A BIGGER AUSTRALIA TEETERS ON THE EDGE: COMPARING THE 2010 'PHYSICAL IMPLICATIONS' AND 2002 'FUTURE DILEMMAS' STUDIES OF POPULATION GROWTH OPTIONS

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Public policy views on long-term population growth options have been augmented by the 2010 'Physical Implications of Population Growth' report. This reveals that a bigger Australia faces protracted water deficits in three main cities, has high vulnerability to oil depletion, will accelerate its greenhouse gas emissions and has generally poor city structure and function. City structure produces low fluency in transport operations and generates increased congestion and poorer quality of life. Since most migrants settle in discrete areas of Sydney, Melbourne and Perth, increased migration levels directly influence local environmental issues of land clearance, biodiversity loss and water pollution. By 2050, a bigger Australia could quadruple economic churn measures such as GDP compared to a doubling for a smaller Australia. However both a bigger and smaller Australia can expect a doubling of GDP per capita by 2050. Taken individually, the physical constraints have logical and practical solutions. However on the basis of past experience, Australia lacks the institutional and engineering fluency to design and implement a bigger Australia across these interacting issues and challenges in an environmentally neutral way.

INTRODUCTION

Globally, there is little doubt that humankind is placing increasing pressures on core biophysical functions of the earth through the continued expansion of human population, and the goods and services required to supply its needs and wants. Climate change is currently the most headlined component of this, but global institutions such as the United Nations attempt to manage many international agreements dealing with biodiversity loss, ozone holes, trans-boundary pollution of acid rain and water allocation from multi-country river catchments.

Globally scaled science is rapidly developing the capability to both integrate and analyse the global implications of the whole, composed logically of the sum of many parts. This has led to the concept of a 'safe operating space' for humanity defined by eleven 'planetary boundaries'.[1] Each boundary defines an earth function where humanity's total pressure has moved well beyond local and regional impacts, and thus threatens the globe's capacity to maintain its biophysical integrity. Two areas, biodiversity loss and the nitrogen cycle, are already well beyond the globe's safe operating space while climate change is rapidly approaching its boundary.

Regarding planetary boundaries, Australia has a tendency towards policy exceptionalism where, because of its continental size and distance from the main centres of population and commerce, it somehow sits outside the rules that govern others. Its continental size and mining resources increase its propensity to this exceptionalism. Yet in reality, Australia's status as the oldest, driest, most weathered continent determines that soils are poor in world league terms, biodiversity is prone to impact, and sluggish rivers are prone to collapse into open drains.

Australia's clash between policy exceptionalism and biophysical realities is rekindled every decade or so when human population explodes once again into the policy area, as it did in the 2010 federal election around the lightening rod of the idea of a bigger Australia. Domestic explorations of this clash go back beyond the Sydney University geographer Griffith Taylor who, at the 1920s level of technology, estimated the continent's reasonable level of population as 20 to 30 million rather than the 100 to 300 million of the Empire's nation-builders.

Population impact studies became more sophisticated in the late 1990s with the decision by the then Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Wildlife and Ecology (in Canberra) to invest the impact of population growth in integrated assessment modelling at a whole economy level. This allowed the assembly of most of the discrete bits of scientific knowledge (agriculture, forestry, fisheries, mining metallurgy, energy, demography and so on) into a coherent whole-of-economy framework governed by real physical laws of thermodynamics and mass balance. This paralleled the development in the 1960s and 1970s of analytical frameworks of the whole economy from an economic perspective, now an everyday tool for policy investigation within government, academic and business arenas.

This paper describes the content and fortunes of two science-based explorations of Australia's population options using as their core the nationally-scaled and long-term integrated assessment approaches described above. The 2010 report, *Research into the Long-Term Physical Implications of Net Overseas Migration: Australia in 2050* (hereafter the *Physical Implications* report) was commissioned by The Department of Immigration and Citizenship (DIAC) and undertaken by Flinders University and CSIRO.[2] The 2002 report, *Future Dilemmas: Options to 2050 for Australia's Population, Technology Resources and Environmen*t (hereafter *Future Dilemmas*) was commissioned by the then named Department of Immigration and Multicultural and Indigenous Affairs (DIMIA), and undertaken by CSIRO.[3]

TWO STUDIES OF POPULATION IMPACT

The 2010 *Physical Implications* study

The 2010 project added further layers of scientific precedent with interacting layers of macro-, meso- and micro-scaled (basically whole-economy, regional and behavioural) studies drawn from different and independent sources. The macro-scale once again used the CSIRO model, now substantially developed from its 2002 operation. It replicated the population, employment and economic outcomes from a DIAC-commissioned study on the *Demographic and Labour Supply Futures for Australia* by the ANU demographer Peter McDonald.[4] Thus the demographic, employment and economic outcomes were pre-defined by the McDonald study and were combined with biophysical structure, technological efficiencies and physical costs to determine the physical and environmental outcomes at a range of spatial scales out to 2050 and beyond.

The meso-scaled studies used demographic mapping to highlight the fact that specific locations within Sydney, Melbourne and Perth contain high proportions of inbound migrants and that, other things being equal, much higher rates of net overseas migration would see physical impacts of more people and the Australian lifestyle sheeted home to those and adjacent suburban areas. The actual resource and environmental impacts in those areas were drawn from a wide range of public utility, catchment management, environmental protection and similar bodies. These were independent of the CSIRO macro-modelling level of analysis although they shared the scientific method and similar databases. This is an important point as DIAC (see later) used an economic consultant to contest the macro-outcomes whereas the critical resource insecurities were tightly defined independently at the regional or meso-level.

Finally, the micro-level accessed a wide range of behavioural and economic studies on issues such as transport demand within cities, many of which highlighted the fact that city function was already problematic in many areas. In the absence of substantially increased investment, it is logical to

conclude that these fragilities could only worsen under rapid rates of population growth. A special colloquium was held in mid-October to critique the *Physical Implications* report[5] and the report was released without a press release just before Christmas on 23 December 2010. DIAC attached a front page to the report highlighting that the CSIRO modelling component had 'highly contested reliability', seemingly in an attempt to discredit the overall report and its findings.

The 2002 *Future Dilemmas* study

The *Future Dilemmas* study was partly funded by DIMIA. When work began on the project, the integrated assessment model of Australia's physical economy (ASFF: *The Australian Stocks and Flows Framework*) was completing its first stage of development. Since the physical economy concept was new in Australian science and policy circles, the report preparation was preceded by 18 linked expert workshops where the modelling framework was assessed for correct structure, justified assumptions and analytical integrity. Three population growth scenarios of 20, 25 and 32 million people at 2050, driven by different rates of net overseas migration, gave the policy assessment structure.

The final release of the report was preceded by institutional difficulties between the client DIMIA and the consultant CSIRO related to policy problems tied to direct and indirect impacts of population growth. The final report of eight chapters highlighted six future dilemmas of population ageing, physical trade, material flows, greenhouse emissions, resource depletion, and environmental quality. The report included a mostly positive assessment of methods and outcomes by a Ministerially-appointed external reference group. The report synopsis,[6] the dynamics of its policy release[7] and an environmental critique[8] were all published in *People and Place*.

KEY RESULTS

The 2010 *Physical Implications* study showed heightened vulnerability of Sydney, Melbourne and Perth to structural water deficits under most population scenarios other than those driven by net overseas migration rates of 50,000 or lower. Re-use, desalination and inter-basin transfer can reduce vulnerability but come with increased physical costs and system complexity, especially at high population growth rates. Suburban land use expands under all population scenarios due to the increasing affluence resulting from the assumed rate of economic growth and the demographic trends of larger house sizes and lower occupancy per house. This expansion exacerbates current problems with local water pollution and imposes additional pressures on Australia's already depleted biodiversity.

Oil supply and timeliness presented further intractable challenges across all population scenarios firstly due to declining domestic oil stocks, secondly due to increasing costs of imports and thirdly due to the problem of being able to assure future supplies in the international marketplace. Australian cities with the exception of Perth must rely mainly on road-based passenger and freight, and thus on oil. Solutions to oil dependency abound, but would take at least one human generation to implement at the scale required for today's population levels, let alone a population that is 60 per cent greater in number.

Greenhouse emissions will double or even triple compared to today's levels. Here it is noteworthy that Australia's physical structure and enviable lifestyle put it in the top five greenhouse emitters per capita in the world. Again, solutions abound but nowhere are they being implemented at the speed and scale required to first stabilise and then rapidly reduce emissions over perhaps two human generations to 2050. Greenhouse was the fourth dilemma of

the 2002 *Future Dilemmas* study. Ten years have passed since the population-greenhouse graph first emerged in federal policy circles and the 2010 *Physical Implications* report reveals that the situation has worsened. The conventional wisdom of public policy asserts that price solutions for carbon are paramount, but to date they remain politically elusive.

The *Physical Implications* and *Future Dilemmas* reports mostly agree on the major issues. However, the analysis in the former has an enhanced discrimination of the lifestyles and location of migrants, thus allowing a specific focus on the key policy decision: the level of net overseas migration. A major omission in the earlier report was that of the capacity to supply water to everyone under all population scenarios. The recent report uses water inflow assumptions reflecting the drying trend of the last two decades whereas the earlier report assumed that historical inflows would be maintained, storages would even out variability, and that inter-basin transfers could mitigate very high population numbers for Sydney and Melbourne until at least 2100. *Future Dilemmas* was more pessimistic on air emissions in city airsheds and did not highlight the issue of city food security due to land and water loss. The drivers of urban land expansion on potential biodiversity loss are clearer in the *Physical Implications* study, helped by recent and spatially focused studies assessed at the meso-scale level.

NEW INSIGHTS AND WICKED FEEDBACKS

The macro-scale physical model in the 2010 report is driven by the assumptions concerning demography, employment and economic growth taken from McDonald's study.[9] These provide insights into potential Achilles heels behind many population growth scenarios. Note that these potential weaknesses are not proven results in the traditional sense, but emerge more from a process of joining of the dots between competing disciplines.

The most important of these weaknesses is restraining unemployment rates with high population levels once house building and a mining boom decline as the core of economic activity. During the foundation stage of the macro-level modelling, a 1.5 per cent per annum productivity growth for workers in all economic sectors requires large increases in consumption to keep unemployment within the target range of 3.8 per cent. Leaving aside that national statistics agencies use clever categorisation to hide gross unemployment levels, the conventional wisdom approach of increasing per capita consumption to generate employment provides impossible targets for technological progress within the realities of the concept of planetary boundaries. Thus doubling consumption causes knock-on effects for the many environmental issues examined in the study. Tendencies to higher unemployment levels are reined in by bigger houses, more food and trinkets, and more energy use for those bigger more opulent houses and thus higher greenhouse emissions. The bigger houses, mostly in cities, require more land and hard surfaces that pressure remnant biodiversity resources and local water quality.

For most policy analysts, the PPP drivers of economic growth (population, participation, productivity) which together ensure rapid aggregate economic growth are enough to justify high population growth. In gross terms, a net overseas migration of zero will double GDP by 2050 while a level of 260,000 per annum will quadruple it by then.[10] By 2050 the per capita GDP levels will double for the lowest level of population growth and be 2.3 times current levels for the highest and there is little separation in per capita levels until after 2040. By mid century the 22 mil-

lion Australians resulting from the study's lowest population scenario will have to wait a further six years to gain the same per capita GDP compared to the 38 million under the high growth scenario. GDP here is reflected as economic churn rather than real wealth and ignores the probability that defensive expenditures will increase if transport fluency, water supply and pollution issues are not neutralised for each new person.

While desalination is a fluent fix for potable water in current coastal cities, urban water deficits under high population growth scenarios and expected climate change of 13,000 GL or more would require nearly 100 plants equal in size to Melbourne's Wonthaggi plant, currently under construction. At an electricity cost of three kilowatt hours per kilolitre, desalination alone of this water deficit requires 15 per cent of national electricity production, presumably generated by low carbon technologies if greenhouse mitigation strategies are then underway. Item by item, none of these response strategies are insoluble but accumulated over all physical sectors, they suggest enormous hurdles to national engineering capacity given current records of delays and cost over-runs on many major projects.

CITIES: DISASTERS ARE FEW BUT CONSTRAINTS ABOUND

Sydney

In reporting the *Grow Suburbs Not Vegies* news headline, *Physical Implications* highlighted what all population and physical-economy analysts know: there is nothing that can't be changed in the pursuit of progress, or as the songstress Joni Mitchell might sing: 'You don't know what you've got till its gone'. Sydney's world-city attractiveness and its constrained geography interact to see it always in catch-up mode (Table 1).

The loss of food production from the Sydney Basin repeats a story of cities worldwide since humans began aggregating into larger units. The food security of many global cities is now a serious policy issue should the extended supply chains and the aviation fuel and diesel that underpin them become broken. However, personal quality of life issues around increasing congestion, urban amenity, polluted waterways and declining biodiversity assets seem to loom large now and will worsen with rapid population growth. The transport expert responsible for Perth's integrated transport network defines the resilient city as one that is reducing its ecological footprint while increasing its citizen's quality of life.[11] Sydney's resilience is declining on both counts. Its ecological footprint of seven to eight hectares per capita is more than three times the limit set by the planetary boundary concept.

Melbourne

Melbourne's geography and history confer some advantages compared to its arch rival Sydney but water supply becomes a critical issue for high population growth rates around 2030 if drying trends see a 20 per cent reduction in rainfall and a 50 per cent reduction in surface runoff (Table 2). Even in the 2010–11 La-Nina high rainfall event, Melbourne's biggest storage the Thompson Dam was only 37 per cent full and its overall system 54 per cent full.[12] Investing in the Sugarloaf pipeline to access storage from Eildon Dam and the Wonthaggi desalination plant are decisive measures to increase supply resilience.

Melbourne's proximity to the nation's foodbowl located in nearby regional Victoria confers a reasonable assurance of immediate food security for day-to-day supplies of fresh milk and vegetables, but recent drought years severely affected fresh commodities and so most cities will rely on other cities' hinterlands hoping that

that rains are good somewhere in Australia and that delivery systems remain timely and fluent. Melbourne faces most of Sydney's problems but at less severe levels. Its biodiversity assets will be whittled away by urban development and political compromise, most of its urban watershed has polluted streams with poor biological health, and its transport system is over-reached and collapses during heatwaves. There is nothing unfixable in Melbourne's future but system-wide competencies are fragile as evidenced by the time and cost over-runs on an expensive ticketing system for public transit, and the lack of strategic intent in replacing high carbon content electricity generators.

Table 1: Broad scale issues of Sydney's function affected by direct and indirect drivers of population growth and lifestyle improvement

City issue	Analytical insight	Report reference
Land and food	Urban development pressures will see the Sydney Basin's food security decline with loss of jobs and economic product. Adjacent regions and imports could make up the shortfall.	p. 124
Water supply	Sufficient water for drinking and bathing but little else. An increasing threat from water salinity in western Sydney, an important node for future development	pp. 153–156
Water quality	44 per cent of catchment areas are impervious (high runoff) giving severe pollution problems that limit reuse. More than 70 per cent of streams in Parramatta region (area of future population increase) are already severely polluted and only 5 per cent in good condition	pp. 177–178
Biodiversity	Sydney Basin is one of Australia's most biodiverse regions. Due to habitat fragmentation, pollution and water extraction the status of 'endangered' or 'threatened' is applied to at least 245 species, ten populations and 32 ecological communities	p. 205
Waste assimilation	Sydney possibly runs out of landfill space by 2016 requiring an increase in the current 250,000 tonnes of waste exported to Goulburn each year.	p. 197
Air quality	Some local hotspots but generally lower air pollution than in other world-size cities	p. 216
Traffic congestion	Passenger and freight congestion a major issue requiring $130 billion over 30 years to revamp an aged and inefficient system	p. 230
Overall prognosis	The financial capital required to restructure key urban functions to a world-city standard seem well beyond the city's capability and the experience of the last 20 years. Future water supply constraints are looming, water pollution is widespread and will limit obvious opportunities for reuse. Urban development threatens the remaining biodiversity values. Expansion is physically feasible but many quality-of-life values may decline.	Author's synthesis

Perth

Perth's main problem is water supply now and even more so with the extra 1.6 million people promised by a bigger Australia (Table 3). By late 2011 30 per cent of Perth's water requirements or 100 gigalitres will be from the climate independent sources of two desalination plants.[13] Conceptually, desalination projects could roll out regularly and maintain the supply ahead of population growth, particularly if each plant is fully powered by windpower or other renewable electricity sources. The current drought in the Perth region sees storage capacity currently at 29 per cent and easily available water at 11 per cent of capacity. For Perth it appears that the future is now.

Perth has invested strategically in an integrated transport system that could require

Table 2: Broad scale issues of Melbourne's function affected by direct and indirect drivers of population growth and lifestyle improvement

City issue	Analytical insight	Report reference
Land and food	Local and community food security will decline with current horticultural water allocated to increasing household use. Adjacent regions and imports could make up the shortfall.	p. 134
Water supply	Supply will increasingly depend on reuse and desalination and be impacted by drought and bushfires. Water inflows have stepped down 35 per cent in the last decade, and water storage was 54 per cent on Australia Day 2011 during a wet La-Nina year.	pp. 157–160
Water quality	Only one of Melbourne's seven catchments has 50 per cent of total stream length in good condition. The remaining six catchments have less than 10 per cent in good condition.	p. 189
Biodiversity	Preservation of green wedge zones is being whittled away by political and development pressures. There are 296 threatened flora and 128 threatened fauna in the Melbourne area.	p. 206
Waste assimilation	Good landfill capacity for the next 50 years	p. 197
Air quality	Some local hotspots but generally lower air pollution than in other world-size cities	p. 217
Traffic congestion	Structure of transport flows is basically good but congestion is growing and requires dispersion to a multi-nodal city. Commuter transport is subject to delays and breakdown during heatwaves. Some population growth centres are poorly connected to the CBD and will become socially isolated.	pp. 235–237
Overall prognosis	A gentler topography confers advantages compared to Sydney, but Melbourne's function requires a systematic overhaul to meet modern city standards. Population growth exacerbates this issue. Water supply is the key issue and becomes critical if the drying trend continues. Water quality and biodiversity status are poor and will be buffeted by increasing development pressures.	Author's synthesis

just new rolling stock for major capacity increases rather than the expensive augmentation works required for Sydney and Melbourne. Similar to other stress zones in a bigger Australia, Perth's expansion will impact on the remaining biodiversity and wetland assets. The additional knock-on effects of water pollution are helped by the sandy soils of the region which easily transmit nutrients from septic systems and farming to produce eutrophication and algal blooms in the waterways that represent an important quality of life asset for Perth's citizens. An optimistic view might be Perth has already made giant steps in its population adaptation strategies but the realities are that so far these efforts have been catch-up on the necessities, rather than preparation for Perth's doubling in size.

OPTIMISTIC ASSUMPTIONS AND UNTRIED OPTIONS

The *Physical Implications* study takes as its key research question question number four (briefly: what actions are required to mitigate impacts) but did not analyse numerically the economy-wide or region-specific actions required to neutralise

Table 3: Broad scale issues of Perth's function affected by direct and indirect drivers of population growth and lifestyle improvement

City issue	Analytical insight	Report reference
Land and food	Local food production immediately around Perth will face constraints due to a drying climate, soil pollution and urban development. However the south-west region and imports can maintain food security.	pp. 138–140
Water supply	Supply gap by 2050 possibly equal to this year's total supply. An increased reliance on groundwater and desalination as catchment inflows stepped down 50 per cent in the 1990s and a further 25 per cent in the 2000s.	pp. 170–172
Water quality	High current and future incidence of eutrophication events due to nutrient leaching and transport from septic systems and general landuse practices	p. 194
Biodiversity	Perth is located in one of the globe's 34 biodiversity hotspots. Native vegetation clearance for urban development has increased ten fold. 80 per cent of the region's wetlands have been lost.	p. 213
Waste assimilation	Landfill and recycling are adequate but over 40 per cent of recycling waste is exported interstate and overseas due to lack of industry scale.	pp. 199–201
Air quality	Some local hotspots but generally lower air pollution than in other world-size cities.	p. 221
Traffic congestion	Perth's integrated transport system is Australia's best, but road congestion is growing.	pp. 248–250
Overall prognosis	Urban development pressures on water supply and quality will force increasing reliance on desalination. Rapid development threatens biodiversity values in the Perth region, an important issue due to the region's global hotspot status. Two decades of investment have provided an enviable integrated transport system.	Author's synthesis

the many impacts of population impact. However the authors did review relevant research and policy documents that charted feasible options for impact reduction on an issue-by-issue basis but without statewide or nation-wide integration. *Future Dilemmas* explored many sub-scenarios whereby reasonably practical technological improvements or system changes could mitigate key impacts. Almost universally these failed with high population growth rates because physical efficiencies plateau or saturate. In general, only a stabilising or declining population reduced overall impact, although it is always possible to displace impact to adjacent regions or to outsource part of it to other countries. With the possible exception of household water use, the revolutionary advances required to mitigate population impacts over the full range of population growth rates have been universally lacking over the past decade.

Much essential physical information needed to measure progress and then modify performance targets is not collected or disseminated by government management and statistical agencies. While black balloon greenhouse reduction advertisements fill our television screens, timely and regionalised information on fuel consumption by the motor car fleet or electricity use by households are almost non existent. Our modelling tells us that the average household uses 7,500 kilowatt hours of electricity per year[14] and our case studies confirm that halving this usage is feasible without much loss in convenience or comfort. Australia's motor car fleet still uses eleven litres per 100 kilometres and emits over 200 grams of carbon dioxide per kilometre travelled, while European benchmarks are approaching half of these values. Policy is almost universally silent on the impact trajectories of these critical drivers, as there are not many success stories worth spinning at a suburban scale.

These fully tested and reconciled data abound within our physical economy models and prove beyond doubt that national policy or business leaders do not seek to improve environmental performance because they do not seek to measure its key physical indicators. Due to the long life of all infrastructure, this dictates that each new Australian acquiring a six star house or urban people mover will enhance the poor environmental performance set in place by the past two generations.

DEPARTMENTAL INCONGRUITIES

In its exploration of the effect of population growth, specifically the immigration component that is under its management, the Department of Immigration and Citizenship (DIAC) for *Physical Implications* or DIMIA for *Future Dilemmas* shows a reluctance for oversight of its public policy making. A bigger Australia became an important policy issue in 2010 particularly in the federal election while research for the 2010 report was underway. Why then would a public policy department release it on 23 December, two day before Christmas, without any covering press release? Furthermore why would they attach a front page noting that one layer of the work was 'highly contested by experts' when it is the meso-scale synthesis of many independent reports that sinks the concept of a bigger Australia. This is due to the direct effect of settlement patterns on important environmental impact and quality of life issues. The 2002 *Future Dilemmas* report faced the same type of corridor assassination by Departmental officials even after a protracted evaluation and wide reaching review process that gained grudging approval for the report at every step of the way.

More telling of the Department's priorities is the nature of the expert's review[15] conducted by George Verikios[16] from the Centre of Policy Studies at Monash University, which hosts the MONASH

macro-economic model frequently used for national policy studies. He appears to believe that a physical-economy model was used in the macro-level of the study, and that from a macro- and micro-economist viewpoint, public policy should only use macro-economic models, and thus any physical-economy approach was wrong. A rhetorical defence would be that macro-economic models Verikios has in mind are not calibrated on 50-year historic periods, do not employ sophisticated vintaging algorithms, do not obey the laws of thermodynamics and mass balance, and thus do not pass the basic tests of physical reality. The essential point here is that all modelling frameworks integrate complex sets of interacting variables and the ASFF model used here had a robust grounding in many disciplines of science and was focused on the *Physical Implications* task of the project brief, not the macro-economic implications of continued population growth. Furthermore the critical important economic, employment and demographic assumptions were fed in from the preceding McDonald study[17] that had been released to general policy acclaim.

More worrying, though, was the Departmental reviewer's outpouring of neo-liberal platitudes more suited to the blogosphere, than a scholarly review of a public policy document. Three issues stand out. The first is the likening of ASFF to 'an Australian latter-day derivative of the Club of Rome (COR) models'. Peer reviewed science papers,[18] now show that key elements of the COR scenarios were substantially correct and that the 1970s study was subject to well-orchestrated misinformation campaigns, principally by the economics profession. The second cause for concern is the reviewer's assumption that a resource cornucopia exists if only we get the prices right, and that a 'higher oil price will induce increased exploration activity and that will increase known oil reserves'. While that sentence may be substantially correct within the narrow quotes, the reviewer's stance will be a great relief to the International Energy Agency which has finally discovered that physical depletion and extraction limits are leading to stagnating supplies of traditional oil in spite of high oil prices.[19] Most worrying for the professional standing of Australia's economics discipline is the reviewer's description of the *Physical Implications* methodological approach to integrated policy analysis as similar to 'that [which] faces planners in centrally-planned economies e.g. the former Soviet Union'.

THE NEED FOR POLICY COHERENCE?

At the start, the planetary boundary concept proposed a brace of absolute physical limits within which the globe, a nation and a region and a city should develop, and embrace its future opportunities. By any account Australia and the three cities in focus in the *Physical Implications* report, are currently operating well outside their boundaries. Water extraction, biodiversity loss and greenhouse emissions are three of the eleven planetary boundaries. Moreover they will accelerate further past their planetary boundaries if the bigger Australia analysed in the 2010 *Physical Implications* report happens with the lack of forethought and attitudes typical of Australian public policy and private capital over the last two to three decades.

It is not that Australians cannot envisage the low-impact development and lifestyle required to live within our environmental means, it's just that they choose not to. There is always an immediate crisis, a flood, a fire, a drought, a cyclone that steers public policy away from the fundamental reforms that refurbish our rivers, remake our soil, augment our biodiversity and set us on the low carbon transition path.

Dealing with population growth and economic growth issues as they tug and push at critical planetary boundaries will require designs so that each extra Australian lives within a safe operating space. Cascades of unintended consequences that require patch-up and catch-up work should not occur. Both the *Physical Implications* and *Future Dilemmas* studies have extracted robust lessons from Australia's future to 2050 and beyond. In both cases the Immigration Department has sought to demean the science behind the findings and to limit public access to the implications of current policies for subsequent generations. It is true that a bigger Australia could provide the rationale and finance to design and implement an urban form better than anything done to date. Unfortunately recent history suggests that public policy making and implementation is concerned mostly with bigger rather than better.

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