Impacts of Service and Infrastructure Provision on Indigenous Temporary Mobility in the Northern Territory of Australia

Insights from the 2011 Census

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Abstract

Indigenous people comprise a significant proportion of the population living in remote parts of Australia, particularly in the north. A growing body of literature has documented high mobility between remote Indigenous settlements, service towns and cities. The extent and nature of this mobility is thought to be driven, at least partly, by the types of services and infrastructure available in communities. Understanding to what extent these service and infrastructure provisions drive people's mobility and the type of people who move is essential for creating policy for remote communities and making investment decisions. We use 2011 census data to examine this issue for the Northern Territory, the Australian jurisdiction with the highest Indigenous composition in its remote population, by constructing generalised linear mixed models comparing Indigenous people's actual locations on census night with their stated usual place of residence. We found that individual characteristics (gender and age) had high impacts on individuals being at home or away on census night and that good health care provision, government subsidised community jobs and Internet access are associated with higher levels of absences from home. Meanwhile those living in communities that had recently received new houses were less likely to be away on census night. The results can contribute to the efficiency of service provision and to understanding the dynamics of Indigenous mobility.

Key words: Housing, Indigenous mobility, Internet access, Northern Territory, Remote populations, Multilevel modelling

1. Introduction

Theories and approaches developed to understand the consequences for society, economy and the environment of increasingly complex flows of people, objects, capital and information (Cresswell, 2006; Hannam et al., 2006; Sheller and Urry, 2006) aim to elucidate factors underlying mobility (and immobility) patterns . For Western society the strongest driver is the promise of marginal economic benefits (Harris and Todaro, 1970; Petrov, 2009), and especially among rural people moving to urban centres (e.g. Solinger, 1999; Henning et al., 2013). For Indigenous people other factors, such as cultural obligations (funerals, ceremonies), attachment to traditional land, hunting practices and kinship networks, may be proportionally more influential on mobility decisions (Taylor and Bell, 1996; Habibis, 2011). However, the high degree of mobility among Indigenous people in remote parts of Australia (e.g. Biddle and Hunter, 2006; Taylor, 1998; Carson, 2011), and particularly short-term (or temporary) mobility, cannot be explained by culture alone (Taylor and Bell, 1996; Biddle and Hunter, 2006). Individual decisions on when and where to travel are grounded in a complex and dynamic set of drivers and needs (Taylor and Carson, 2009; Taylor et al., 2011a).

While Indigenous Australians comprise just three percent of the Australian population, it is far higher in remote parts in the north of the country (ABS, 2012a). The highest is in the Northern Territory (NT) where a third of the total population of 220,000 are Indigenous (see Figure 1). Many of those residing in remote areas are poor (Altman et al., 2008; SCRGSP, 2011).

Recent policies delivered by the national and State or Territory Governments of Australia to improve the livelihoods of Indigenous Australian's living in remote areas have focused on improving services and infrastructure *in situ* (at remote communities), possibly at the expense of those in towns and cities that Indigenous people visit. This policy paradigm is founded on

the tenet that improving employment, housing, education and infrastructure *in situ* is important for developing local economies and 're-connecting' a mobile population with services and employment opportunities (Taylor et al., 2011a; Department of Social Services, 2014a).

While no policy explicitly mentions a favouritism towards *in-situ* development, the dominant ethos is clearly that Indigenous people from remote regions will benefit the most from living on or near traditional lands. A growing body of research suggests greater well-being of Indigenous people living on their own traditional country (Burgess et al., 2005; Garnett et al., 2009; Campbell et al., 2011). This is likewise reflected in contemporary international approaches to Indigenous affairs in developed nations like Canada (Carson, 2011). However, the devotion to *in situ* development contrasts with evidence that there has been a net migration into larger urban centres (Darwin and Alice Springs) over the last 30 years (Carson and Taylor, 2009). There is therefore a critical need for greater understanding of the relationships between service provision and contemporary mobility in remote Indigenous communities (Taylor, 1998; Biddle and Prout, 2009).

In this paper we assess the extent to which factors cited as drivers of global mobility can also help explain the temporary mobility of Indigenous people in and around remote communities in Australia. To do so we test whether infrastructure and service provision in communities affect the propensity for people to be away or at home on census night and, if so, reveal the characteristics of those people staying or moving. Our paper is one of the first on temporary mobility among Australian Indigenous people using 2011 census data. It is also one of the first to construct predictive models in the Indigenous Australian context based on their individual choices on whether to be away or at home on census night. Given the similarity of Indigenous settlement patterns in other developed nations and congruent approaches to

Indigenous affairs and community development, both the approaches taken and the findings should be pertinent to the internationally.

2. Indigenous mobility

2.1. Type of mobility among Indigenous Australians and approaches to its assessment

In the Australian Indigenous context, two broad forms of mobility are identified – residential (long-term) and temporary (short-term) – and literature on both has developed almost entirely in isolation (Bell and Ward, 2000). Residential movements entail a change in usual residence and represent only a small proportion of all population mobility in Australia (Bell and Ward, 1998). Temporary mobility incorporates trips away from home without a change of residence (Zelinsky, 1971). However, in an Indigenous context of frequent mobility with extended time away, separation of the two can be difficult (see e.g. Morphy, 2007). Thus the temporary movements from and around remote Indigenous communities, the focus of this paper, can vary greatly in duration and are commonly blamed for dislocations between core service provision and the efficacy of these for their influence on the social determinants of wellbeing; particularly health, housing, employment and education services (Taylor, 1998; Prout, 2008a; Taylor and Dunn, 2010). For these reasons, understanding temporary movements to and from small and remote communities is an important task since even small demographic changes may result in rapid, significant and long lasting impacts on service and infrastructure demand (Biddle and Prout, 2009).

In the national census of Australia, which takes place every five years (most recently in 2011), every person is asked to nominate their 'place of usual residence'. This can be compared to the address at which individuals were located (sleeping) on census night. These variables permit users of census data to create a snapshot (at one and five year intervals) of

not only the size and characteristics of people 'on the move' but also comparisons and contrasts between the characteristics of movers and non-movers as well as the characteristics of source and destination settlements (Bell and Ward, 1998, 2000).

While the extent of Indigenous temporary mobility in remote areas is well documented, there are fewer comprehensive and consistent accounts about the drivers of that mobility or about whether spatial variation in infrastructure influences peoples' mobility to and from communities. While broad scale statistical analyses (e.g. Taylor and Bell, 2006) describe who is mobile and the characteristics of their journeys (source, destination, trip length etc.), small-scale ethnographic studies (e.g. Prout, 2009; Morphy, 2010) can speak only for the population being examined and then generalise their findings to try and explain phenomena across the diverse spectrum of remote Indigenous lives. Our paper sits between these alternative, as we assessed multiple (15) Indigenous communities at a regional scale (whole of NT).

Studies at both ends of this scale usually emphasise participation in cultural activities and cultural responsibilities as primary drivers (Memmott et al., 2006), with mobility being seen as 'a unique expression of Indigenous spatiality' (Prout, 2009; Morphy, 2010; J. Taylor, 2012). Many of the cultural reasons for mobility, such as ceremonial events and family visits, may be largely invisible to non-Indigenous people, service providers and administrators (Peterson, 2000). They have been described as being outside of the bounds of systems and services designed to intersect with remote dwellers (including the census), and therefore a 'known unknowable' (Prout, 2008a; Taylor et al., 2011a). Instead, quantitative assessments such as our own have had to focus on drivers from mainstream institutions (education, employment etc.) for which data are available through the census.

2.2. Framework

Sociologists such as Urry (2007), who with others developed the 'Mobility Turn' framework for understanding mobility in multiple spheres (Cresswell, 2006; Hannam et al., 2006; Sheller and Urry, 2006), anticipate that modern mobility will increase 'fluidification' of social relations, that is, the more or less rapid dissolution of established social hierarchies and institutional structures. From a demographic perspective, we employ a related framework derived from transitional migration theories. Emanating from Zelinsky's (1970) work, these depict changes spatiality according to the social and economic contexts of the populations in question. Transitional migration has been applied in the Indigenous Australian context by Taylor and Bell (2004) and to the New Zealand Maori by Bedford and Pool (2004). These scholars have argued that social, legal and structural changes have seen temporary mobility effecting a de-concentration of the Indigenous population. Transitional migration theory also aligns with significant changes to Indigenous settlement patterns brought about by residential migration as a result of structural (most prominently the transition away from traditional lifestyles and towards employment) and aspirational factors in Alaska, parts of Canada and the Northern Sparsely Populated Areas of Europe (Huskey et al., 2004; Taylor, 2011).

2.3. Determinants of Indigenous mobility

To understand which pull and push factors might affect temporary mobility, a range of drivers were identified from the literature for inclusion in our analysis.

Intuitively, the placement of additional and improved health, education, transport and other services and infrastructure into remote communities might be expected to reduce the need to travel. Taylor and Bell (2004), for example, found that distances from essential services were resulting in trips away from communities to larger service centres. Similarly, Taylor and Carson (2009) found that factors such as accessing health services, 'getting away', shopping

and visiting friends and relatives were significant. Habibis et al. (2011) identified access to medical services (notably treatment for renal diseases) as a prominent pull factor shaping temporary mobility. We therefore include a variable that reflects the presence of health care facilities and one that reflects the presence of getting good education in a community as potential explanators of mobility.

In the same sense, mobility can also be affected by housing availability, its quality (Andersen, 2011) and its affordability (Boyle and Shen, 1997; Andersen, 2011; Zabel, 2012). Habibis (2013) found that the provision of new houses in two NT townships can contribute to decisions by people to leave their community. Anthropological research suggests that the provision of new houses can also draw people into communities from others where there is overcrowding, or contribute to people's perceptions that they can more readily move between communities since there is likely to be room available (Prout 2008b). In Australia, the governments have been providing new houses or refurbishing existing houses in many Indigenous communities, allowing our study to include housing data as potential explanator for mobility.

We considered two additional factors: uptake of Internet-based information communication technologies, which has been associated with an increase in mobility, globally and in remote Indigenous communities (Muto, 2009; A. Taylor, 2012), and improved transport infrastructure and services, which are likewise reported as driving factors for increasing mobility (e.g. Walford, 2004).

While these characteristics of mobile Indigenous Australians align with global mobility, there is little evidence to suggest that search for or uptake of jobs, globally prominent pull factors in driving movements from rural and remote to urban areas, are significant for Indigenous mobility (Taylor and Bell, 2004; Taylor, et al., 2011a). Indigenous participation rates in the labour force are equally low in both remote and urban areas of the NT (ABS, 2012b).

Conversely, labour markets in Indigenous communities are not necessarily a true reflection of the employment opportunities available to Indigenous people there. At the time of the census many Indigenous residents were employed in government subsidised jobs under the 'Community Development Employment Program' (CDEP). We therefore included the number of CDEP jobs available in a community as an explanatory variable.

The latter point relates to the equally important issue of understanding who is likely to be mobile. Existing analyses from Australia suggest that young people are more likely to be mobile than older people, males more mobile than females and single people more mobile than those in a relationship or with a family (Taylor et al., 2011b; ABS, 2012b). A high degree of mobility of women and young people in rural areas has also been found for Indigenous people in other developed countries (e.g. Hamilton and Seyfrit, 1994; Gabriel, 2002; Rasmussen, 2007), and hence we chose age and gender as potential explanatory variables.

3. Materials and methods

3.1. Research area

There are 70-80 discrete Indigenous communities across the NT operating as central-place service hubs (Sanders, 2010). Most are located on Crown Land or Indigenous owned land. The setting for our research is 15 'discrete Indigenous communities' in the NT (Figure 1): Angurugu (Groote Eylandt), Galiwinku (Elcho Island), Gapuwiyak, Gunbalanya, Hermannsburg, Lajamanu, Maningrida, Milingimbi (Crocodile Islands), Nguiu (Tiwi Islands), Ngukurr, Numbulwar, Umbakumba (Groote Eylandt), Wadeye, Yirrkala and Yuendumu. The 15 communities were selected because they were designated as priority communities for accelerated investment into social and economic infrastructure (Department of Community

Services, 2014; Department of Social Services, 2014b) under the National Partnership Agreement on Remote Service Delivery scheme (Department of Social Services, 2014c).

The 15 communities range in population size from 500 (Umbakumba) to nearly 2 500 (Maningrida). Typically around 80% of the population are Indigenous people. They are isolated from one another and from the larger urban centres, with few connected by sealed roads or other regular forms of transport. Economic activities in these communities focus on the provision of government, education, and health services. Collectively, nearly three quarters of the workforce in the focus communities are employed in these sectors. In some communities there are some opportunities for employment in the private sector (e.g., in mining, hospitality, retail and arts).

3.2. Data and sources

The modelling is based on the most recent (2011) census data made available by the Australian Bureau of Statistics in July 2012 (ABS, 2012b,c). The modelling is based on comparisons of individual's home residence with their location on census night. We obtained data for each individual who was Indigenous, Torres Strait Islander or both and resided in one of the 15 selected communities at the time of the 2011 census. As Australian Bureau of Statistics designated spatial category we chose Indigenous Locations (ILOCs). The first step was to extract aggregated data from the Australian Bureau of Statistics census data, using the Table Builder software. In a second step the aggregated data were transformed into individual data (micro data), i.e. the data of each individual were represented in one row of the dataset. A total of 15 262 Indigenous people resided in one of the 15 communities of interest. We were thus able to create 15 262 data entries (rows) in the data sheet identifying the location of their usual residence on census night, their age class and gender. Because there were few observations of older people, anyone 60 years and older was clustered together. For

comparison, we also extracted data on temporary mobility from the 2006 census along with age and gender of people who were away on census night 2006 (ABS, 2006).

[Figure 1]

Data which characterised the 15 communities and for entry into the model as explanatory variables (see next section) were obtained from Local Implementation Plans (Department of Community Services, 2014; Department of Social Services, 2014d) and Job Profiles (Department of Community Services, 2014). Data on new houses and refurbishments built under the 'Strategic Indigenous Housing and Infrastructure Program' were obtained from the NT Government's Department of Housing, Local Government and Regional Services (Department of Housing, 2014). Some basic characteristics are similar across all 15 communities: for example, they all have primary and secondary schools and all have approximately the same levels of health care infrastructure. As proxy for quality of the services, we therefore considered the number of jobs filled in a sector per 100 citizens. The 'job' variables were relative to community size, as larger communities would usually have more absolute numbers of jobs in each sector. For example, we included the number of jobs per 100 citizens in a community in the education sector rather than simply the number of schools. The more jobs filled, the better the job prospects in the community and the better the prospects of coping with the demand for service. Data on number of cars and internet connections were obtained from census dwelling characteristics (ABS, 2012d). In total we included six variables describing the quality of service provision and four variables describing the infrastructure in each community (Table 1).

[Table 1]

Yuendumu and Hermannsburg have the most jobs in the health sector, around 6 jobs per 100 citizens; Umbakumba has only 0.3 health jobs per 100 citizens (Table 1). Wadeye has the most jobs filled in the education sector with almost 9 per 100 citizens while Umbakumba has

less than 1 education job per 100 citizens. Yirrkala has the most public administration jobs per 100 citizens (more than 17) while Umbakumba has only 1.5 per 100 citizens. Numbulwar has almost 8 persons per 100 citizens employed in the trade/retail sector while Angurugu has only 0.2 trade jobs filled per 100 citizens.

The average ratio of dwellings/houses with Internet versus those without was 0.8 (ABS, 2012d), meaning that on average 45% (0.8/[0.8+1]) of houses are currently connected in the 15 communities. For comparison, Australian-wide 79% of households are connected to the Internet with an even higher percentage (95%) among high income households (ABS, 2011). Hermannsburg is the best connected community with 2.5 houses with Internet connection per house without Internet connection (=72% [2.55/(2.55+1)] houses connected). Gunbalanya and Milingimbi also have about twice as many houses with than without Internet connection. Umbakumba has the lowest connection rate with only 13% of the houses having Internet access.

3.3. Analysis

The dependent variable was dichotomous, with the location on census night as being away from home (1) or being at home (0). Commonly used models to analyse such data are binary logit models. However, we are dealing with repeated measures (pseudo-replications) in the same location (the 15 communities) which violates the assumption of non-linearity between observations. We therefore used a mixed-effect (multilevel) model with a random intercept that takes into account the multiple observations for each location. We fitted generalized linear mixed effects models (GLMM) using the *glme*r command which is part of the *lme4* package (Bates et al., 2012) in Program R (R Development Core Team, 2011). GLMMs combine the linear mixed-effects model approach, which incorporates random effects (in our case the communities), and generalized linear models, which handle non-normal data (e.g. binary response). We used the GLMM to test for significant fixed effects on the decision of

an individual to either be at home or away on census night. The fixed effects are analogous to standard regression coefficients and are estimated directly (Bryk and Raudenbush, 2002). The random effects are not directly estimated but are summarised according to their estimated variance and covariance. GLMMs are often referred to as multilevel (hierarchical) models (Bryk and Raudenbush, 2002), which for our case study means that the data have a two-level hierarchical structure with 15 communities at level 1 and 15 262 individuals at level 2, nested within level 1. These individuals are modelled as making decisions in level 2, independent of level 1 (the community). It is important to separate impacts of variables of interest from the impact the communities as a whole can have on peoples' decision to be away or at home on census night. We do that by including 'community' as a 'random' factor.

We first estimated a model with only a random intercept for the community effect (an unconditional model) only to check if there is any between-community variance in the first place.

$$\log\frac{\pi_{it}}{1-\pi i_{ij}} = \beta_0 + u_{0j} \qquad (1)$$

where β_0 is an intercept shared by all communities and u_{0j} is a normally distributed (with variance $\sigma^2{}_{u0}$) random effect specific to community *j*. We then added explanatory variables to the model in order to estimate between-community variance as a function of characteristics of the community where people temporarily depart from and individual characteristics as control variables (age and gender).

$$\log\frac{\pi_{it}}{1-\pi i_{ij}} = \beta_0 + \beta_k X_{ij} + u_{0j} + u_{kj} \qquad (2)$$

where X is a vector of explanatory variables k for individual i. The random effects u_{0j} and u_{kj} are assumed to follow a normal distribution with mean vector 0 and variance-covariance matrix Ω_u. The community variance is now given by the matrix of $\sigma_{uk}^{\ 2}$ and σ_{u0k}.

Coefficients from the final GLMM are first presented as log odds which are hard to interpret. They are therefore converted into odds ratios which estimate changes in the odds of being away from home on census night that is caused by a one unit increase in the respectively (continuous) explanatory variable, everything else being equal. For a dummy (0/1) coded explanatory variable it is the estimated change in the odds of being away caused by a discrete shift in this variable from 0 to 1.

Before constructing the model we computed a Pearson product-moment correlation matrix to examine intercorrelation among the explanatory variables.

4. Results

4.1. Description of temporary mobility on census night 2011 and comparison to 2006

Overall 6.1% of Indigenous people (930 out of 15 262) in the 15 communities were away from home on census night 2011, compared to 5.8% (796 out of 13 650) in 2006. This was slightly lower than the national average of 6.9% of Indigenous people away from home on census night (ABS, 2012b; for comparison, for non-Indigenous people this was 4.4%). The largest proportion of people away from home on census night 2011 was in Hermannsburg (12.5%) and the lowest proportion in Umbakumba (1%; Figure 2). Compared to 2006, the greatest increase in people away from home was found for Ngukurr (88%). Angurugu, Nguiu, Numbulwar and Wadeye also experienced high (around 50%) increases compared to 2006. Yirrkala (61%) and Gapuwiyak (56%) experienced large declines in the percentage of people

away from home on census night. The percentage of people away also decreased in Umbakumba, Milingimbi and Lajamanu while it remained stable in Galiwinku, Maningrida and Yuendumu.

[Figure 2]

Fifty-six percent of those away (517 out of 930) were women. The strongest temporary mobility was among young people (between 10 and 19; Figure 3) while older people (≥60 years) were the least mobile with mobility decreasing continuously with age. In six communities the proportion of men and women away from home on census night was about equal (Gapuwiyak, Lajamanu, Maningrida, Ngukurr, Numbulwar and Yirrkala). In Nguiu it was only women who were away on census night and significantly more woman than men were away from home on census night in Gunbalanya, Milingimbi, Wadeye and Yuendumu. Hermannsburg had the largest proportion of men away from home on census night and Angurugu and Galiwinku also had significantly more men than women temporarily mobile.

[Figure 3]

4.2. Factors explaining temporary mobility on census night 2011

The random-intercept-only model showed a significant variance at the community levels ($P<0.001$; Table 2). Therefore there is clear evidence for between-community variation, confirming that the GLMM is the appropriate model. Converting the coefficient of the intercept into an odds ratio ($e^{-2.817} = 0.6$) showed that on average 6% of individuals were away on census night across all 15 communities, which was, as expected, very similar to the unconditional mean. The between-community correlation coefficient was 0.087 (calculated as: $0.315 / [0.315 + (\pi^2/3)]$). This means that almost 9% of the variance is attributable to unobserved community characteristics.

Multicollinearity prevented the inclusion of all explanatory variables in the saturated model. The variable 'Refurbishment' was positively correlated with 'New houses' (Pearson's r=0.85) and jobs in the education sector was positively correlated with jobs in the public administration sector (Pearson's r=0.77). We therefore did not include 'Refurbishment' and jobs in the public administration sector as explanatory variables. We started with the saturated model and then manually omitted and re-introduced explanatory variables using likelihood ratio and Wald tests. With the addition of the explanatory variables at level 2, the between-community variance was significantly (P<0.001) reduced from 0.31 to 0.07. A Wald-test showed that the final model was statistically significant at the 99% level of significance. The final model (Table 2) showed that the following factors were positively correlated with being away from the home community on census night: relative number of CDEP jobs, relative number of health jobs and the proportion of houses with Internet access in the home community.

An increase in the odds of houses having Internet access by a factor of one increased the odds of being away from home on census night by 44%. For each additional CDEP job available (per 100 citizens), peoples' propensity to be away increased by 0.1% and for each additional job in the health sector it increased by 0.2%. The variable 'new houses', on the other hand, had a negative impact on being away, i.e. the more new houses a community obtained, the less likely were people to be away on census night in that community. The odds ratio showed that for each new house built in a community, peoples' propensity to be temporarily mobile decreased by 0.1%.

The control factors gave the expected results. Being a woman increased the odds of being away from home on census night by 27%, holding all other factors constant. Children (0-9) were one third less likely to be away from home on census night than people of all other age groups, while young people (10-19) were 33% more likely to be away than people of other

age groups. Older people (≥60 years) were only less likely to be away from home on census night when they were female; in fact older men were almost three times more likely to be away than older women (1/0.29-1). People of the remaining age groups were not significantly more or less likely to be away from home on census night than the average.

[Table 2]

The model results predicted an overall percentage of people away from home to be 6.28% which is slightly higher than that actually observed on the 2011 census night (Table 3). Almost 7% of women were predicted to be away on future census nights but only 5.7% of men. The percentage increased to slightly more than 7% for women in their teens. The biggest increase in mobility was predicted for communities with a high percentage of houses connected to the Internet. If Internet access was to be increased to three out of four houses (75%) being connected, overall mobility doubled to 12.4% (Table 3). While the mobility doubled on average, the changes were slightly less in some of the communities. For example, if the odds of having Internet increased by a factor of one in Maningrida (from a ratio of 0.49 to 1.49, Table1 – or from 33% to 60% of all houses), holding all other factors constant, mobility in this community was predicted to increase by 29%. In Wadeye, another community with relatively few houses connected to the Internet, increasing the ratio of dwellings/households having the Internet by a factor of one would lead to an increase in mobility by 30%. In Hermannsburg, a community with already high Internet connectivity, increasing the odds of having Internet by a factor of one (from a ratio of 2.55 to 3.55 – or from 72% to 78%) and holding all other factors constant, mobility was predicted to increase by 29%.

If a community was to receive 100 new houses, mobility in that community was predicted to decrease to about 4% on average (from 6.28% = 36% decrease). In some communities the decrease was even greater. In a community with currently no new houses received, like in

Hermannsburg, overall mobility in this community was predicted to decrease by 46% if 100 new houses were built, holding all other factors constant. In Ngukurr and Yirrkala mobility was predicted to decrease by 47% with the reception of 100 new houses. In Wadeye, which has already received 100 new houses, increasing this number by another 100 would lead to a decrease in mobility by 48%.

[Table 3]

5. Discussion

5.1. Significance and implications of gender and age

The modelling results corroborate earlier research on the rising mobility of Indigenous people who reside in remote parts of developed nations (Hamilton and Seyfrit, 1994; Rasmussen, 2007). In particular, this research has identified young people and women living in remote Indigenous communities as being relatively mobile. We provide statistical confirmation for this 'female tripping' and high youth mobility. We estimated that women were 27% more likely than men and young people 33% more likely to be temporarily mobile than people of other age groups. These are not negligible numbers and have the potential to challenge the delivery of cohort-specific programs and policies. Service providers will need to continue to devise innovative ways to engage with mobile people and to make use of existing and emerging digital technologies.

Young children (0-9 years) had a lower propensity to be away on census night. Intuitively this could be because these include school-aged children (5-9) and they and their families might move less frequently, at least during school term time (Prout, 2008b). This would be in line with the national wide relatively low level of Indigenous temporary mobility for those aged 5 to 9, the age of compulsory school years (ABS, 2012b). However, other studies talk about high mobility rates for school-aged children (e.g. Morphy, 2007). Moreover, we cannot

correlate this age group to the mobility of the parents. If these were related, and if those people who were away on census night (younger women for instance) took their children, we would have expected a positive coefficient for the age group 0-9 years. Thus the negative coefficient could have two implications: either those highly mobile women are childless, or they leave the children in the care of their families in the communities, often of the more sedentary grandparents, to, for instance, avoid school-term interruption, while the parents themselves are away temporarily (Martin and Taylor, 1996; Prout, 2008a; Prout, 2009).

The model results show that Indigenous people between 10 and 19 had a higher propensity to be away on census night than the average. The most likely reason could be that these are the teenagers at the higher end of this age cohort, i.e. the 15 to 19 years old who have completed school in their community. On a national scale, Indigenous people aged 15-19 also had a higher than average propensity to be away on census night (8.1%; ABS, 2012b).

The level of mobility for people aged 20-59 years, on the other hand, was not significantly different to the average. This is surprising for the age group 20-29, as among Indigenous people on a national scale, this age group has had the highest temporary mobility (9.1%; ABS, 2012b). While these people's mobility is likely to be driven by the search of post-school qualifications and jobs, this does not seem to be the case for this cohort across the 15 remote Indigenous communities included in our model.

Older women were almost three times less likely to be temporarily mobile. One reason for older men to be away from their home communities on census night could have been hospitalisation elsewhere, which can have important implications for gender-specific age and health care. If this trend persists it can put additional pressure on already challenged health/age care and social support services in remote communities (mainly high costs, shortage of funding and professional staff; Kainz et al., 2012).

5.2. Significance and implications of Internet access

In terms of community services and infrastructure, the model results showed that Internet access is positively related to temporary mobility, as also shown in previous research in Australia (Muto, 2009; A. Taylor, 2012). However, our study is one of the few to provide empirical evidence of this positive relationship. An increase in dwellings with Internet connections from 45% to 75% is predicted to increase temporary mobility by 100% to 12.4% (Table 3).

The 'Internet' variable, as included in the model, embraced broadband, dial-up internet as well as internet access via mobile devices. Most people in Indigenous communities access the Internet via the last of these, their mobile devices, often on a daily basis (A. Taylor, 2012). Such connectivity may underpin some of the high mobility among young people, encouraging them to move between locations to maintain social ties as well as to take advantage of previously unimaginable opportunities outside their communities. The rapid adoption of mobile devices in Australian Indigenous communities resembles the phenomenon of technology 'leapfrogging' seen in Africa (Hahn and Kibora, 2008).

In a global context, our findings are in line with the 'new mobilities paradigm' (Sheller and Urry, 2006). Although the use of mobile devices means that many activities no longer need to be performed at certain places or times, it was found that increased mobile communications resulted in people moving even more frequently (Axhausen, 2005; Kwan, 2007). Higher levels of communication can lead to expanding social networks and increase knowledge of the availability of services and commodities elsewhere. This is likely to increase the need and wish to travel (Urry, 2002, 2007). Kral (2010a) found that using Internet-based technologies for community projects, such as song-writing, recording music and presenting it on YouTube, can affirm young peoples' contemporary Indigenous identity and their 'belongingness'. This

could mean that young people are more engaged in cultural events and that they hence need to travel more frequently.

Increasing mobile communications and the increase in physical mobility are mutually reinforcing and travel is the means by which social networks are 'glued' together (Kwan, 2007). Sheller and Urry (2006) talk about a new convergence between physical movements of people, wireless distributed computing and communications, and vehicles. The widespread use of mobile phones in Indigenous communities is thus likely to lead to increasingly high levels of mobility, and mutually, as people become more mobile, they have greater need for coordinating their social activities while traveling. Indigenous people often have great extended family networks around Australia, and being able to communicate cheaply and quickly will allow them to be more flexible and increase their mobility still further. So the Internet is becoming a medium for enacting 'new spatialities' in remote Australian communities (A. Taylor, 2012).

With government plans to expand the broadband network (Next-G network), rates of household and individual Internet use are likely to climb further. Policy makers will need to consider how this and the associated mobility impacts will influence the mix of other efforts to improve services *in situ*, and in what *in situ* services can be replaced by the internet. Education (see also section5.4) and health in particular may benefit from having a high percentage of young Internet users in remote communities as they will be well-equipped to take advantage of virtual services that can be as mobile as their users. One can image that in future both training and medical consultations could be undertaken increasingly through Internet-based mobile devices (e-health/telehealth; e.g. Peddle, 2007).

5.3. Significance and implications of housing

Meanwhile improved housing has been shown to have a negative impact on the propensity to be away on census night, i.e. there appears to be less mobility among people in communities that have recently had new houses. This finding contributes to the still very limited literature on the impacts of housing in Indigenous communities. Our results contradict findings of Habibis (2013) and (Prout 2008b), both of whom suggested an increase in mobility following construction of new houses. Habibis (2013), who worked in the two medium-sized townships of Tennant Creek and Nhulunbuy in the NT, described how the new houses provided by the government impinged on Indigenous aspirations to remain on homeland communities and that the policy took insufficient account of Indigenous peoples' cultural realities. As a consequence some tenants left their homes as a culturally sanctioned form of resistance to state control. While this might also be true for some people among the 15 communities in our analysis, the effect was swamped by the greater proportion of people who decided to stay in the community and move into the newly provided houses. From an international, non-Indigenous perspective, our findings corroborate research by Boyle and Shen (1997), Andersen (2011) and Zabel (2012) arguing that affordable houses and housing availability increase the likelihood that people stay. Our model predicts that the additional 318 houses planned by the government will decrease the odds of being mobile by 76% across all 15 communities, holding all other factors constant, i.e. from 6.28% to 1.5%. The government policy of transferring some public housing in remote communities to private ownership may also reduce mobility rates. The predictions will be testable in the next census (2016). In 2011 less than half of the 580 new houses planned for remote NT communities had been built. The new housing stock will all be available by 2016.

5.4. Significance and implications of service provision

Service providers often perceive high levels of Indigenous mobility to be problematic (Prout, 2008b; Kainz et al., 2012) and it is hypothesised that people with different levels of mobility are likely to have different service needs. In this analysis we obtained mixed results on the impact of service provision on peoples' temporary mobility.

A comparatively high number of jobs in the health sector and CDEP jobs increased the likelihood of a person being away on census night. This positive relationship may be explained by the relatively better financial situation of those in these jobs with more disposable income to be spent on travelling. However one would therefore expect that this argument would also apply to other employment sectors, which was not the case. However, a characteristic of both health and CDEP work is the provision of cars in order to access sites away from communities, and such travel arrangements commonly involve not just workers but family members as well. Thus on census night 2011 many health care and CDEP workers may have been away from their home communities, to travel to very remote settlements or outstations, especially as the census was conducted during the dry season when roads are most likely to be open to traffic (in the wet season (December-May, they are commonly impassable). However the link between health and mobility may be more complex (see below).

Apart from these two sectors, differences in service provision across Indigenous communities are not correlated with Indigenous temporary mobility. This included employment levels in the education sector, for which the government is the main employer as well as in private sectors, though most of these are very small, even in the arts, which is probably the best developed private business in most communities (Garnett et al. in press). Thus conventional theories that suggest work availability in a community reduces the mobility of its residents (Taylor and Bell, 2004; Taylor, et al., 2011a) is not supported and investment in *in situ*

development does not appear to 'stabilise' the population for easier planning and cost-efficient service provision.

The education sector

Our prior assumptions about how the education sector might affect temporary mobility had been mixed. In communities where the education sector had many people employed we expected lower mobility among those who are employed by it (because of job engagement) and those currently using the service (young people at school). However education investment was not correlated with mobility of either adults or children, although it should not be assumed that children were not being educated – many Indigenous children are educated outside the formal system (Kral, 2010b; Prout, 2012) or, now, are learning or learn and improving their skills (e.g. problem-solving, creative literacies) by using the Internet and multimedia (Kral, 2010a). Potential shifts from formal to informal education warrant investigation to improve service provision in the education sector. The provision of Internet and multi-media facilities to cater for temporary visitors might be explored by policy makers for its positive impacts on education more broadly.

We also expected higher mobility among young adults in the communities with greater educational investment – other studies, while not so much in Australia but in other developed countries with First-Nation people such as Canada and Arctic Europe (e.g. Rasmussen, 2007; Croy et al., 2009), have demonstrated a link between high formal educational outcomes and an increase in rural to urban migration/residential movements for Indigenous people. Nationally, however, this shift occurs among the 20-24 year-olds whereas, in our study, it was the 15-19 year-old cohort that were more mobile, which suggests that the same phenomenon is occurring but among a population with a lower school leaving age. It may be that mobile/virtual education service provision can continue to engage this group even after they leave the formal system.

The health care sector

Our results suggest that the general assumption that better health care provision inhibits peoples' desire to leave their communities might be false. It has been hypothesised that Indigenous people often follow family members who seek medical health elsewhere when not available in their home communities (e.g. Kainz et al., 2012). In this case we would have expected a negative relationship between good health care provision and mobility, as people do not have to travel, unless needing to be hospitalised, to seek health care when it is provided in their home communities. Our findings suggest this relationship is more complex. The results could mean that healthier people are more likely to be able to travel. Health service providers are challenged by peoples' extended mobility, making post-care monitoring and follow-up treatment difficult (Prout, 2008; Habibis et al., 2011; Kainz et al., 2012). Some health care centers might need to provide services to regional areas (with several language groups) rather than to individual settlements (Warchivker et al., 2000). Alternatively it could mean that health needs are higher in those communities, with the result that a higher proportion of people are likely to be away having intensive treatment.

5.5. Limitations

There are two broad approaches to conduct studies on temporary mobility in Indigenous communities: one relies on primary data collection in one or a few communities, which is often of qualitative nature (e.g. Morphy, 2007; Prout, 2009; Habibis, 2011), the other is more quantitative and relies on secondary data, from censuses or periodic national surveys. Most mobility literature using statistical information derives data from the 5-yearly census, as our study does. Data on mobility from the census certainly do not have the depth (e.g. reasons for movements, number and duration of trips) than ethnographic accounts (Taylor and Bell, 2012) as it remains a static snapshot (Biddle and Prout, 2009). This static concept can be particularly constraining for Indigenous populations amongst whom temporary movement can be frequent

and/or seasonal (Memmott et al. 2006; Morphy, 2007; Biddle and Prout, 2009). So analyses using census data need to be aware of their limitations.

There are difficulties collecting census data in remote Indigenous communities and constraints of coverage and accuracy (Martin and Taylor, 1996; Warchivker et al., 2000; Morphy et al., 2004). Unlike in other parts of Australia, where the census data are collected on the same day everywhere, data collection is often extended because of the difficulties in accessing remote settlements. Morphy (2007), for example, has described how in many parts of the remote NT, the census collection process can take up to nine weeks. It's not a simple matter of one-night collection. This could have serious implications for interpretations of 'being away from home on census night' when analysing 'place of usual residence' against 'place of enumeration'. There are two reasons why the current analysis is worth conducting. First, while variation may be greater, there is no particular reason why, on the day of collection, the data are not as valid as they might be had all data collection been on the same day. Secondly there is no a-priori reason to suspect bias in the results in one direction or the other.

A potential limitation of our study is the transferability of our findings. While our results can certainly be useful for planning in the 15 major service towns analysed, and into which the government is making major investments into infrastructure and housing, transferring implications to the other 65 Indigenous communities in the NT, let alone in Australia or beyond is challenging given the diversity in peoples' aspirations, opportunities and community-specific challenges. Some determinants of mobility, however, such as the movements of young and educated people, are not only universal to Indigenous communities in the NT but are common to such communities globally. Given this commonality, our results can be seen as working hypotheses that can be tested in broader studies and over time.

5.6. Outlook and further research

Applying a GLMM in the context of Australian Indigenous mobility is a novel approach which delivers robust results. GLMM models have largely been used in ecology (Bolker et al., 2009), and their application in demographics is sparse. These models are more flexible than logit/probit models and they handle large census data sets with hierarchical structure and spatial autocorrelation. Other models that are of interest, and that have not yet been applied to Australian Indigenous demographics, are discrete choice models. These models are widely used in transportation, marketing, environmental valuation and health economics but their application in demography is still relatively rare. Hoffman and Duncan (1988) advocated discrete choice models for demography but no recent attempts have been made. In fact this should now be much easier as models have improved substantially since then (Hunt et al., 2004), becoming more flexible with less stringent assumptions applied to conditional logit models by allowing the estimation of random and mixed effects (e.g. mixed logit models; Hensher et al., 2005). While we have concentrated on the effect on mobility of the characteristics of the communities in which people live, models can also be constructed that investigate characteristics of destinations. Furthermore, (spatial) choice models on Indigenous peoples' permanent mobility can be estimated, investigating which destinations people prefer over others and linking these destinations to their particular characteristics, as well as those of the people moving and of the communities from whence they came.

Future research should also investigate the many changes to service provision that have been made since the 2011 census, such as refurbishment of health care centers, establishment of child care centers and strengthening of police presence. Similarly, while there had been almost no private home ownership in smaller Indigenous communities before 2011, future investigations could examine the effects of changes in ownership rates given the experience in other countries (e.g. Lux and Sunega, 2012). Further research investigating the correlation

between vehicle use and mobile devices and how this can converge to even higher mobility would also provide useful information for community development and planning.

The higher rate of mobility in communities with relatively greater proportions of CDEP employment can have multiple explanations. These need to be disentangled through further research. In general, more research is needed to find out how jobs in the private sector can contribute to people choosing to stay in their home communities or else leave them when attracted by more desirable private jobs in other communities.

6. Conclusions

The application of a generalized linear mixed effects models (GLMM) helps to understand factors that may be influencing Indigenous Australians temporary mobility (defined here as the propensity to be away on census night). We investigated whether differences in community characteristics affect peoples' temporary mobility. We found that temporary mobility is more likely in communities with more jobs in health care, more Community Development Employment Program (CDEP) jobs and higher rates of internet access. There was less mobility, however, where new houses had recently been provided. Demographic characteristics also explain some temporary mobility. The propensity to be away on census night is higher for women and people in their teens while babies and older women are more likely to be at home on census night. Government and private service providers in Indigenous communities may need to consider how to deliver timely and effective services to more temporary visitors to communities given that some service improvements lead to increased rates of temporary mobility.

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Tables

Table 1: Community characteristics used in a model of Indigenous Australian temporary mobility

	Infrastructure				Service provision (in jobs per 100 citizen)					
	New houses	Refurbishment	Internet	Poor roads (%)	CDEP	Trade	PA	Health	Education	Arts / recreation
Angurugu	18	10	0.34	0.9	0	0.2	5.7	1.4	6.6	0
Galiwinku	11	24	0.61	0.6	1.6	2.6	8.5	3.0	3.7	0.3
Gapuwiyak	0	0	0.35	0.53	0.6	4.2	4.9	0.8	3.2	0.2
Gunbalanya	23	45	2.25	0.48	3.1	1.9	5.5	1.6	2.8	1.5
Hermannsburg	0	0	2.55	0.41	0.5	5.1	14.7	5.9	6.9	1.6
Lajamanu	0	0	1.05	0.96	0.6	3.2	6.1	2.7	5.5	1.1
Maningrida	47	32	0.49	0.66	7.2	0.3	8.2	1.0	2.9	0.0
Milingimbi	0	0	1.85	0.62	1.7	3.6	3.5	0.8	3.4	0.0
Nguiu	51	91	0.26	0.67	7.4	5.3	9.6	3.2	7.9	1.7
Ngukurr	0	57	1.21	0.4	3.2	2.8	10.2	2.6	7.4	0.9
Numbulwar	0	0	0.54	0.7	2.2	7.7	12.0	1.9	7.7	0
Umbakumba	12	34	0.13	0.18	0.5	0.4	1.5	0.3	0.8	0
Wadeye	100	104	0.33	0.75	2.0	2.9	12.2	2.7	8.7	0
Yirrkala	0	0	1.23	0.52	0	1.7	17.7	1.4	7.8	3.2
Yuendumu	0	0	1.20	0.15	1.5	1.7	11.4	6.3	6.0	0.7

Source: 2011 Census data (ABS, 2012b,d)

CDEP = Community Development Employment Projects; PA = public administration

Table 2: Generalized linear mixed-effects model results and odds ratios (including the lower and upper bound of the 95% confidence interval)

	Random intercept model			Final model			Odds ratios		
	Estimate	Std. Error	Std. Dev.	Estimate	Std. Error	Std. Dev.	Mean	Lower	Upper
Intercept	-2.817***	0.151	0.561***	-3.692***	0.315	0.854***			
Female				0.242***	0.070		1.27	1.11	1.46
Age 0-9				-0.411***	0.096		0.66	0.55	0.80
Age 10-19				0.287***	0.080		1.33	1.14	1.56
Age ≥60				0.168	0.260		1.18	0.71	1.97
Female x ≥60				-1.238**	0.415		0.29	0.13	0.65
New houses				-0.006*	0.003	0.007***	0.99	0.99	1.00
CDEP jobs				0.005***	0.001	0.002***	1.01	1.00	1.01
Health jobs				0.018**	0.006	0.001***	1.02	1.01	1.03
Internet				0.362**	0.115	0.316***	1.44	1.15	1.80
Random effects:									
	Variation	Std. Error	Deviance	Variation	Std. Error	Deviance			
Town	0.315***	0.561	6908	0.073***	0.854	6817			
AIC	6912			6867					
Log likelihood	-3454			-3408					
Observations	15262			15262					
Groups (towns)	15			15					

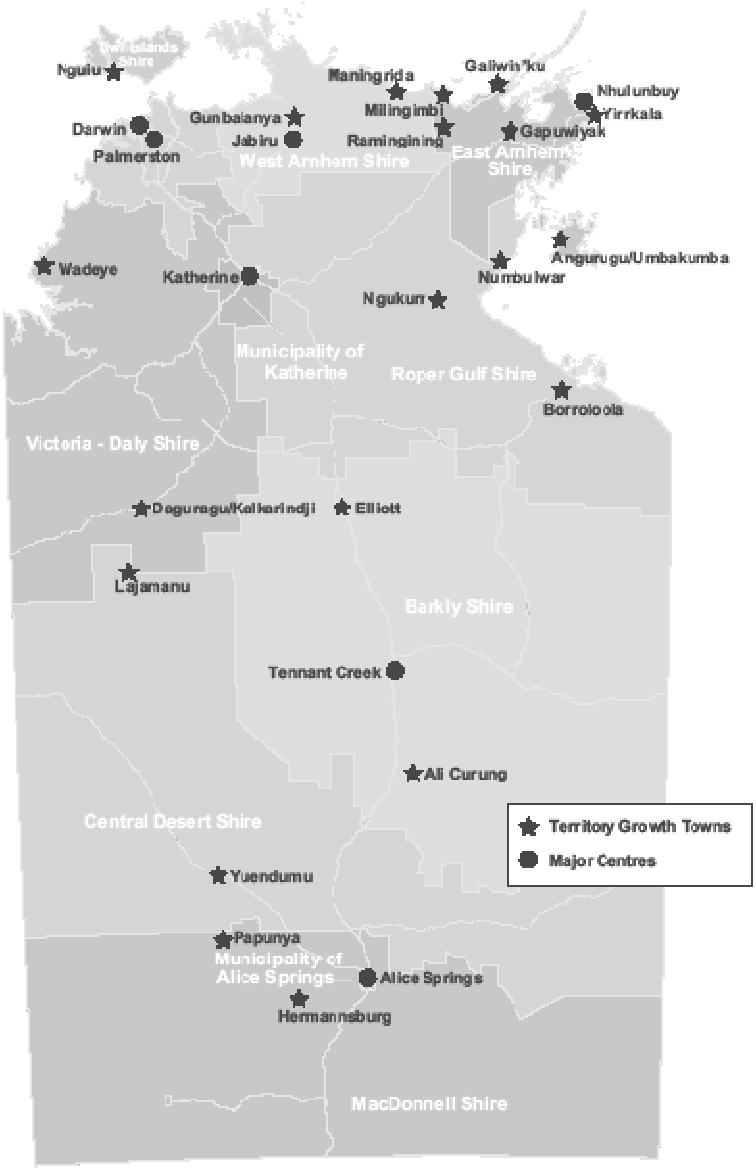
*** = 1% significance level; ** = 5% significance level; * = 10% significance level

Table 3: Predicted probabilities of the percentage of Indigenous people absent from home on census night (as an indicator of temporary mobility) under different community infrastructure scenarios

	All	Men	Women	Young women	Men ≥60
Without changes	6.28	5.70	6.89	7.08	6.61
Town with 100 new houses	4.01	3.62	4.41	4.53	4.22
Town with 75% of houses connected to Internet	12.40	11.34	13.51	13.86	13.02

Figures

Figure 1: Map of the Northern Territory in Australia showing major Indigenous service communities (named 'Territory Growth Towns' here) for which census data were obtained for analysis



Source: Northern Territory Government (http://www.workingfuture.nt.gov.au/Overview/docs/Report%204/6.%20Appendix%20B.pdf)

Figure 2: Proportions of Australian Indigenous people away from home on census night 2006 and 2011 in 15 communities in the Northern Territory

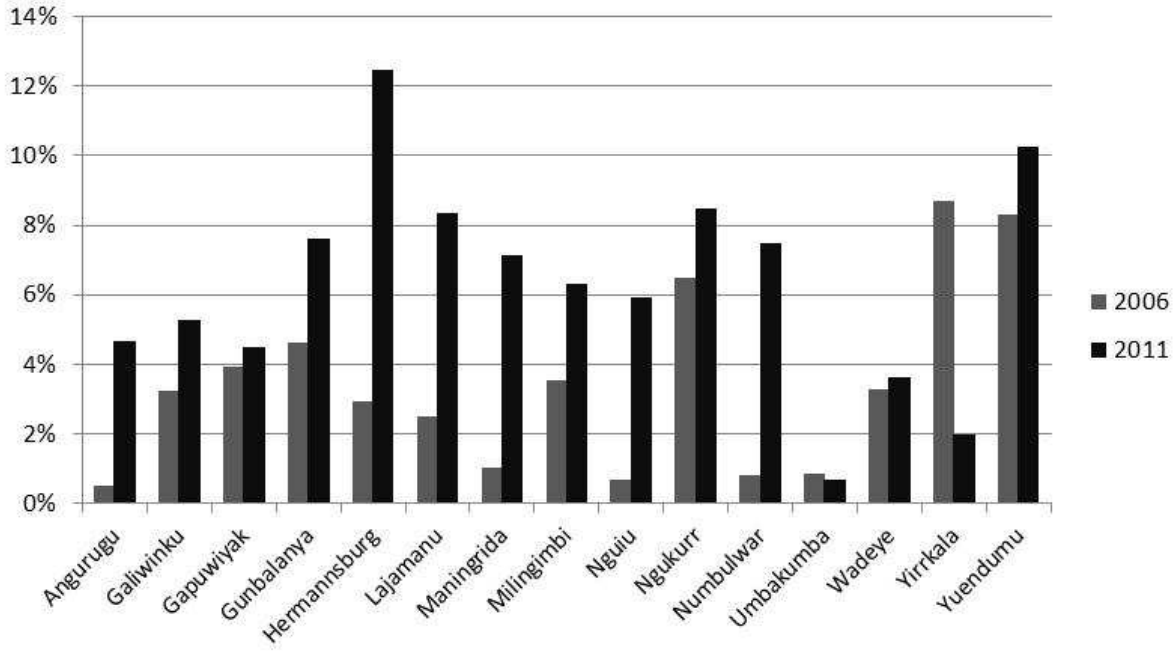


Figure 3: Age-sex structure of Indigenous people being away from home on census night 2011 in 15 communities in the Northern Territory