle City Planning Commission	1951	Manual	Report	Official statistics	Other			Redistribution of resident pop according to time and employment
Foley	1952	Systematic	Article	Transport	Survey			Scaling estimates from surveys
Institute for Research in Social Science University of North Carolina	1952	Manual	Report	Survey				Direct estimates from survey data
Menzler	1952	Manual	Article	Survey				Direct estimates of working pop derived from survey
Sharp	1955	Manual	Article	Survey				Direct estimates from two surveys
Bureau of the Census	1956	Manual	Report	Official statistics	Survey			Sum of pop at home, pop at work and pop in transit estimates
Weir	1960	Manual	Article	Survey	Official statistics			Direct estimates from surveys and census
Erickson	1961	Systematic	Article	Survey				Direct estimates from census (summer pop)
Wurtele	1968	Systematic	Report	Official statistics	Survey			Equation based pop estimates across land use-activity profiles
Goldschmidt	1976	Manual	Article	Utilities	Survey			Four components of wastewater used to estimate pop
Fulton	1984	Systematic	Article	Official statistics				Daytime pop derived from working pop + nonworking residents
Gober	1984	Manual	Article	Official statistics				Direct estimates from census (persons enumerated ousdie of state of residence)
Kavanaugh	1990	Systematic	Conference	Official statistics	Survey	Transport		Equation based: resident pop + hotel population - departures + arrivals
Banz	1992	Systematic	Conference	Other				Prediction of stocks and flows from activity profiles
Nelson	1992	Systematic	Article	Official statistics	Survey			Equation based: sum of residential, employment and commercial pop using facility size and % week present
Stutz	1992	Systematic	Article	Survey				Equation based: daytime pop = resident pop + hotels, adjusted for in- and outflows

Author	Year of publication	Source	Type of publication	Main data type 1	Main data type 2	Main data type 3	Main data type 4	Method of estimating temporary population
Akkerman	1995	Systematic	Article	Official statistics				Daytime pop derived from diurnal ratio estimated from average households size
Galvez	1996	Systematic	Article	Survey				Survey data extrapolated to overall pop
Bell M	1998	Systematic	Article	Official statistics				Direct estimates from census (individuals enumerated away from home on census night)
Roddis	1998	Manual	Conference	Survey				Redisttributing population on the basis of OD of trips
Taylor	1998	Systematic	Article	Official statistics				Direct estimates from census
Yong li	1998	Systematic	Article	Other				Equations for calculating mobile populations in mobile places
Lamb	1999	Manual	Report	Other	Official statistics	Survey		Visitors derived from average sales tax and redistributed with traffic and accomodation data
Warchivker	2000	Systematic	Article	Survey				Direct estimates from survey - ‘visitor’ category
Happel	2002	Systematic	Article	Survey				Survey data extrapolated
McPherson	2003	Systematic	Report	Official statistics	Other			Disagregation of nightime pop according to JTW patterns
Smith G	2005	Systematic	Report	Official statistics				Equations to redistribute census counts; peak weekday/weekend po
Sleeter	2006	Systematic	Conference	Official statistics				Dasymetric mapping of counts adjusted for workers and pupils
Ahola	2007	Systematic	Article	Official statistics	Transport	Other		Spatio-temporal model based on three domain and space-time composite models
Bhaduri	2007	Systematic	Article	Official statistics				Multi-dimensional dasymetric interpolation
Collins	2007	Systematic	Article	Survey				Weighted spatial allocation of survey participants based on travel diary records
Needham	2007	Systematic	Thesis	Official statistics				Model adjusting usual pop with factors based on land use and time
Taubenböck	2007	Systematic	Conference	Remote sensing	Official statistics			Redistribution of census pop using RS data and survey
Monmouth County Planning Board	2008	Manual	Report	Utilities				Visitor pop estimated from difference in wastewater levels
Lau	2009	Systematic	Article	Survey	Transport			Trip chains used to interpolate individuals in transit
Campbell	2010	Systematic	Thesis	Official statistics	Survey			Redistribution of pupils from residence to school via transport route
Freire	2010	Systematic	Book chapter	Official statistics	Transport			Dasymetric mapping with redistribution of daytime workers
Horanont	2010	Systematic	Conference	Survey				Rescaling pop using dynamic magnification factors
Rigall-I-Torrent	2010	Systematic	Article	Utilities	Survey			Household level estimation from utilities and survey data
Bell K	2011	Systematic	Thesis	Official statistics				Daytime pop derived from: gross square footage of buildings and parking spaces demand; direct counts of worker pop, pop at home, students, jail pop
Bengtsson	2011	Manual	Article	Mobile phones				MP data extrapolated to pop based on penetration

Author	Year of publication	Source	Type of publication	Main data type 1	Main data type 2	Main data type 3	Main data type 4	Method of estimating temporary population
Charles-Edwards	2011	Systematic	Thesis	Survey	Official statistics			Simulation of visitor nights based on model profiles of sesonality and duration
Kobayashi	2011	Systematic	Article	Official statistics				Interpolation of CTPP data from TAZ to surface
Sekimoto	2011	Systematic	Article	Survey	Transport			Travel survey data redistributed over transport network, scaled to pop
Swanson	2011	Systematic	Book chapter	Official statistics	Survey			Equations for daytime, visitor and seasonal pop
Walker	2012	Systematic	Conference	Official statistics	Survey			Agent-based modelling
Charles-Edwards	2013	Systematic	Article	Survey				Cordon count of visitors to the UQ Campus plus symptomatic indicators
Hugo	2013	Systematic	Report	Survey	Official statistics			Survey of non-resident ratepayesr in 9 LGAs supported by census data and data from Survey of Smal Area Accommodatin
Markham	2013	Systematic	Report	Official statistics				Service population estimated from service use
McKenzie B	2013	Systematic	Report	Official statistics	Survey			Total area pop adjusted for in- and outflow of workers from area
Office for National Statistics	2013	Manual	Report	Official statistics				Direct estimates from census (address of main employment)
Terada	2013	Manual	Article	Mobile phones				Extrapolation of MP data
Ara	2014	Systematic	Article	Official statistics				Building level pop derived from densities of occupational clasees
Deville	2014	Manual	Article	Mobile phones				Scaling nightime MP pop using census
Fehr & Peers	2014	Manual	Report	Survey	Mobile phones	Transport	Other	Refining MP counts with survey and transportation data
Gao X	2014	Manual	Article	Official statistics				Redistributing census pop, tourists and institution pop accoring to land use and building char
Graebert	2014	Manual	Report	Official statistics	Survey	Other		Seasonal pop derived from volume, average number of visitors & occupancy of second homes; Overnight pop derived from volume of tourist accomodation & average occupancy
Himoto	2014	Systematic	Book chapter	Official statistics	Survey			Interpolating census pop from residence to work/school using economic data and time survey
Greger	2015	Systematic	Article	Official statistics	Transport			Building pop derived from census redistributed using floorspace
Hodur	2015	Systematic	Report	Official statistics				Census pop corrected with est of new housing units * occupancy rates
Martin D	2015	Systematic	Article	Official statistics				Redistribution of counts between origins, destinations and transit using temporal profiles of places.
Qi	2015	Systematic	Article	Official statistics				Equation based redistribution of census pop using land use

Author	Year of publication	Source	Type of publication	Main data type 1	Main data type 2	Main data type 3	Main data type 4	Method of estimating temporary population
Khakpour	2016	Systematic	Article	Official statistics				Cellular automaton system with SIS epidemiological model and attraction points
Khodabandelou	2016	Systematic	Conference	Mobile phones				Scaling of MP using census
Lwin	2016	Systematic	Article	Survey	Mobile phones	Social media		Pop predicted from ST regression model with trip survey, MP calls and SM posts
McKenzie F	2016	Manual	Report	Official statistics	Utilities			Peak capacity of area from resident pop and unoccupied buildings; Proportion of local ratepayers who live outside of region; Counts of non-resident electors
Wilson	2016	Manual	Article	Mobile phones				CDR data scaled to pop
Xu F	2016	Manual	Conference	Mobile phones				Scaling MP data using gound truth pop in functional regions
Adamiak	2017	Systematic	Article	Official statistics				Equation based: seasonal population = number of second home users + registered population - population expected to leave permanent residence to visit a second home
Batista e Silva	2017	Manual	Conference	Official statistics				Spatial disaggregation of stocks using land use & other sources
Järv	2017	Systematic	Article	Mobile phones				Multi-temporal function-based dasymetric interpolation
Kashiyama	2017	Update	Article	Official statistics	Survey			Agent based simulation on the basis of census & survey data
Kim	2017	Manual	Article	Official statistics				Random redistribution of working pop in sector specific activity ranges
Kontokosta	2017	Systematic	Article	Wi-Fi	Survey			Extrapolating users classified into residents, workers and visitors
Ma	2017	Systematic	Article	Transport	Official statistics			Hourly pop derived from nightime pop adjusted for metro traffic
Morton	2017	Systematic	Conference	Official statistics				Simulating flows from residence to likely place of work across industries
Stathakis	2017	Update	Article	Remote sensing				Sum of lights index as proxy of pop
Thomas	2017	Systematic	Article	Mobile phones				MP data normalized with census pop
Batran	2018	Update	Article	Mobile phones				MP data scaled up locally using external pop
Boeing	2018	Update	Article	Official statistics				Pop estimated from census and commuter flows
Chen	2018	Update	Article	Mobile phones				Artificial neural network estimates based on past stationary & inflow pop size
Esri	2018	Update	Report	Official statistics	Survey	Other		Equation based: aytime pop = workers + commuters + daytime residents (proprietary methodology)
Liu Z	2018	Update	Article	Mobile phones				Pop density estimated from CDR trajectories using neural networks
Picornell	2018	Update	Article	Mobile phones				MP data scaled using age & sex regional factors

Author	Year of publication	Source	Type of publication	Main data type 1	Main data type 2	Main data type 3	Main data type 4	Method of estimating temporary population
Thakur	2018	Update	Thesis	Other				Equation to derive equivalent residents from sales tax data
Zagatti	2018	Update	Article	Mobile phones				MP data scaled using census pop
Zin	2018	Update	Article	Mobile phones				MP data scaled up locally using census pop
Crols	2019	Update	Article	Wi-Fi	Official statistics	Survey		ABM model derived from census & time survey data with inputs from Wi-Fi footfal
Edmondson	2019	Update	Report	Official statistics	Transport	Mobile phones	Utilities	Combining and scaling multiple sources of data
Harris	2019	Update	Report	Survey	Official statistics	Other		Combining multiple sources of data
Xu Y	2019	Update	Article	Mobile phones				MP data scaled using gridded population
Yun	2019	Update	Conference	Mobile phones				MP data scaled and averaged from 36 months to weekly & hourly

2 Other characteristics

FA_surname	Year_pub	National	Country_1	Country_2	Region_type	Region	Day	Est_tunit	Est_tunit_num	Purpose_1
Census of England and Wales 1921	1925	Yes	England & Wales				Yes	Daytime/nighttime	2	
Thornthwaite	1929	No	USA		Single city	Louisville	Yes	Minute/hour	13	
Breese	1947	No	USA		Single city	Chicago	Yes	Minute/hour	12	
New York Regional Plan Association	1949	No	USA		Single city	New York	Yes	Daytime	4	
Seattle City Planning Commission	1951	No	USA		Single city	Seattle	Yes	Daytime/nighttime	3	Emergency p
Foley	1952	No	USA		Multiple cities	63 cities	Yes	Daytime	1	
Institute for Research in Social Science University of North Carolina	1952	No	USA		Multiple cities	Erie, Flint, Grand Rapids, St Paul, Camden	Yes	Minute/hour	24	
Menzler	1952	No	UK		Single city	London	Yes	Daytime/nighttime	2	
Sharp	1955	No	USA		Single city	Flint	Yes	Daytime	8	
Bureau of the Census	1956	No	USA		Multiple cities	Houston, Milwaukee, St. Louis, Washington	Yes	Daytime	1	Emergency p
Weir	1960	No	Canada		Single city	Winnipeg	Yes	Daytime	1	
Erickson	1961	No	USA		Multiple cities	Wildwood, Stone Harbor, NJ	No	Weekday/weekend	1	tourism
Wurtele	1968	No	USA		Multiple cities		Yes	Minute/hour	24	
Goldschmidt	1976	No	USA		Single city	Ocean City	No	Month	60	Service popu
Fulton	1984	No	USA		Single city	Atlanta	Yes	Daytime	1	
Gober	1984	Yes	USA				No	Other	1	
Kavanaugh	1990	No	USA		Single city	San Diego	Yes	Daytime/nighttime	4	
Banz	1992	No	Canada		Single city	Toronto	Yes	Minute/hour	24	Emergency p
Nelson	1992						Yes	Minute/hour	168	Service popu
Stutz	1992	No	USA		Single city	San Diego	Yes	Minute/hour	24	
Akkerman	1995	No	Canada		Single city	Saskatoon	Yes	Daytime/nighttime	2	Commuting

FA_surname	Year_pub	National	Country_1	Country_2	Region_type	Region	Day	Est_tunit	Est_tunit_num	Purpose_1
Galvez	1996	No	USA		Administrative region	Florida	No	Month	12	
Bell M	1998	Yes	Australia		Administrative region		No	Other		characteristic movers
Roddis	1998	No	Australia		Single city	Melbourne	Yes	Minute/hour	24	
Taylor	1998	Yes	Australia				No	Other	1	Service popu
Yong li	1998						Yes			Service popu
Lamb	1999	No	USA		Administrative region	Door County	No	Month	12	
Warchivker	2000	No	Australia		Administrative region	community in Central Austrlia	No	Other	4	Service popu
Happel	2002	No	USA		Administrative region	Phoenix	No	Other	4	
McPherson	2003	Yes	USA				Yes	Daytime/nighttime	2	Emergency p
Smith G	2005	Yes	UK				Yes	Daytime/nighttime	5	Emergency p
Sleeter	2006	No	USA		Administrative region	Clatsop County, OR	Yes	Daytime/nighttime	2	Emergency p
Ahola	2007	No	Finland		Single city	Helsinki	Yes	Daytime/nighttime	14	Emergency p
Bhaduri	2007	Yes	USA				Yes	Daytime/nighttime	2	
Collins	2007	No	Australia		Single city	Sydney	Yes	Minute/hour	48	Emergency p
Needham	2007	No	UK		Single city	Chester	Yes	Minute/hour	576	Emergency p
Taubenböck	2007	No	Turkey		Single city	Istanbul	Yes	Daytime/nighttime	2	
Monmouth County Planning Board	2008	No	USA		Administrative region	Monmouth County	Yes	Daytime	1	Emergency p
Lau	2009	No	Australia		Single city	Melbourne	Yes	Minute/hour	24	vehicle route planning
Campbell	2010	No	UK		Single city	Southampton	Yes	Minute/hour	40	
Freire	2010	No	Portugal		Single city	Lisbon	Yes	Daytime/nighttime	2	Emergency p
Horanont	2010	No	Japan		Single city	Tokyo	Yes	Minute/hour		
Rigall-I-Torrent	2010	No	Spain		Single city	Roses	No	Month	38	
Bell K	2011	No	USA		Single city	Indianapolis	Yes	Daytime	1	Emergency p
Bengtsson	2011	No	Haiti		Single city	Port-au-Prince	Yes	Day	200	Emergency p
Charles-Edwards	2011	Yes	Australia				No	Month	12	
Kobayashi	2011	No	USA		Single city	Salt Lake County	Yes	Minute/hour	24	Emergency p
Sekimoto	2011	No	Japan	Vietnam	Multiple cities	Tokyo, Hanoi	Yes	Minute/hour		
Swanson	2011	No	USA				Yes			Emergency p
Walker	2012	No	UK		Single city	Wolverhampton	Yes	Minute/hour	24	
Charles-Edwards	2013	No	Australia		Single city	Brisbane	Yes	Daytime	1	Service popu
Hugo	2013	No	Australia		Administrative region	various	No			
Markham	2013	No	Australia		Administrative region		No	Other		Service popu
McKenzie B	2013	Yes	USA				Yes	Daytime/nighttime	2	
Office for National Statistics	2013	Yes	England & Wales				Yes	Daytime/nighttime	2	Emergency p
Terada	2013	Yes	Japan				Yes			
Ara	2014	No	Bangladesh		Single city	Sylhet	Yes	Minute/hour	48	Emergency p
Deville	2014	Yes	Portugal	France			No	Daytime/nighttime	6	
Fehr & Peers	2014	No	USA		Administrative region	Napa County	Both	Weekday/weekend	3	Travel behavi

FA_surname	Year_pub	National	Country_1	Country_2	Region_type	Region	Day	Est_tunit	Est_tunit_num	Purpose_1
Gao X	2014	No	China		Single city	Beijing	Yes	Daytime/nighttime	2	Emergency p
Graebert	2014	No	USA		Administrative region	Northwest Michigan	No	Month	12	
Himoto	2014	No	Japan		Multiple cities	Kyoto, Osaka, Kobe	Yes	Daytime/nighttime	4	Emergency p
Greger	2015	No	Japan		Single city	Tokyo	Yes	Minute/hour	24	
Hodur	2015	No	USA		Single city	Williston	Yes	Daytime	1	Service popu
Martin D	2015	No	UK		Single city	Southampton	Yes	Minute/hour		
Qi	2015	No	China		Single city	Beijing	Yes	Daytime/nighttime	2	
Khakpour	2016	No	Norway		Single city	Trondheim	Yes	Minute/hour	120	
Khodabandelou	2016	No	Italy		Multiple cities	Milan, Turin, Rome	Yes	Minute/hour		
Lwin	2016	No	Japan		Single city	Kobe City	Yes	Minute/hour	96	
McKenzie F	2016	No	Austrlia		Administrative region	Victoria	No			Emergency p
Wilson	2016	Yes	Nepal				No	Day		Emergency p
Xu F	2016	No	China		Single city	Shanghai	Yes	Minute/hour	48	Commuting
Adamiak	2017	Yes	Finland				No	Other	2	Counterurba
Batista e Silva	2017	Yes	European Union				No	Daytime/nighttime	24	
Järv	2017	No	Estonia		Single city	Tallin	Yes	Daytime/nighttime	2	
Kashiyama	2017	No	Japan		Multiple cities	Tokyo, Chukyo	Yes	Minute/hour	24	Creation of o dataset
Kim	2017	No	USA		Single city	Athens-Clarke County	Yes	Daytime	1	Emergency p
Kontokosta	2017	No	USA		Single city	New York	Yes	Minute/hour	5856	
Ma	2017	No	China		Single city	Beijing	Yes	Minute/hour	12	
Morton	2017	No	USA		Single city	Knoxville	Yes	Daytime	1	
Stathakis	2017	Yes	Greece				No	Month	12	
Thomas	2017	No	Norway		Single city	Oslo	Yes	Minute/hour	1512	Epidemiology
Batran	2018	No	Mozambique		Single city	Greater Maputo	Yes	Minute/hour	48	
Boeing	2018	No	USA		Single city	San Francisco Bay Area	Yes	Daytime	1	
Chen	2018	No	China		Single city	Shanghai	Yes	Minute/hour	48	
Esri	2018	Yes	USA				Yes	Daytime	1	
Liu Z	2018	No	China		Single city	Beijing	Yes	Minute/hour	24	
Picornell	2018	No	Spain		Single city	Madrid	Yes	Minute/hour	24	Epidemiology
Thakur	2018	No	USA		Administrative region	North Carolina	No	Month	60	
Zagatti	2018	No	Haiti		Multiple cities	Port-au-Prince, Cap-Haïtien	Yes	Daytime/nighttime	2	Commuting
Zin	2018	No	Myanmar		Single city	Yangon	Yes	Minute/hour	48	
Crols	2019	No	UK		Single city	Otley	Yes	Minute/hour	24	
Edmondson	2019	No	USA		Administrative region	Nantucket	Both	Month	12	
Harris	2019	No	USA		Administrative region	Washington County	No	Month	12	
Xu Y	2019	No	China		Single city	Beijing	Yes	Minute/hour	24	Epidemiology
Yun	2019	No	South Korea		Single city	Songdo	Yes	Minute/hour	168	Hotspot of p