

INTRODUCTION: The essential meaning of sustainability in the context of urban systems

- Historical context
- Developing urban & network system requirements
- Optioneering & engaging community
- Principles of sustainability assessment



#### Definition

- "Sustainability" is the ability to sustain, which means continue or uphold (Macquarie University NSW, 1982).
- Sustainability, can become one of those words which is widely used: we know it to be a worthy societal goal, but no one is too sure of its precise meaning.

#### Historical context

- Late 1960's, impact of urbanisation and development on the environment
   >community concern
- Declaration of the Report of the UN Conference on the Human Environment, Stockholm, 1972
- principles espoused for a sustainable civilisation

By the late 1960's, humanity had begun to realise the impact that urbanisation and development in the post World War Two economic boom was beginning to have on the environment. Increasing community concern leading to the elevation through national levels of government and international discussion and resolutions.

To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development

### Principle 1:

- Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being,
- bears responsibility to protect and improve the environment for present and future generations.

Principle 1: Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations. (p. 1)

## Principle 2:

 The natural resources of the earth must be safeguarded for the benefit of present and future generations through careful planning or management

Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate. (p. 1)

## Principle 15:

- Planning must be applied to human settlements and urbanisation with a view to avoiding adverse effects on the environment
- and obtaining maximum social, economic and environmental benefits for all

Principle 15: Planning must be applied to human settlements and urbanisation with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all. (p. 1)

#### More Definition

- a new type of development paradigm was required
- the concept of sustainable development

(World Commission on Environment and Development, 1987).

Report "Our Common Future" in 1987 which made it clear that the world's current pattern of economic growth was not sustainable on ecological grounds and that a new type of development paradigm was required to meet the foreseeable human needs

development was often a pattern of rapid depletion of available resources, rapid use of the ecological capacity and an increasing gap in share of the development benefits between the developed and undeveloped world.

The Report introduced the concept of sustainable development, defining it as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'

#### More Definition

 economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development
 (World Summit on Social Development, 1995 & World Summit on Sustainable Development, 2002).

By 1995, at the World Summit on Social Development, in Copenhagen the interrelationship between the economic, social and environmental components of sustainable development were being thoughtfully discussed, coming to this conclusion.

Three interdependent and mutually reinforcing components: economic development, equitable social development and environmental protection (stewardship) became known as the so-called "three E's" of environment, economy and equity. These became the interdependent and mutually reinforcing **pillars** of sustainable development at the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg (United Nations, 2002), where Agenda 21 was reaffirmed by member countries.

also known as triple bottom line

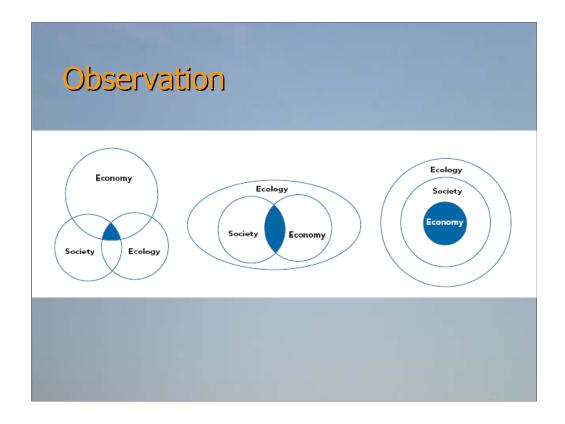
The United Nations World Summit for Social Development held at Copenhagen in 1995 identified that the physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation

#### **Action**

- UN provide broad principles and supporting role
- National governments prime responsibility for leading

The United Nations General Assembly, and United Nations agencies to facilitate sustainable development saw that they needed to provide supportive roles but the effectiveness depends on the actions of national governments, who have the prime responsibilities and were encouraged to lead and set up institutional arrangements that facilitated sustainable development in their own countries.

A particular role and function for the United Nations Commission on Sustainable Development is to provide a forum for consideration of issues related to integration of the three dimensions of sustainable development.



The interrelationships between the three pillars of environment, economy and equity in society stimulated various debates in Australia about the relative importance for these pillars and which was the more important pillar .

These figures represent some of the variations in thinking on the equivalence of each of the pillars. For example whether some pillars are more important then others or whether while each pillar is of equal importance, the ecological pillar has absolute constraints providing the framework in which the other pillars need to fit.

The appropriate equivalence may vary with the community and the values that the community holds.

Often the natural and social systems are assumed to be in equilibrium.

However, in practice accumulated changes can result in a vulnerable system where additional change can shift the system into instability.

Resilience in a system instead can provide the system with capability to recover from shocks rather than be brought to a point of vulnerability. Researchers such as Walker and Salt (2006) are endeavouring to understand the existing resilience in natural and social systems.

Understanding these characteristics could define some limits on balancing the three pillars of sustainability.

#### Summary

Environment degrading>>Community concern >>national>>>international>>>economic & social equity of response? >> UN define sustainable development>>>3 mutual pillars environment, economy, social equity>>>National governments prime responsibility for leading >>>> integrated approach to the assessment of the three pillars?

Community concern throughout the developed world over the past thirty five years has lead to the elevation of environmental degradation and social equity concerns to national and international levels. The concept of sustainability has gained popularity through the course of these events and come to be defined in terms of sustainable development, with clear goals of environmental stewardship, social equity and economic efficiency. Action needs to be led at the national level for each country.

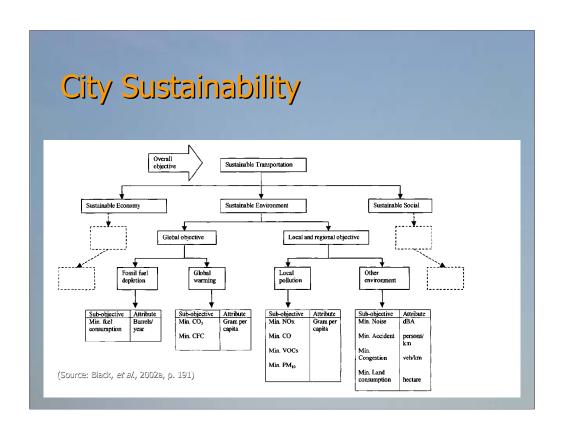
A need for a holistic, integrated approach to the assessment of the three pillars of sustainability (environmental stewardship, social equity and economic efficiency) is recognised as a challenge that continues today.

#### City Sustainability

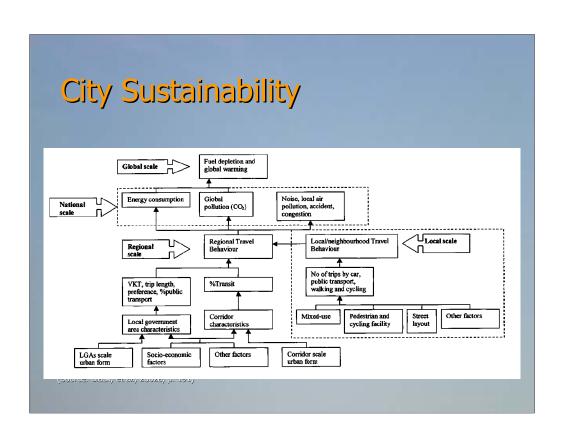
- 2008, > half human population, 3.3 billion people, are living in urban areas
- By 2030, UN forecasts are for the towns and cities of the developing world to make up 81 per cent of urban humanity
- urban form, transport and the interactions with communities

Various United Nations reports emphasise that the world's economic system is increasingly an urban one, providing the backbone for national development. The 1992 United Nation's Agenda 21 identifies that rapidly growing cities, unless well-managed, face major environmental problems.

The centrality of urban form, transport and the interactions with communities, to the question of sustainability in cities, is demonstrated in the responses from governments, non government organisations and the academic researchers over the past 15 years. Governments have initiated various programmes to provide frameworks, requirements, implementation support and methods of monitoring progress towards sustainability. Understanding of interaction between urban form, transport and community has been shown to be essential for meaningful interpretation of performance of the three pillars of sustainability.



Transportation an integral part of the urban structure. A view on objectives that lead to sustainable transportation

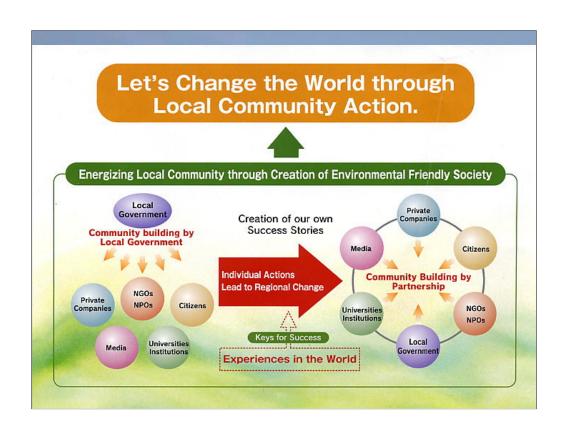


## City Sustainability

- Cities must look urgently to the future. The projected expansion of the urban population in Asia and Africa, from 1.7 to 3.4 billion over a period of only 30 years, and the reduced level of available resources, stress the need for a more imaginative but pragmatic response.
- In turn, this will demand a realistic vision for the future, better information at the local and regional level, as well as participatory approaches and negotiated agreements that build on the knowledge and experience of the poor.

(UN 2007 report on the state of the world's population)

The importance of participation between government, non government organisations and local community is seen in the following extract from the United Nations 2007 report on the state of the world's population (http://www.unfpa.org/swp/2007/english /chapter\_6/ preparing.html, Jan 2008):



## STAKEHOLDER CONSULTATION Inquiry by design Agency views Workshop process Futures Forum Sapporo (Japan) strategic transport plan (1000 persons)

#### Visioning

An example of this is the "Accessible City" strategy (Sydney City Council, 1995). The approach differed from previous strategies by the Council in that it approached the whole transport question from the point of view of accessibility, not as only one of a number of objectives. The first steps were to visualise the city as it should be in terms of ease of access, both moving about within the city and in relation to getting to the city from neighbouring communities and regions. Sydney City Council used accessibility to first shape the city form scenario it perceived the community would like to see, that is to visualise it and only then looked at strategies and programmes to form the framework for the years ahead.

## City Sustainability Visions

- Canberra initiative
- "sustainable communities program"
- "to put into effect a planning policy framework for more sustainable living that draws on the inherent qualities of Canberra and builds a greater sense of place, spirituality and responsibility".

The aim of the Government's sustainable communities program is "to put into effect a planning policy framework for more sustainable living that draws on the inherent qualities of Canberra and builds a greater sense of place, spirituality and responsibility".



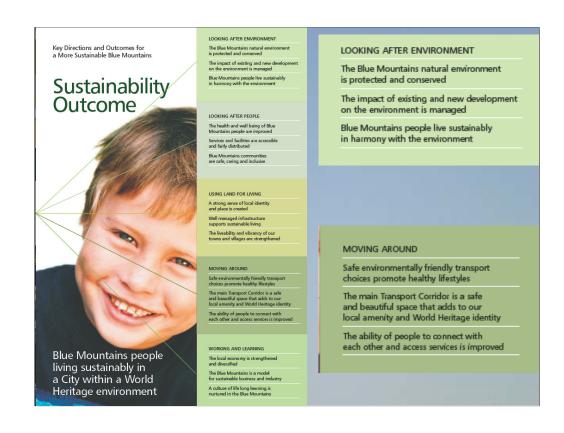
#### Canberra vision:

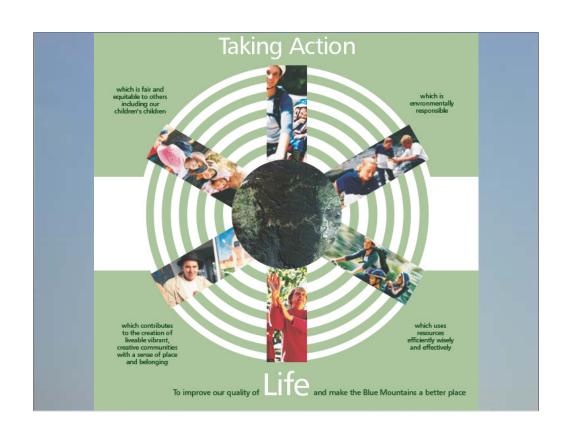
A series of objectives are derived from major drivers of change, as shown in this figure

Under each of the drivers of change are a set of objectives grouped under Built Form, Urban Ecology and Community

The Figure identifies these interrelationships between the various elements of Canberra's form and urban systems.

Allows for a diversity of land uses and encourages enterprise, innovation and increasing self-sufficiency within the local community;





### Context

#### Sustainability

- Community aspirations
- Visions by communities and city governments

Community aspirations: 40 years of generational experience of city growth, environment and livability stressing>>>> community by and large share the desire for sustainability>>> community and government together are developing visions of sustainability in their cities.

#### Context

#### Climate Change

- The clock is ticking for sustainability responses
- World Bank/UN Marseille symposium....An urgent agenda
- WCTR Nagoya symposium...transport on the agenda post COP15
- Post COP15.... A time for intensive cooperative effort

Climate Change: A new imperative for sustainability responses, the clock is ticking. Need to respond is setting an urgent timeframe for cities to act.

July 09 Marseille Symposium set an urgent agenda for cities to respond to climate change. Sustainability responses for mitigation and adaptation must accelerate to avoid major risks. The symposium set the challenge for practitioners and researchers to work together to empower cities and their governments with the funds, the tools and the mentoring to make the responses needed.

Nov 14 2009 Nagoya Symposium concluded that transport needs to be incorporated into the post Copenhagen Climate Change processes. Presently it is not on the agenda. It is a time to bring together the efforts of the transport community with the efforts of the those focused on wider city level responses. Backcasting seen as an imperative by ADB.

Discussions around Cop 15 are the beginning point for some important years of cooperative effort.





City De	ustainability Re	quirements	
Aim	Measure	Benchmark	
Enhance Liveability	Quality of Living Maintain or improve Sydney's index and ranking of quality of living, according to Mercer Human Resource Consulting global quality of living survey.	In 2005 Sydney ranked 8 out of 260 cities in the Quality of Living Survey with an index of 105.	
Strengthen Economic Competitiveness	Contribution to National Economy Maintain or increase the proportion and value of Sydney's contribution to Gross Domestic Product (GDP).	In 1998–99, Sydney produced 23% of Australia's value added wealth, totalling \$130 billion.	
Ensure Faimess	Access to Services Increase the percentage of the population living within 30 minutes by public transport of a city or major centre.	In 2005, 80% of Sydney residents can access a major centre, regional city or global Sydney within 30 minutes by public transport.	
Protect the Environment	Environmental Footprint No increase in Sydney's environmental footprint per capita.	During five years from 1994 to 1999, the environmental footprint of Sydney's residents increased by 16% to 7.4 hectares per person.	Source: City of Cities – A plan for Sydney's future: Metropolitan Strategy Supporting Information
Improve Governance	Metropolitan Strategy and Infrastructure Metropolitan Strategy directions and identified transport and infrastructure needs inform the annual State Infrastructure Strategy.	Budget Paper 4 responds to transport and infrastructure priorities as identified in the State Infrastructure Strategy.	

Sydney Metropolitan strategy gives an indication of the goals at a high level and some indication of measures and targets.

#### City Sustainability Requirements Table 1: Performance Measures of Sustainable Transportation Issues GHG emissions from all transport (CO<sub>2</sub>). Reduce air emission contributing to the Climate Change atmosphere from all forms of transport. Reduce the air quality impacts on human health. Index of emissions of air pollutants from roads transport (VOCs, NOx) Air quality levels or exceedance. Air Quality/Air Pollutions Air quality levels or exceedances. Number of vehicle registrations. Urban land use per capita. Urban land use by size class and zone. Land Use and Infrastructure Planning Land use mix (per cent walking to work; ratio of jobs to employed labor Reduce travel length and travel cost (both time and economic cost) by proper land planning and management Decrease consumption of other mineral Decrease consumption of other mineral force). Travait and modal split by wban zone. Length of paved roads and sustainable infrastructure. Transit seat-kilometres per capita. time and economic cost) by proper land planning and management Decrease consumption of other mineral and capital resources in transportation equipments and infrastructures. Minimise adverse impacts on natural Negative Environmental Impacts • Proximity of infrastructure to sensitive areas, and ecosystem fragmentation. Waste from road transport. Water Pollutions (wastes discharge into seawater and freshwater). Minimise adverse impacts on natural habitats and ecosystems Increase the use of alternative fuels. Reduce the use of fossil fuels. Sustainable use of non-renewable resources. February attachable apparate of ficiency. Index of energy intensity of cars and trucks. Index of emissions intensity of the road-vehicle fleet. % of alternative flue levelicles in the fleet. % of passenger-km and tonne-km fuelled from renewable energy. Innovative Technologies of Transportation Fuels Enhance automobile energy efficiency. Maximise road safety Social Aspects Maximise road safety Minimise car accidents. Reduces the no. of fatal and serious injured accidents from car crash. Index of casualties (killed or seriously injured, and slight) for all vehicle Road Safety Number of people killed or seriously injured in road traffic collisions. Number of children (aged under 16 years) killed or seriously injured in road traffic collisions. Number of crime incidents at transport interchange User rating. Transport diversity. Inclusive planning. Satisfy community demands for public transport. Encourage community to use public Accessibility to Public Transport • transport and reduce the usage of automobiles. Provision of diverse forms of public transport (including light rail)

Transport Canada likewise gives guidance on goals (objectives) but also links these to issues and to the three broad pillars of sustainability in environmental stewardship, social equity and economic efficiency.

# City Sustainability Requirements Economic efficiency Liveable streets and neighbourhoods Protection of the environment Equity and social inclusion Safety Contribution to economic growth

These are well recognised city wide goals for Sydney.

#### City Sustainability Requirements

- Moving from vision to options
- Goals for the city as a whole
- targets defined by the city's community itself
- Unpacking these goals to more specific lower level goals>>>>>

Moving from vision to options first requires

Defining the goals for the city as a whole

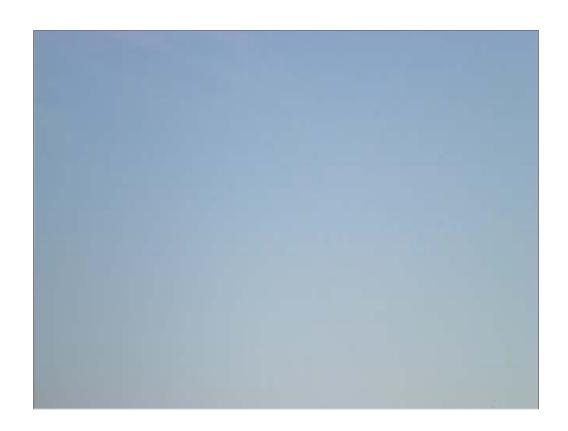
Setting targets for these goals needs to be largely defined for each city by that community itself (with the assistance of the planning profession) Exception where more global action is needed i.e. Greenhouse......also need to recognise absolute limits of environment...resilience perspectives.....where accumulated changes can result in a vulnerable system where additional change can shift the system into instability.

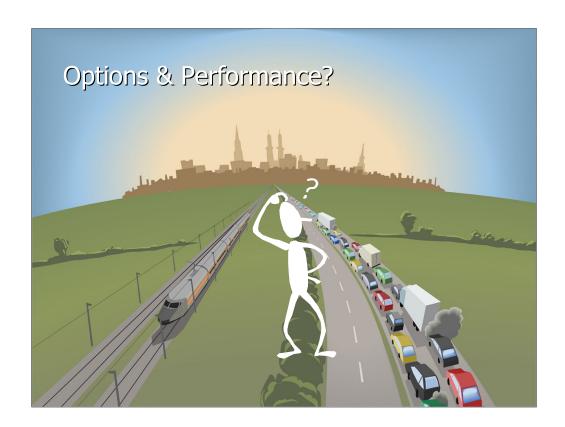
Unpacking these goals to more specific lower level goals>>>>>

#### City Sustainability Requirements

- Unpacking these goals to more specific lower level goals:
- relating to individual community sectors and their needs
- specific goals as requirements for parts of the urban system and sectors of the city,
- identify the functions it is expected to deliver, putting a boundary around the contribution.

Unpacking these goals to more specific lower level goals: relating to individual community sectors and their needs and identifying specific goals as requirements for parts of the urban system and sectors of the city, For the part of the system being planned identifying these requirements is easier if first identify the functions it is expected to deliver, putting a boundary around the contribution the system part is able to make towards the higher level goal.





Whilst community and government have been able to develop shared visions for the character of the cities into the future and suggest the goals and options, community participation beyond this has been limited.

When it comes to the question of which scenario should be selected, there is little scope for government and community to interactively shape the choice. This risks a disconnect between community and the planning agencies beyond this point.

Without quantifiable assessment methods, the connection between scenarios and sustainability outcomes are extremely subjective to the point where little benefit may come from public discussion.

### City Sustainability Optioneering

- Assess against requirements
- How to assess
- How to visualise

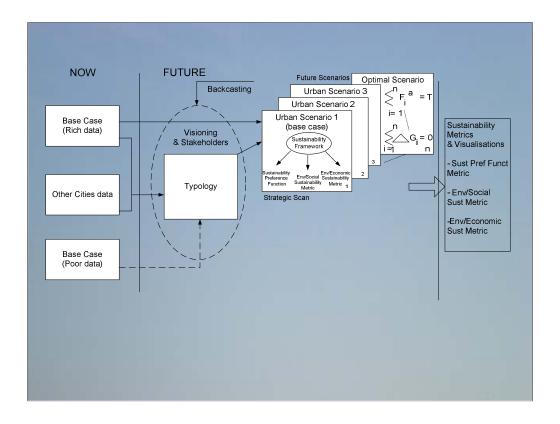
Use the sustainability requirements but assess the city wide sustainability performance change.

Use building block methods of transport planning to provide the analytical basis and traceability to the levers that drive sustainability.

#### City Sustainability Optioneering

- relating to individual community sectors and their needs
- specific goals as requirements for parts of the urban system and sectors of the city,
- identify the functions it is expected to deliver, putting a boundary around the contribution.
- Interactive community /government "what if and sustainability performance" process
- Use of simple visible assessment methods to display the system wide sustainability outcomes for each option

Improving the visibility of these connections for community and decision makers alike will increase the opportunity for better choices and community ownership of the options that are to be progressed.



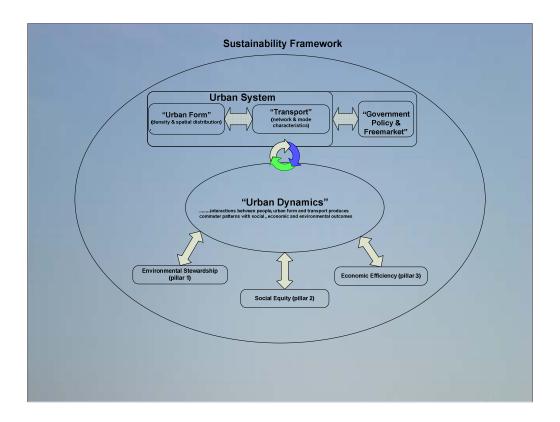
Sustainability Responses in Cities requires new directions.......Trend Breaking Scenario planning! Scenario Optioneering and Backcasting is becoming a favoured technique in meeting this Challenge. As the name implies, this is about not necessarily planning by extrapolation of business as usual trends. Rather, it is planning for sustainable scenarios that may be different to past trends. Said more plainly, the transport infrastructure, urban form and policies may need to be different to what we have now.

The World Conference on Transport Research (WCTR) in Lisbon 2010 raised the need for evidence based assessment tools to underpin scenario optioneering & backcasting.

An Initiative discussed at the WCTR session led to a number of research bodies and individual researchers expressing interest in collaborating in efforts to enable a Strategic Scan methodology to develop to fill this need. The principles are shown in this figure

Backcasting will help formulate a sequence of policy packages or actions to achieve the most desirable future.

**A land use/transport scenario assessment model** provides a methodology that informs the visioning and backcasting process with simple visualizations to give the evidence basis to the scenarios being assessed.



Underpinning this strategic methodology is a sustainability framework, formulated to bring not only the three pillars of sustainability together, but also a holistic consideration of the urban system, the urban dynamics and the resulting sustainability performance.

This framework is represented by this figure, showing the interconnection between the urban system elements, the urban dynamics and identifying the three pillars of sustainability. This framework lays out the frame points for ensuring that the systems elements and interactions that drive the sustainability performance of the city are visible and measured.

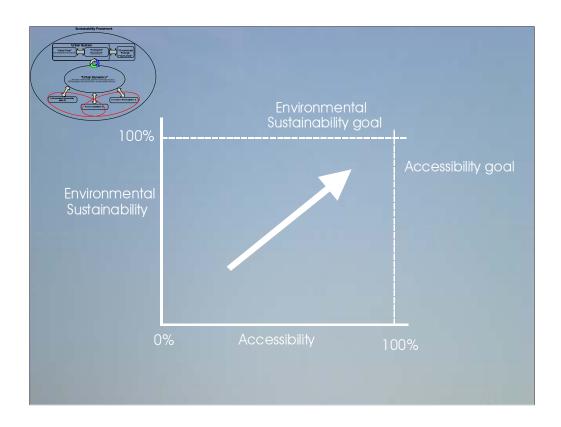
The "Urban System" is the physical aspect of the framework, consisting of the "Urban Form" and "Transport" elements which define the structural configuration of the city. Interaction between these two elements shows their interdependencies. "Urban Form" is characterised by density and spatial distribution of land-use. "Transport" on the other hand is characterised by the transport network spatial layout and the specific mode characteristics.

The system function is to provide for the needs of the community (including industry). Response by the community to the "Urban System" produces interactions – the selection of location of residence and workplace, industry and travel patterns, and so on. These interactions are collectively known as "Urban Dynamics". It is an iterative process as indicated by the circular arrow having feedback effect between each element.

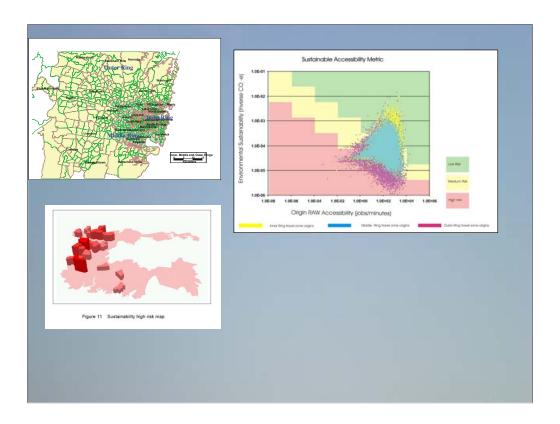
The resulting "Urban Dynamics" outcomes generate the sustainability performance in terms of the three pillars included as elements in in the figure. Each pillar has a feedback to the "Urban Dynamics" and consequently the "Urban System". This is indicated by the double headed arrows.

Under climate change Environmental Stewardship is a measure of greenhouse gas emissions. Social equity and economic efficiency can be usefully indicated by accessibility to work and workforce for example.

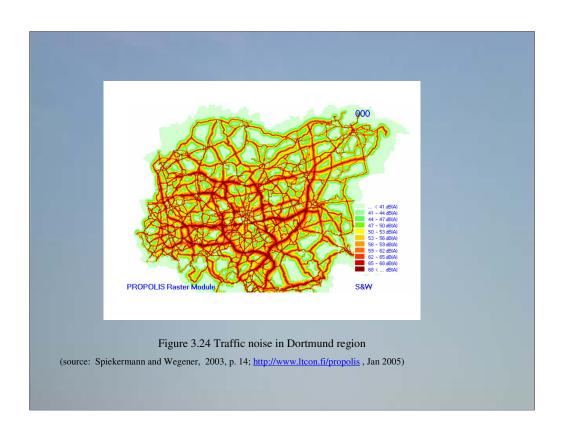
By starting with our visions and the constraints now needed to avoid climate change risk, we can use the framework in both a downward and upward flow to help identify system and policy packages.



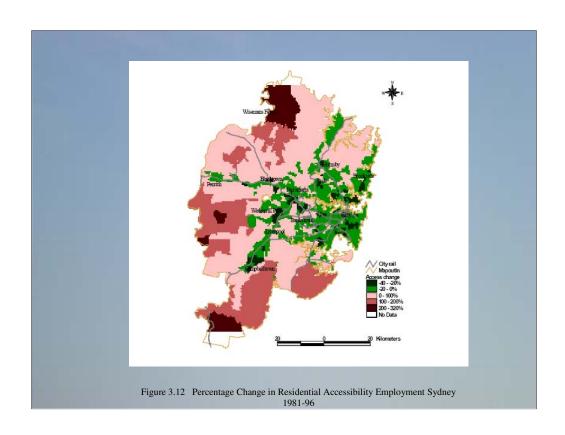
For a scenario of system changes and policy packages, the city wide trip matrix can be estimated. The trip matrix consists of each travel zone origin and destination pair resulting from the changes. For each pair the sustainability performance can be estimated in measures of the three pillars. Sustainability aims for mutual achievement of good outcomes in each of the pillars. With environmental sustainability – accessibility space, the mutuality can also be assessed. The position and spread of the origin-destination pairs gives an effective view of the city wide differences in performance.

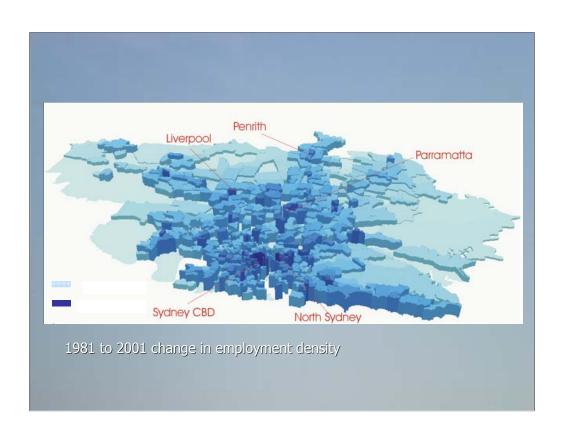


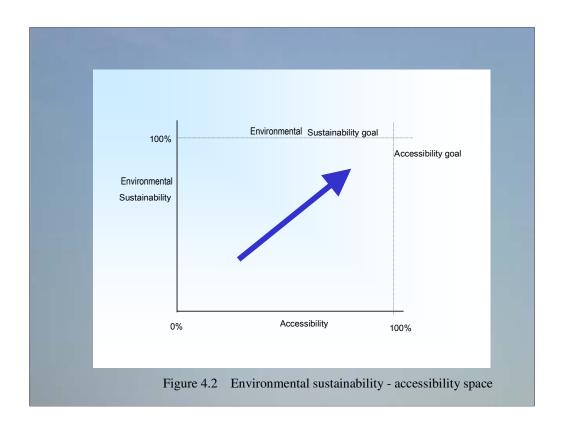
Visualisations such as these in combination with backcasting has the potential to involve community into the development and assessment of system scenarios and policy packaging. More examples and details are shown in the following slides.



Existing visualisation methods using GIS and graphical displays illustrate the value of visual metrics in communicating urban dynamic outcomes and sustainability performance. Visualisation using GIS techniques is proving to be effective in displaying complex information in a simple but meaningful way

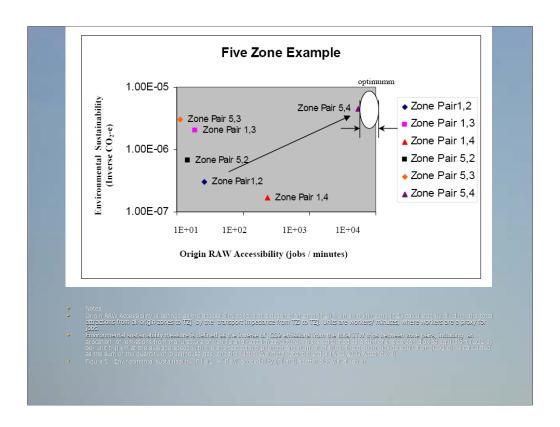




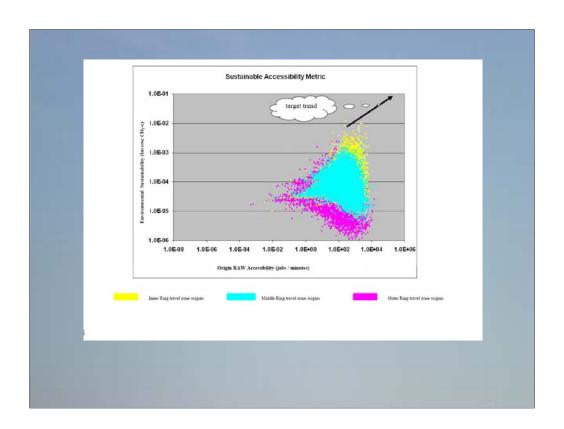


sustainability metrics, using visualisations in "environmental sustainability – accessibility space" can be generated. These visualisations display a social spatial equity form of accessibility in a metric indicating the accessibility to jobs for workers from their place of residence. Visualisations for measures of environmental sustainability and economic efficiency focused accessibility (the first and third pillars of sustainability) were also produced.

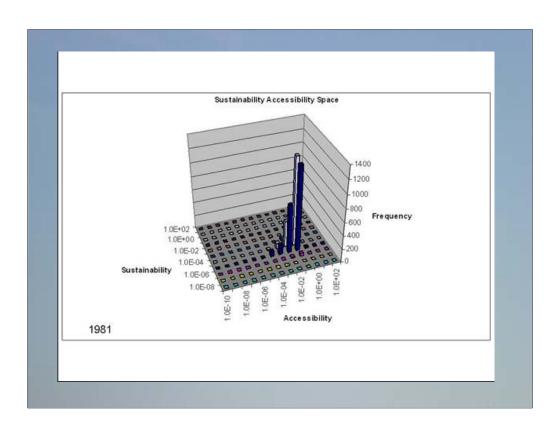
The metrics have been developed based on the concept of a sustainability goal in "environmental sustainability – accessibility space". Figure 4 illustrates this spatial concept and the idealised performance goal. A city's transport related sustainability performance can be quantified and visualised in a detailed but simple manner by collectively plotting in this space the points for different locations in the city. Each of these points represents the environmental sustainability and accessibility performance for a specific origin and destination location pairing. For a city divided into travel zones, each origin and destination zone pair has an environmental sustainability characteristic and an accessibility characteristic.



The simple five zone example provides the fundamentals of the concept. The scatter plot shown shows the sustainability performance against the desirable trend in sustainability. A shift to the top right hand corner and a limited spread in accessibility is identified as the theorised optimum.

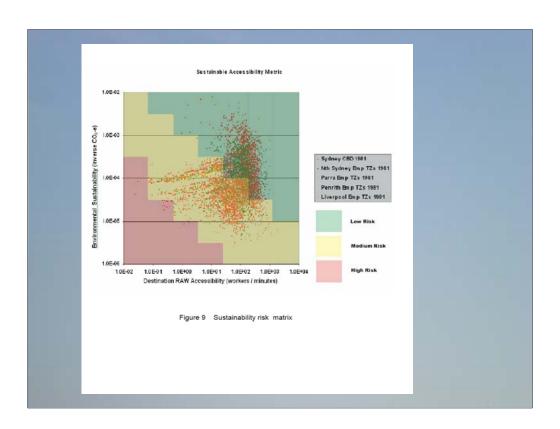


Each of these visualisations provide insight into the position, spread and internal frequency trends for a city's urban sustainability pillars of environmental stewardship, social equity and economic efficiency.



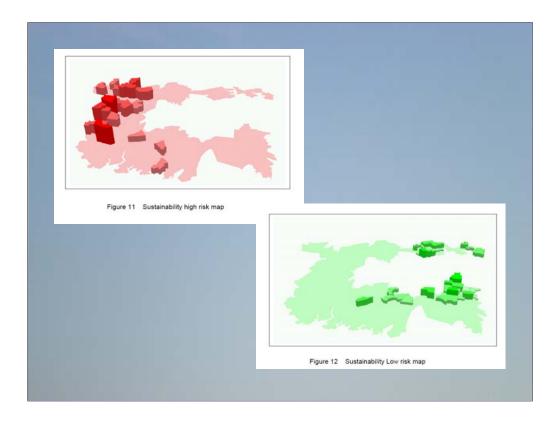
To give a greater degree of visualisation of the data sets, the "environmental sustainability – accessibility space" was divided into a grid and plotted as a prism map with the frequency in "environmental sustainability – accessibility space"

Through these three dimensional visualisations of the data sets, a number of additional differences between each set become visible.



These metrics can also be applied in a way that expresses sustainability performance in terms of sustainability risk. High risk where sustainability performance is poor, indicated by low metric values. Low risk where sustainability performance is satisfactory, indicated by a higher metric value, above a community accepted minimum target.

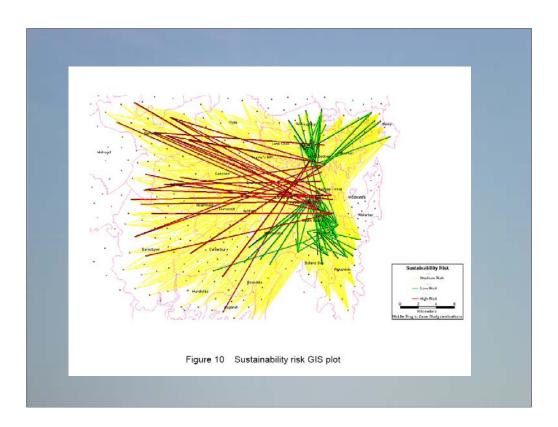
The grid concept can be likened to a risk matrix allowing each zone pair to be assigned a sustainability risk rating (Figure 9). This sustainability risk rating can then be plotted onto geographic space using geographic information system (GIS) thematic mapping. Figures 10, 11&12 illustrate some examples of visualisations in geographic space.



For community and decision makers these visual differences give a simple snapshot of overall sustainability performance, for each scenario being considered. Change the scenario, use the building block techniques and produce a new metric plot to see the sustainability effect. Stakeholders can see measurable change for their communities in relation to sustainability goals. The process provides another dimension to visioning and sustainability strategy development by adding the means by which community can measure and judge one infrastructure and urban form scenario with another.

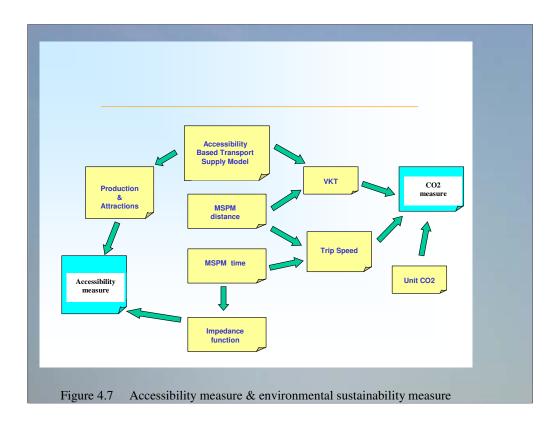
Choice of boundaries between low, medium and high risk of unsustainability needs discussion and may vary from city to city. For example, what are the points in environmental sustainability – accessibility space that moves a community from a low risk to a medium risk of being unsustainable? In the case of a city system with current scenario of transport & urban form a baseline assessment can be made.

An important aspect of the metric methodologies is their analytical basis. All visualisations have traceability back through the algorithms to the source inputs. This is a particular strength when checking results, making scenarios changes and applying different planning instruments. A particular strength of using the sustainability framework and the metrics demonstrated is that they are derived from data sets that have been commonly used by planners for many years. These are commonplace amongst transport and city planning departments. With these inputs and the assistance of readily available GIS/T software, all of the urban dynamics and sustainability metrics are able to be derived. The sustainability framework enables the holistic picture of sustainability to be maintained during the assessment process.



Optioneering of changes in transport & urban form puts forward different possibilities for a cities future. This assessment methodology enables these scenario options to be assessed for change in sustainability performance over the system as it exists now. Not only can the snapshots of performance with current demands be made, but also as is done in traditional planning, the projected performance with projected demands.

The sustainability assessment of various transport and urban form options is therefore seen as a valuable tool for comparing the relative performance where the variables are transport and urban system characteristics, urban dynamics associated with demand choices people make in place of living, where they work, relax, shop and visit and how and when they choose to travel. These variables we are familiar with. However, climate change adds another dimension with constraints and feedback effects to each of these variables which have not previously been assumed to occur.



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## Where to from here

## **Case Studies**

- Collaboration
- Develop case studies for typologies

## **Enabling City Responses**

- Mentor City level agencies
- Application

Collaboration with other researchers to enable collective team effort and improve the methodology. Include practitioners for lessons learnt and test methodology.

Develop case studies around the world to enable the building of typologies for reference in other cities.

Effort to mentor city level agencies in using this framework

## Application to cities

Those interested in collaborating to see me after the session and provide business card or email or follow the CUSCCRR links on the www.windana.com website.

