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Analysis

Regional sustainability in Northern Australia —A quantitative assessment of social, economic and environmental impacts

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ABSTRACT

This paper seeks to provide a picture of sustainability of the Northern Territory by analysing a number of sustainability indicators across indigenous status and remoteness class. The paper seeks to extend current socio-economic statistics and analysis by including environmental considerations in a 'triple bottom line' or 'sustainability assessment' approach. Further, a life-cycle approach is employed for a number of indicators so that both direct and indirect impacts are considered where applicable. Whereas urban populations are generally doing better against most quantitative economic and social indicators, environmental indicators show the opposite, reflecting the increasing market-based environmental impacts of urban populations. As we seek to value these environmental impacts appropriately, it would be beneficial to start incorporating these results in policy and planning.

1. Introduction

In a recent article (Wood and Garnett, 2009), we estimated the ecological footprint by region and indigenous status of the Northern Territory of Australia. In this work, we broaden the assessment of sustainability by examining a suite of economic, social and environmental indicators. We do so in response to sustained urbanisation of the remote indigenous population and the development of policies in the Northern Territory with the long-term vision of sustainability (A Working Future[1], Territory 2030[2], NT Climate Change Policy[3]). While the indigenous population of urban areas and regional centres has grown rapidly in recent decades, remote jurisdictions are seeing minor or negative population growth (Taylor and Carson, 2009; Taylor and Biddle, 2008). How this affects sustainability is currently unclear: comparisons of indigenous and non-indigenous populations for a range of social indicators (e.g. SCRGSP, 2009, Australian Institute of Health and Welfare, 2007) have never been brought together with measures of environmental health to assess sustainability. Thus, while urban areas are generally correlated with higher incomes and better education, they are also associated with a disconnect from traditional livelihoods, with a reduced reliance on traditional sources of sustenance, increased dependence on external energy inputs, and a dislocation from environmental impact. The sustainability consequences of this disconnect are seldom measured but probably should be given that planners are also needing to incorporate the effects of their decisions on issues such as global warming, water shortages and ecological space. The purpose of this paper is to examine the differences that urbanisation has on the overall sustainability of the population in the Northern Territory. As a first step, we are limiting ourselves to setting the baseline of the sustainability indicators, set against the benchmark of the Australian average. These underpin the development of targets and identification of potential thresholds-baselines, benchmarks, targets and thresholds being the distinguishing features of indicators over raw data and statistics (Hák et al., 2007). We seek to provide a starting point for policy decisions and modelling of dynamic effects within the population, and allude to these issues in our discussion.

Our previous work (Wood and Garnett, 2009) investigated only one indicator of environmental sustainability, the ecological footprint. As Grazi et al. (2007) point out, making broad decisions on only one indicator can give results inconsistent with broader notions of sustainability. Hence it is important to incorporate other effects – on social and economic factors – when trying to plan for sustainable futures. We also do not provide a single aggregate measure of sustainability, as the relative valuation of environmental, social and economic impacts is highly subjective, and we believe such an aggregation takes meaning away, rather than adds value, to our results.

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1 http://www.workingfuture.nt.gov.au/index.html.
2 http://www.territory2030.nt.gov.au/.
3 http://www.greeningnt.nt.gov.au/climate/docs/Climate_Change_Policy.pdf.

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In the remainder of this paper, we first introduce the sustainability indicators used in this study, followed by specific methodological considerations of some of the indicators. In Section 3, we present our assessments based on regional and indigenous status. Section 4 provides a discussion of our results in light of questions of population urbanisation.

2. Method

2.1. Sustainability Indicators

Sustainability assessments come under various guises, and we refer the reader elsewhere for more comprehensive reviews of indicator development (Mayer, 2008; Singh et al., 2009). Data limitations are often a significant obstacle to generating large indicator sets, and, as is often the case with regional analysis (Graymore et al., 2008), we are confronted with this issue in our analysis. Most sustainability assessments involve either direct quantitative measurement and/or qualitative assessments given quantitative rankings. We focus here on quantitative assessment, and use a combination of disaggregated and aggregated indicators in order to keep the total number of indicators to a level that will make effective policy formulation possible.

The purpose of this work was to provide a measure for thus far unaddressed components of sustainability in this region, and is intended to be used alongside expert knowledge on cultural and social issues in the implementation of policy. We first investigated the 143 indicators embedded in the 68 sustainability indices identified by Singh et al. (2009). This showed that no indicator or combination of indicators is yet available to give a reasonable reflection of complex cultural issues (Shanahan et al., 2009), and we do not pretend to cover this complexity here. We also do not focus on the sustainability of industrial production in this region — we instead are focussing on population livelihoods, while acknowledging the two are interconnected. We are interested in interpreting livelihoods for both local and global issues, and thus we intertwine indicators across both scales. The final choice of indicators was driven by five main foci. Firstly, indicators were chosen that had most relevance to the study subject. Secondly, that they reflect both local and global issues. Thirdly, that they could complement and not replicate existing literature and statistics, particularly on health. Fourthly, the indicators were selected from each of the environment, social and economic spheres of sustainability. Finally, ability to quantify and data availability were also serious considerations. Ten indicators were selected, being the ecological footprint, greenhouse gas emissions, water use, land disturbance, qualification, employment, alcohol use, income (own), income (generated) and cost of living. Details on these indicators are given following a short description of the life-cycle perspective.

2.2. Life-cycle Approach — Direct and Indirect Impacts

Often sustainability assessments only include local or 'on-site' indicators. For example, they include only employment of the local population, not the employment required to support the population, or for greenhouse gases, the emissions from fuel use, but not the emissions embodied in the goods and services consumed by the population. In this assessment, we have sought to integrate both local and global indicators by taking a life-cycle approach where applicable and coupling indicators of importance for local or on the ground issues, with issues of global importance. The indicators identified below where the life-cycle approach is applicable include the ecological footprint, greenhouse gas emissions, water use, land disturbance and income (generated).

By incorporating indirect impacts, we are providing a holistic assessment of the upstream requirements of the consumption of market-based goods, and the provision of government services. We use input–output analysis to implement this life-cycle approach and calculate the indirect impacts (see Wood and Garnett (2009) for a more complete exposition and additional references):

$$Q = \mathbf{Q}^{\mathrm{ind}}(\mathbf{I}-\mathbf{A})^{-1}\left(\mathbf{y}_{\mathrm{m}} + \mathbf{y}_{\mathrm{g}}\right) + Q^{\mathrm{hh}}.$$

Where Q is the total per-capita direct and indirect impact, $\mathbf{Q}^{\mathrm{ind}}$ is the direct impact of each industry in the economy per $ of output, and is specified differently for each indicator, $\mathbf{I}$ is the identity matrix, $\mathbf{A}$ is the coefficient table derived from input–output tables showing the percentage requirements of one industry in the economy from each other industry, $\mathbf{y}_{\mathrm{m}}$ and $\mathbf{y}_{\mathrm{g}}$ are the per-capita vectors of population and government consumption respectively, and $\mathbf{Q}^{\mathrm{hh}}$ is the direct impact of the household (e.g. emissions from motor vehicle use). National input–output tables have been used, as most goods and services consumed within the Northern Territory are brought in from elsewhere in Australia. Apart from the actual consumption of the population, the relative value of margins is the main point of diversion for consumption within the Northern Territory, and specific data is included for this. Input–output data is taken from 1999 statistics (Australian Bureau of Statistics, 2004), with the final demand estimated for 2003–4, and deflated from purchaser to basic prices and to 1999 levels. See Wood and Garnett (2009) for a more complete discussion of the issues, data sources and for the estimation of consumption vectors.

2.3. Summary of Indicators

In this section we describe each of the ten indicators. In order to provide a consistent direction of indicators towards a sustainability ideal, we flag each indicator as negative or positive depending on whether increased values are good or bad within a sustainability context.

2.3.1. Environmental

2.3.1.1. Ecological Footprint (Negative)[4]. The ecological footprint (Rees, 1992; Wackernagel and Rees, 1995) is an aggregated "measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. Because trade is global, an individual or country's Footprint includes land or sea from all over the world" (Global Footprint Network, 2008). In this case, the ecological footprint helps provide an assessment of the disconnection of the livelihoods of local populations with the land required to support them. In Northern Australia, very few resource flows are local (traditional or customary impacts have not been included — see Wood and Garnett, 2009), so with an increasing ecological footprint, we are seeing not only increased impact on ecological space, but also increased reliance on imported resources and export of waste (principally greenhouse gas emissions). This indicator can thus give an idea of the disconnect of the population from its resource base, with the larger the footprint the more distant from sustainability ideals. The ecological footprint was calculated using a hybrid input–output model with data on direct impacts coupled with regionally estimated consumption by indigenous status. An extensive description of how the ecological footprint was calculated in this research is available in our previous work (Wood and Garnett, 2009).

2.3.1.2. Greenhouse Gas Emissions (Negative). This indicator measures the greenhouse gas emissions resulting from a population's activities (direct emissions) and consumption, including all embodied greenhouse gas emissions of goods and services consumed (indirect emissions). As greenhouse gas emissions are of global importance,

[4] See Section 2.3, refers to sustainability context of indicator.

the inclusion of indirect emissions is necessary to give a proper assessment of the impact of a population's livelihood. Highly correlated with energy use, the level of greenhouse gas emissions gives an indication of both global warming impacts and the movement away from customary livelihoods to resource dependent livelihoods. The indirect greenhouse gas emissions were calculated using the same method as per the ecological footprint (based on an input–output model with regionalised demand), while direct greenhouse gas emissions were again calculated explicitly for transport and residential activities, and regionalised using estimated fuel consumption (see Wood and Dey, 2009; Wood and Garnett, 2009 for data sources and full method description).

2.3.1.3. Water Use (Negative). Water use denotes the consumption of self-supplied and in-stream water (from rivers, lakes and aquifers, mainly extracted by farmers for irrigation) as well as mains water (piped water from utility). Collected rainfall such as in livestock dams on grazing properties is not included. In the northern part of the Northern Territory, water use is not a major issue during the wet season. However, for about eight months of the year, very little rain falls, and the increasing population and consumption is putting pressure on current water storages. In the southern part of the Northern Territory, water is a constant issue, due to the desert climate. The population of the Northern Territory is also highly reliant on goods imported from other parts of Australia, which is often under water stress. These “water footprints” or “virtual water flows” from other parts of Australia are included by assessing the amount of water embodied in the goods and services consumed within the Northern Territory. The residential water use was extracted from utility statistics for 2004 for both remote indigenous populations and other populations (Power and Water Corporation, 2006), and split by population within these two groups. Embodied or ‘virtual’ water use was calculated using the aforementioned input–output and consumption statistics, along with detailed water accounts for Australia (Lenzen, 2004).

2.3.1.4. Land Disturbance (Negative). The land disturbance factor considers effects of land use on biodiversity and ecosystem quality. It measures the condition of land, that is, the degree of alteration from its natural state, based on satellite imagery (Graetz et al., 1995). The household component suffers from lack of data and is negligible when compared to the indirect impacts of agricultural and other goods so is not included here. However, the use of particularly primary goods can cause considerable impacts on the Australian landscape, and significant land clearing, salinity and other impacts have caused widespread problems in rural Australia. This indicator was selected to cover these issues. The method of calculation of the land disturbance metric is described in Lenzen and Murray (2001). Here it is applied with the specific population consumption statistics. The indicator is thus focussed on the indirect impacts on landscape of consumption, and is thus comparable to the ecological footprint. The point of departure, and reason for including here, is that the indicator gives a much better interpretation of the level of impact specific to the Australian landscape.

2.3.2. Social

2.3.2.1. Qualification (Positive). Qualification is an enumeration of the level of education attained (Australian Bureau of Statistics, 2006c, 2008). The levels of qualification include: Postgraduate degree; Graduate diploma and graduate certificate; Bachelor degree; Advanced diploma and diploma; Certificate; School (Year 12, 11, etc.). Each education level is enumerated on a scale of 0–5 and aggregated by percentage of the population attaining this level.

2.3.2.2. Employment (Positive). Employment is calculated as the labour force participation rate. Statistics are available by remoteness class and indigenous status in the Northern Territory (Australian Bureau of Statistics, 2008). Among those considered employed are those who have participated in the Commonwealth Employment Development Program, a scheme by which people work in exchange for unemployment benefits.

2.3.2.3. Alcohol (Negative). Alcohol refers to the volume of pure alcohol consumed per-capita per year. Estimates for the Northern Territory as a whole compared to the rest of Australia are taken from (Gray and Chikritzhs, 2000). Regional variability is estimated from level of high risk (Australian Bureau of Statistics, 2006b) alcohol consumption for remote and non-remote regions. Alcohol consumption is a significant issue for Northern Australia, with numerous social problems resulting from it (Brady, 2004; Martin and Brady, 2004; McKnight, 2002).

2.3.3. Economic

2.3.3.1. Income — Own (Positive). Income is calculated as the per-capita income by remoteness and indigenous status (Australian Bureau of Statistics, 2008). This indicator is marked as a positive indicator, meaning we would like to see higher incomes available to the population of the Northern Territory. It should be noted, however, that high incomes are not necessarily sustainable, and as such, this could also be interpreted as a negative indicator. Of most importance from a social equity point of view, is that this indicator is reasonably equal among population groups. Hence, in the results, large deviations from average should be considered negative.

2.3.3.2. Income — Generated (Positive). Effects on income across Australia as a result of activities in the Northern Territory are also calculated as the indirect amount of income generated in the provision of goods and services to the population. This is hence a more ‘global’ view of the contribution of the population to the wealth of all Australians. We include this indicator as it gives a very interesting insight into the multiplier or flow-on effects of supporting regional populations. It effectively shows the amount of income associated with employment in delivering the goods and services to each population. This indicator is again based on indirect impacts (in this case compensation of employees) associated with both private and government consumption and growth of capital (e.g. housing). The required data for the indirect income impacts per unit of consumption can be calculated directly from data in input–output tables (Australian Bureau of Statistics, 2004) using the basic input–output relation in Section 2.2.

2.3.3.3. Cost of Living (Negative). The cost of living is included as an estimate of economic difficulties directly facing the population. The relative cost of living of consumables is estimated from the consumption of each population alongside data on price indices — we assume a higher cost of living is shown by higher consumer price indices in the region. The cost of living reported here is the weighted average price index by actual consumption — that is we show the expected difference in prices paid for all goods and services consumed by one population compared to another population. The cost of living is obviously strongly affected by distance, and it is of course expected that there is a higher cost of living in remote areas. We include this indicator, as it is often seen as highly desirable to equalise cost of living in different regions in order to maintain communities. This indicator shows the extent to which these policies are failing. It should also be noted that price indices are equivalent for indigenous and non-indigenous populations in a region, but the weighting of the prices will be different. For example if indigenous populations do not purchase much fresh produce (which generally has a higher price index in the Northern Territory) but non-indigenous populations still do, then the weighted average price index will be less affected by the relatively higher price index for fresh produce for the indigenous population. Explanations on how price data was estimated were given in our previous article (Wood and Garnett, 2009).

2.4. Remoteness Classes

We seek to put this study within a regional context, and hence use the statistically defined remoteness classes. There are five remoteness classes, of which only three apply to the Northern Territory — "outer regional" (which only includes Darwin), "remote" (including outer Darwin, Katherine and Alice Springs) and "very remote" (balance of Northern Territory) (Australian Bureau of Statistics, 2006a; Bureau of Transport and Regional Economics, 2007). As this classification provides us with the best delineation of demographic data at the indigenous versus non-indigenous level, we apply our analysis at this level. To reduce confusion for the context of the Northern Territory, from this point, "outer regional" is referred to as Darwin, "remote" as Regional and "very remote" as Remote. Division of remoteness classes and indigenous status is done at the statistical level. Where full statistics was not available for all breakdowns, proxy values were used as outlined individually for each indicator above.

2.5. Benchmarks

We use Australian average impacts for each indicator as a benchmark. Choice of benchmark is subjective, and can influence presentation of results. Three obvious choices were the Australian average, Northern Territory average, and a 'sustainable' level. The Northern Territory average is disproportionately influenced by the large non-indigenous urban population of Darwin, such that little information could be garnered from those results. While a 'sustainable level' is advantageous for environmental indicators, where a reasonable estimate can be made from resources limitations, it is problematic in terms of social and economic indicators, which mostly have no pre-defined limits or constraints. As a consequence, we choose the Australian average as the benchmark indicator for our results. Results are calculated relative to the benchmark indicators, so that we present ratios of performance of the specific population group compared to the Australian average, and weighted positively or negatively depending on the indicator (see Section 2.3). We plot the results on spider diagrams.

3. Results

In this section, we present results by region for both the indigenous and non-indigenous populations. Results are also presented for indigenous and total impacts across all three regions.

Firstly, we present results for the urban region of Darwin (Fig. 1). Results are normalised to the Australian average such that, if the performance on an indicator was the same as the Australian average, the figure would traverse the contour valued 1. Better performance is shown by results being closer to the centre of the figure, and worse performance on an indicator is shown by results being further from the centre.

Environmental indicators are grouped in the top right, social indicators at the bottom of the diagram, and economic indicators to the left.

Environmental impacts of both indigenous and non-indigenous Darwin residents are worse than the Australian average (denoted by the contour valued 1) across all four environmental indicators, with the non-indigenous population being considerably worse than the indigenous population. Social indicators show close to parity to the Australian average for the non-indigenous population for employment and qualifications, but not for alcohol consumption. Indigenous indicators are considerably worse for employment and alcohol consumption. In economic outcomes, the incomes of the population are higher for non-indigenous residents, but lower for indigenous residents. Considerable income is generated in the wider economy to service the Darwin residents (the multiplier effect), mainly due to the higher levels of consumption and the higher level of per-capita government expenditure in the Northern Territory. The final economic indicator, cost of living, is comparable for both groups, but some 8% higher than the national average.

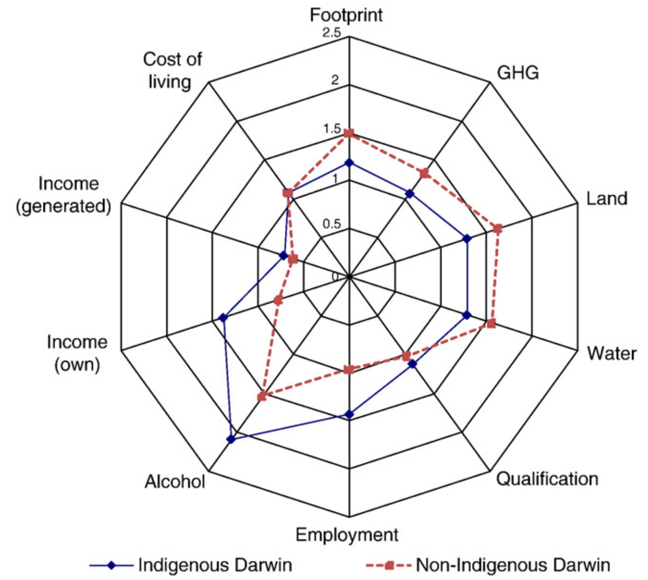

Fig. 1. Sustainability indicators for Darwin region, indigenous and non-indigenous population, normalised to Australian average (contour 1). Sustainability 'ideal' towards the centre —see Section 2.3.

Regional results (Fig. 2) are similar to Darwin results across most indicators although an increased disparity between indigenous and non-indigenous residents can be observed for most indicators. Compared to the Australian average, most results remain consistent.

In remote areas of the Northern Territory (Fig. 3), a different picture emerges. Environmental impacts are lower in the indigenous population, with both footprints and greenhouse gas emissions being lower than the national average. Some significant social problems exist, with low levels of qualifications and employment, and high levels of alcohol consumption prevalent in the indigenous population. Income (own) of the indigenous population is almost 2.5 times lower than the Australian average. Income generated is high in the indigenous population, principally due to the numerous government support services implemented. For the non-

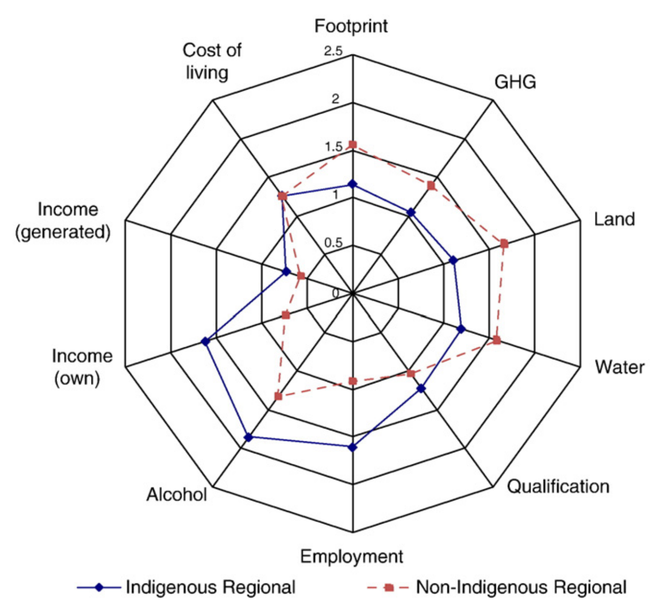

Fig. 2. Sustainability indicators for regional northern territory, indigenous and non-indigenous population, normalised to Australian average. Sustainability 'ideal' towards the centre —see Section 2.3.

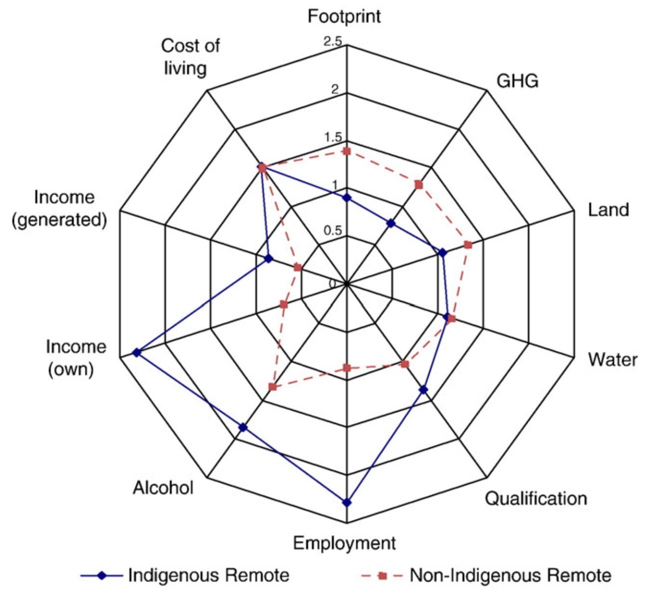

Fig. 3. Sustainability indicators for remote northern territory, indigenous and non-indigenous population, normalised to Australian average. Sustainability 'ideal' towards the centre —see Section 2.3.

indigenous population, environmental impact is similar to other regions, and social indicators are close to parity. Economic indicators are considerably stronger, with incomes being high for non-indigenous, but cost of living increases to over 1.5 times the national average for both populations. The high incomes for non-indigenous people are strongly influenced by the presence of export-oriented resource industries in these remote areas, particularly large mines.

Condensing indigenous results into one figure (Fig. 4) shows a trend towards lower environmental impacts across all four environmental indicators as we move from urban to remote populations. The inverse occurs for social indicators, excluding alcohol consumption, where employment and qualification trends worse in remote areas. Economic indicators are mixed, with lower incomes in remote areas, but higher costs of living. Generated income is fairly consistent. The impacts across both indigenous and non-indigenous populations (combined) re-affirm the same conclusions, as shown in Fig. 5.

4. Discussion

To summarise these results, we would like to concentrate on a few findings. Firstly, that the environmental impact of urban populations is generally higher than that of remote populations. This is partly due to the persistence of the traditional economy and the reduced reliance on off-site sources of energy, nutrients and water (Altman et al., 2006), but also due to the lower levels of material consumption in more remote areas. This has sustainability implications for recent policy settings that concentrate on expanding the urban population of Darwin and concentrating investment outside of Darwin in regional centres and away from remote settlements. Secondly, as noted by Altmann et al. (2008) and the SCRGSP (2009), there is a significant disparity in social outcomes, principally indigenous employment, in remote areas. Indeed the employment statistics are biased by the inclusion of statistics on mandatory employment in exchange for social welfare (the Community Development Employment Projects (CDEP) scheme in Australia) within the employment statistics, and are strongly correlated with the lower levels of education (Gray and Hunter, 2002). Thirdly, own incomes are much lower in remote indigenous populations, reflecting the employment indicator. In contrast, the generated income is high across all regions. In the indigenous population, this is principally due to the provision of government services to the region. Ideally, we would see a lessening of this government service linked to an increase in the own incomes of the population. As it is the incomes and services enjoyed by many non-indigenous people, both within and outside the Northern Territory, benefit from the provision of welfare to indigenous people while indigenous social indicators remain persistently low. This is likely to continue, certainly while a federal funding model rewards jurisdictions with high levels of indigenous disadvantage but does not tie the grants towards overcoming that disadvantage (Morris, 2002).

One possible means by which remote disadvantage can be reduced is investment in indigenous natural resource management (Luckert et al., 2007). This investment has the potential to increase income and decrease the need for government services by improving health, increasing social function and raising the proportion of food and other materials obtained from the land (Garnett and Sithole, 2007; Garnett

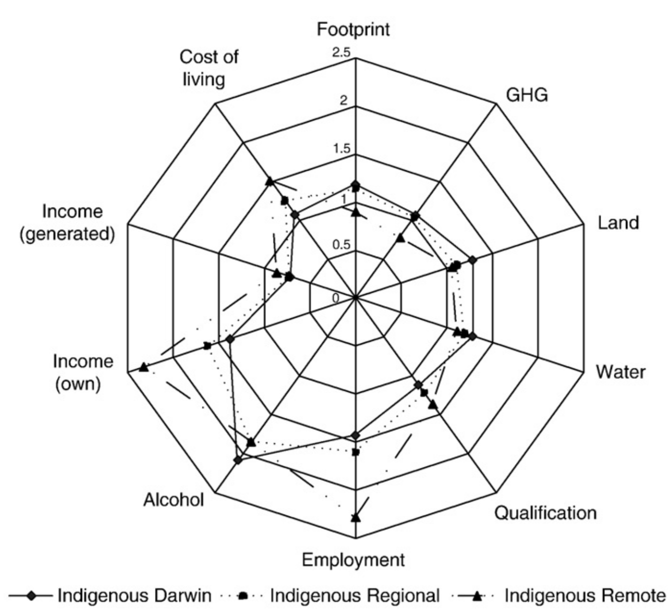

Fig. 4. Sustainability indicators across three regional classes, indigenous population, normalised to Australian average. Sustainability 'ideal' towards the centre —see Section 2.3.

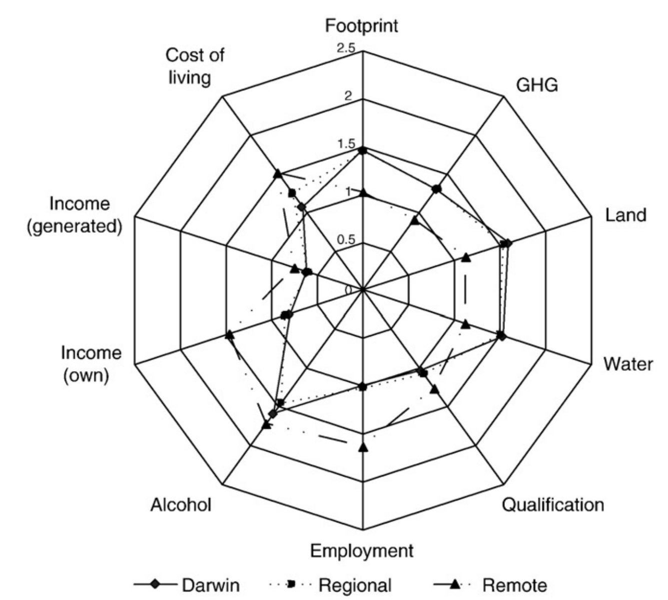

Fig. 5. Sustainability indicators across three regional classes, indigenous and non-indigenous population combined, normalised to Australian average. Sustainability 'ideal' towards the centre —see Section 2.3.

et al., 2009). There is also the opportunity for active management of the land to offset greenhouse gas production elsewhere. While it is not yet possible to account for this reinvestment in ecological services using this type of analysis, the payments for active management of fire by indigenous people to reduce greenhouse gas production currently being rolled out across remote Northern Australia could be interpreted as a credit against the debit of their consumption.

There have been substantial policy changes since the data on which these indices are based was collected. Potentially on the positive side has been the banning of alcohol consumption in many remote communities. Potentially on the negative side has been the introduction of policies that encourage indigenous people to move away from remote homelands into regional centres. This trend is likely to lead to a decline in several of the environmental indicators for indigenous people. Whatever the trends, the current study provides a baseline against which the impacts of these policy changes can be tested.

Finally it must be emphasised, that this study, as with all sustainability metrics, is restricted by quantitative foci. We have sought to provide an assessment within a measurable framework, but recognise that these are only partial surrogates for non-measurable aspects of the livelihoods of the population, many of which are likely to be more fundamental measures of societal well-being. We have also not included dynamic effects of both population movement and economic change. While a study that includes these dynamic effects may provide the best solution, data availability is highly limited, and we have thus sought instead to give a detailed benchmark of the current situation.

5. Conclusions

This paper has sought to provide a picture of sustainability of the Northern Territory by analysing a number of sustainability indicators across indigenous status and remoteness class. A significant discord is evident across many indicators between the indigenous and non-indigenous populations. Urban populations are generally doing better against most quantitative economic and social indicators, whereas environmental indicators show the opposite. These results reflect the decreasing reliance on traditional lifestyles in the region and the increasing access to markets, with the associated market-based environmental impacts of urban populations. As we seek to value these environmental impacts appropriately, it would be beneficial to start incorporating these results into policy and planning. While ongoing urbanisation appears inevitable (Taylor and Carson, 2009), policies that improve social and environmental trends in remote areas may have broader long-term societal benefits. These are currently unmeasured and, as the Northern Territory develops sustainability policy, the time is appropriate for suitable indicators to be incorporated into monitoring regimes to help guide remote area policy.

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