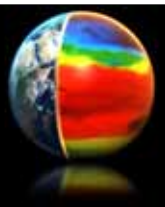

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UNSW

Planning Sustainable Infrastructure

Week1: 10th March 2009

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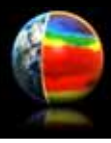
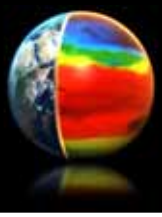
INTRODUCTION - Transport 1: The essential meaning of sustainability in the context of transport systems

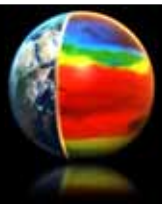
- Historical context & relationship to transport
- Developing urban & network system requirements
- Optioneering & engaging community
- Principles of sustainability assessment



Historical context & relationship to transport



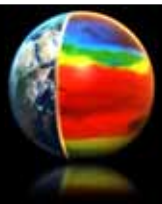
Definition



- “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.

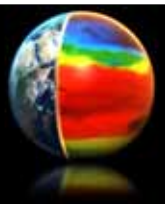
To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development

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)

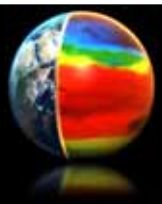
Principle 2:



- 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)

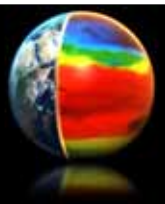
Principle 15:



- 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

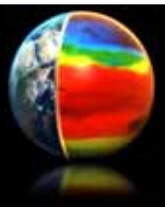
(World Commission on Environment and Development, 1987).

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).

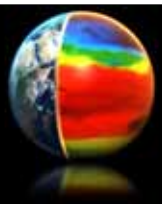
By 1995, at the World Summit on Social Development, in Copenhagen the inter-relationship between the economic, social and environmental components of sustainable development were being thoughtfully discussed, coming to this conclusion.

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

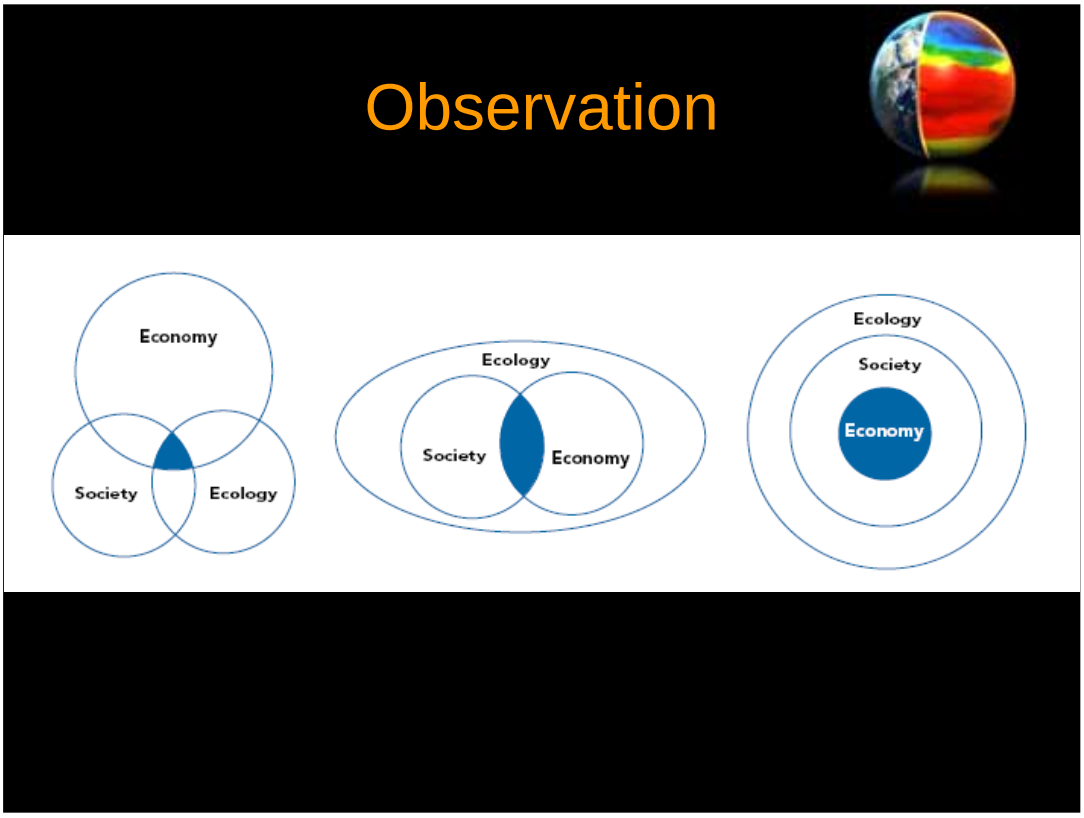
Action



- 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.

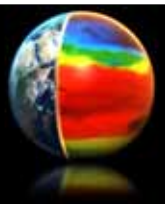
Often the natural and social systems are assumed to be in equilibrium.

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

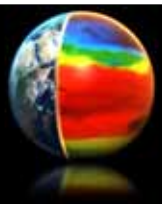


- Environment degrading>>Community concern >>national >>>international>>>economic & social equity of response? >> UN define sustainable development>>>3 mutual pillars environment, economy, social equity>>>National governments prime responsibility for leading >>>> integrated approach to the assessment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

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

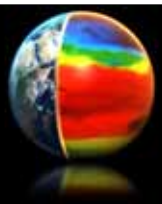


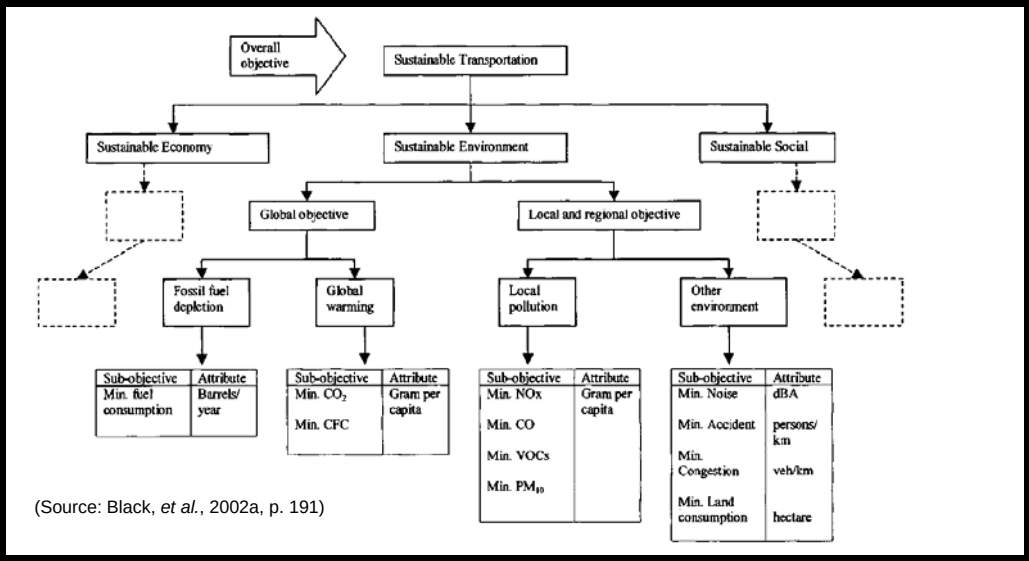
- 2008, > half human population, 3.3 billion people, are living in urban areas
- By 2030, UN forecasts are for the towns and cities of the developing world to make up 81 per cent of urban humanity
- urban form, transport and the interactions with communities

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.

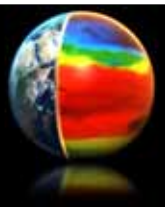
City Sustainability

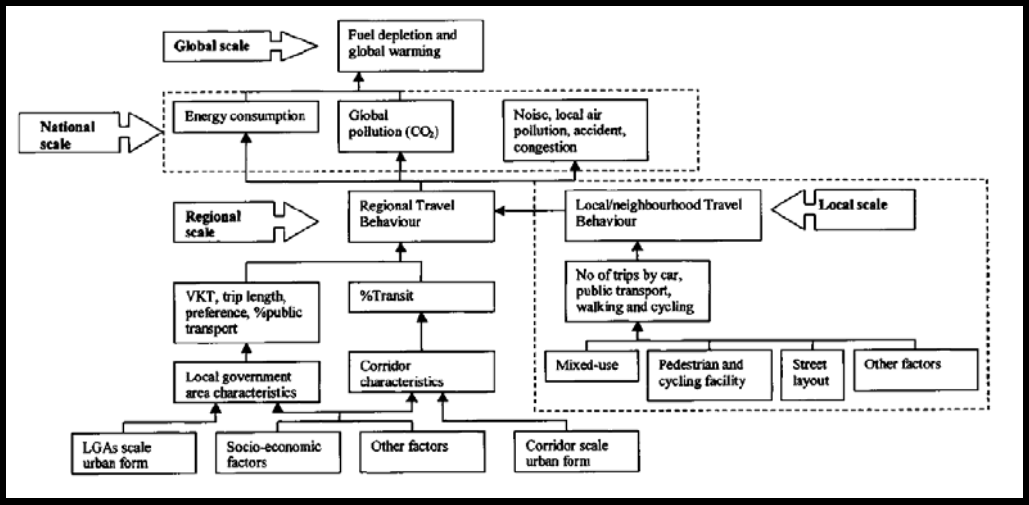




(Source: Black, *et al.*, 2002a, p. 191)

City Sustainability





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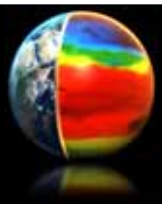


- Cities must look urgently to the future. The projected expansion of the urban population in Asia and Africa, from 1.7 to 3.4 billion over a period of only 30 years, and the reduced level of available resources, stress the need for a more imaginative but pragmatic response.
- In turn, this will demand 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):


Let's Change the World through Local Community Action.
Energizing Local Community through Creation of Environmental Friendly Society
Local Government
Community building by Local Government
Private Companies
NGOs NPOs
Citizens
Media
Universities Institutions
Creation of our own Success Stories
Individual Actions Lead to Regional Change
Keys for Success
Experiences in the World
Private Companies
Media
Citizens
Community Building by Partnership
Universities Institutions
NGOs NPOs
Local Government

STAKEHOLDER CONSULTATION

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

Visioning

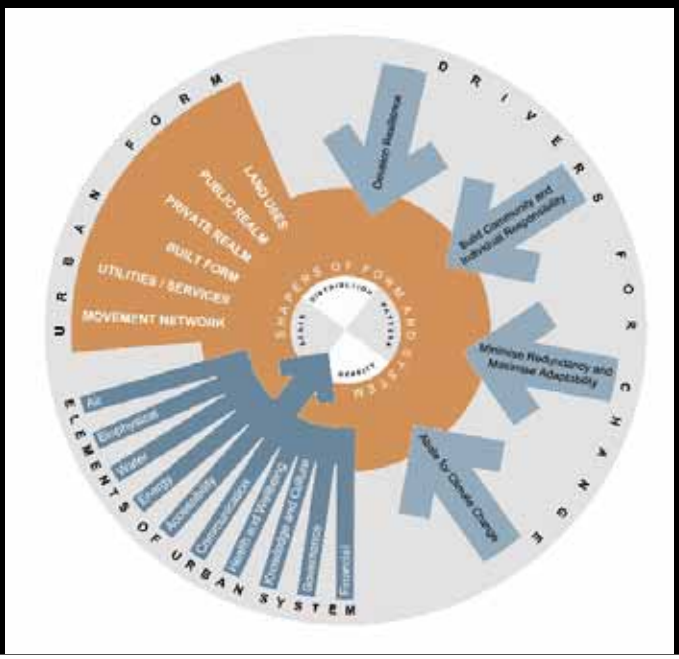
An example of this is the “Accessible City” strategy (Sydney City Council, 1995). The approach differed from previous strategies by the Council in that it approached the whole transport question from the point of view of accessibility, not as only one of a number of objectives. The first steps were to 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*”.

City Sustainability Visions



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;

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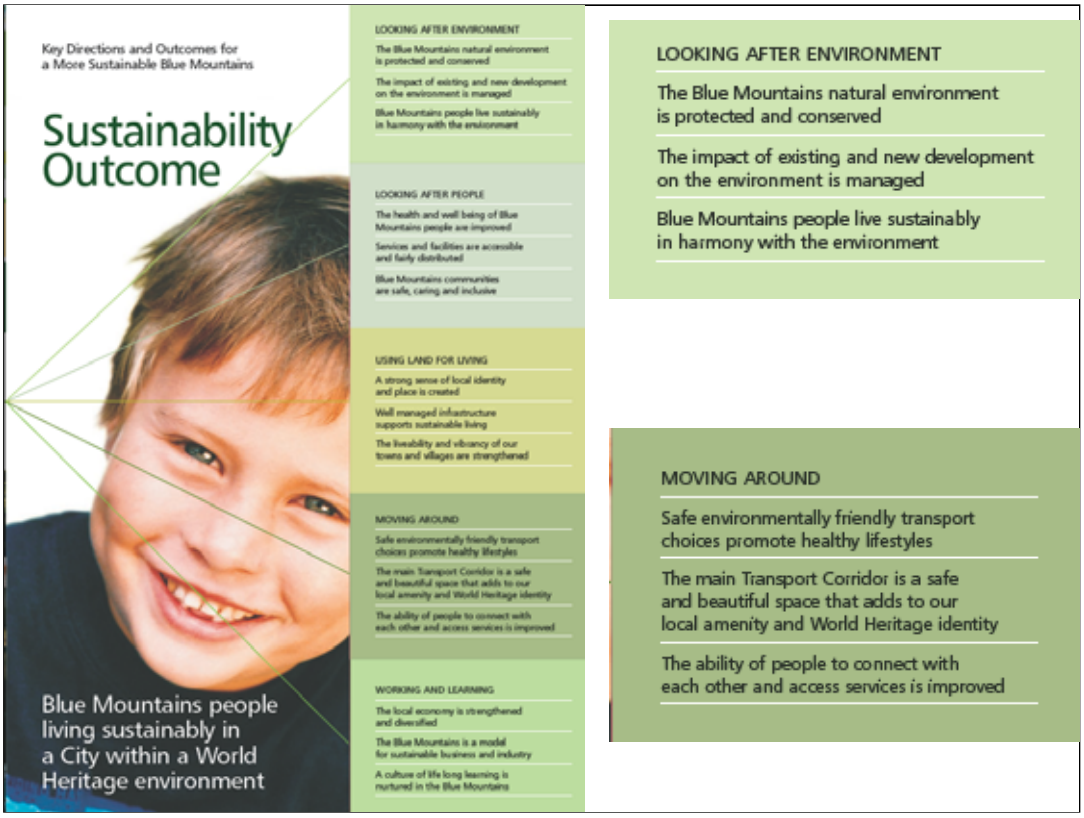
Key Directions and Outcomes for a More Sustainable Blue Mountains
Sustainability Outcome
Blue Mountains people living sustainably in a City within a World Heritage environment
LOOKING AFTER ENVIRONMENT
The Blue Mountains natural environment is protected and conserved
The impact of existing and new development on the environment is managed
Blue Mountains people live sustainably in harmony with the environment
LOOKING AFTER PEOPLE
The health and well being of Blue Mountains people are improved
Services and facilities are accessible and fairly distributed
Blue Mountains communities are safe, caring and inclusive
USING LAND FOR LIVING
A strong sense of local identity and place is created
Well managed infrastructure supports sustainable living
The liveability and vibrancy of our towns and villages are strengthened
MOVING AROUND
Safe environmentally friendly transport choices promote healthy lifestyles
The main Transport Corridor is a safe and beautiful space that adds to our local amenity and World Heritage identity
The ability of people to connect with each other and access services is improved
WORKING AND LEARNING
The local economy is strengthened and diversified
The Blue Mountains is a model for sustainable business and industry
A culture of life long learning is nurtured in the Blue Mountains
LOOKING AFTER ENVIRONMENT
The Blue Mountains natural environment is protected and conserved
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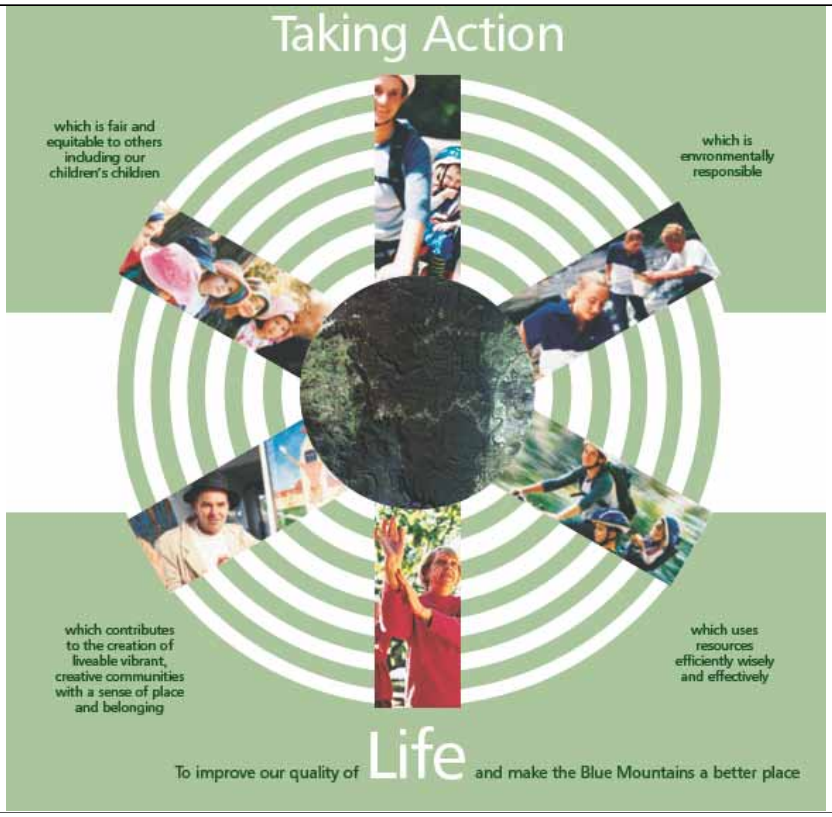

Taking Action
which is fair and equitable to others including our children's children
which is environmentally responsible
which contributes to the creation of liveable vibrant, creative communities with a sense of place and belonging
which uses resources efficiently wisely and effectively
To improve our quality of Life and make the Blue Mountains a better place

developing the 25 year strategy for the City.

1. The values of Blue Mountains people will shape a 'whole of City' vision for the kind of City we want to pass on to the community of 25 years time
2. We will encourage residents to work together across the City to achieve broad agreement about the way forward
3. We will seek broad ownership by the community and key stakeholders/partners through involvement and input in all stages of the project
4. We will promote partnerships with stakeholders critical to the success of the Key Directions and Outcomes identified for a more sustainable future
5. The way forward will build on our existing strengths and capabilities while being open to new ideas and creative responses
6. The vision for the future will respond to and support diversity within our community
7. The City Strategy action plan for the future will be flexible so it can be consistent with changing trends. It will also promote the effective and efficient use of resources
8. Council will have a leadership role
9. A range of scenarios for the kind of City we want will be considered
10. Our communication will be clear and not full of technical jargon
11. We will provide a framework within which Council's four yearly Management Plans and Annual Business Plans can be developed (in

future project built upon a comprehensive community Visioning process known as the Oregon Model (Ames, 1993). The project was fortunate to benefit from a number of guest lectures from Steven Ames, the developer of the model.

The Oregon Model comprises a comprehensive four-step process. Each step focuses on a driving question, involves different activities and results in specific products.

Using the Oregon frameworks as a base process, two components were added – *Where have we come from?* and a fifth step, *How will we know we are on track?* The *Blue Mountains – Our Future* project was a three stage process as as detailed in the Table below:

Table: Staged Project Methodology

Stage One

Step 1:	**Profiling the community and the City**
Driving questions:	Where have we come from and where are we now?
Activities:	Research and data collection, community survey and consultation
Products:	1976 Strategy documentation, Community Profile, Values Statement
Step 2:	**Assessing the trends**
Driving question:	Where are we going?
Activities:	Assessment of current and projected trends and their future impact

Stage Two

Step 3:	Creating the Vision
Driving question:	What kind of Blue Mountains will the people of 2025 appreciate we have passed onto them?
Activities:	Creation of a preferred scenario and final vision through consultation
Products:	Preferred scenario, City Vision and Key Direction statements, 25 year Outcomes and Strategic Objectives

1.5. Consultation Approaches

Different approaches were used in consulting events and processes including:

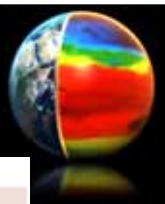
- Surveys
- Focus groups
- Workshops
- Celebratory events
- Story writing competitions
- Exhibitions at community events
- Formal Council public exhibitions
- Communication by letter, household package and in media outlets
- Stakeholder forums
- Oral communication through local radio station

Stage Three

Step 4:	Developing an action plan
Driving question:	What action will we take?
Activities:	Developing a course of action Decision making to take action now
Products:	Map for Action – 5-10 Year Priority Action Areas and Sustainability benefits
Step 5:	**Taking action and monitoring our progress**
Driving question:	How will we know we are on track?
Activities:	Developing a system for monitoring progress Empowering and engaging with community Building partnerships with key stakeholders
Project: State of City Monitoring 2004-2008 in progress	State of City Monitoring – development of a range of tools and approaches for understanding the effects of our decision making and action – where we have achieved the Vision and Outcomes and what we will do differently as a result of what we have learnt


Sustainability Requirements?

City Sustainability Requirements



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.
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.

TABLE 7 METROPOLITAN STRATEGY PERFORMANCE — MEASURES OF SUCCESS

Source: City of Cities – A plan for Sydney's future: Metropolitan Strategy Supporting Information

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

Sustainability Aspects	Sustainable Transportation Issues	Sustainability Objectives and Targets	Possible Performance indicators
Environmental Aspects	Climate Change	• Reduce air emission contributing to the atmosphere from all forms of transport. • Reduce the air quality impacts on human health.	• GHG emissions from all transport (CO_2).
	Air Quality/Air Pollutions		• Index of emissions of air pollutants from roads transport ($VOCs$, NO_X). • Air quality levels or exceedances. • Number of vehicle registrations.
	Land Use and Infrastructure Planning	• Sustainable use of land released for transportation. • Enhance the interrelations between urban design and sustainable transport system. • Reduce travel length and travel cost (both time and economic cost) by proper land planning and management	• Urban land use per capita. • Urban land use by size class and zone. • Land use mix (per cent walking to work; ratio of jobs to employed labor force). • Travel and modal split by urban zone. • Length of paved roads and sustainable infrastructure. • Transit seat-kilometres per capita.
	Negative Environmental Impacts	• Decrease consumption of other mineral and capital resources in transportation equipments and infrastructures. • Minimise adverse impacts on natural habitats and ecosystems	• Transport effects on ecosystem health. • Proximity of infrastructure to sensitive areas, and ecosystem fragmentation. • Waste from road transport. • Water Pollutions (wastes discharge into seawater and freshwater).
	Innovative Technologies of Transportation Fuels	• Increase the use of alternative fuels. • Reduce the use of fossil fuels. • Sustainable use of non-renewable resources. • Enhance automobile energy efficiency.	• Index of energy intensity of cars and trucks. • Index of emissions intensity of the road-vehicle fleet. • % of alternative fuel vehicles in the fleet. • % of passenger-km and tonne-km fuelled from renewable energy.
Social Aspects	Road Safety	• 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 classifications. • 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 interchanges.
	Accessibility to Public Transport	• Satisfy community demands for public transport. • Encourage community to use public transport and reduce the usage of automobiles. • Provision of diverse forms of public transport (including light rail).	• User rating. • Transport diversity. • Inclusive planning.

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

Sustainability Aspects	Sustainable Transportation Issues	Sustainability Objectives and Targets	Possible Performance Indicators
Social Aspects	Social Equity	• Reduce disadvantages of age for community members (e.g. for those people who do not drive.). • Enhance the accessibility of facilities for disable people at all forms of transport. • Improve the performance of children travel facilities.	• Affordability. • Disabilities (Percentage of pedestrian crossings with facilities for disabled people). • Children's travel (Percentage of primary and secondary schools with school road safety schemes implemented Proportion of school trips by modes other than car).
	Mobility	• Remove mobility barriers. • Improve central interchange services or to extend the network /nods of public transport in order to achieve comparable mobility. • Reduce the impacts of freight transports on passenger transports. • Harmonizing the use of transportation facilities and infrastructure share by different road users. • Shorten time and other costs for travel.	• Non-motorized transport (NMT). • Movement of light-duty passengers vehicles. • Share of passenger travel not by land-based public transport. • Total motorized movement of freight. • Total motorized movement of people. • Use of passenger vehicles. • Use of freight vehicles. • Urban automobile vehicle-kilometers. • Travel by non-motorized modes of urban areas. • Journey-to-work mode shares. • Urban and intercity person-kilometers. • Freight modal participation. • Number of vehicle registrations. • Urban transit ridership.
	User Satisfaction Rate	• Satisfy community needs of transport facilities. • Reduce any negative impacts generated from transportation (e.g. all forms of pollutions and human health effects). • Increase public awareness of sustainability issues related to transportation.	• Proportion of footway in poor condition. • Business satisfaction with fairness of enforcement of parking and loading regulations. • Percentage of resident satisfaction with street cleansing service. • Percentage of principal roads with negative residual life. • Local street and environmental cleanliness. • Cultural preservation. • Noise pollution by transport (vehicle and aircraft). • Transport effects on human health.
	Community Livability		
	Community Cohesion		• Public support for initiatives to achieve sustainable transport
Economic Aspects	Electronic communication	• Improved transport information which is focused on passengers via electronic communication. • Enhance efficient use of freeways.	• Per cent of transportation systems providing real-time traveler information • Per cent of transit systems with smart card fare collection and per cent of toll roads with "open" toll collection systems • Share of households with a computer and Internet penetration rates

City Sustainability Requirements

Sustainability Aspects	Sustainable Transportation Issues	Sustainability Objectives and Targets	Possible Performance indicators
Economic Aspects	Transportation/Consumer Cost	• Minimise all forms of transportation cost. • To better achieve economic efficiency.	• Index of relative household transport cost. • Index of relative cost of urban transport. • Per cent of net government transport expenditures spent on ground-based public transport. • Transport-related user charges. • Expenditures by businesses on transportation. • Commuting time. • Congestion index (congestion delay).
	Economic Efficiency		• Freight efficiency. • Efficient delivery services. • Crash costs.
	Contribution to Economic Activities	• Ensure the transportation system is favourable to regional economic growth.	• Employment accessibility. • Employment density by CMA, and urban size class and zone. • Share of urban population and jobs served by transit. • Share of population and employment growth on already urbanized lands.

(Sources: 1. TRB 2008; 2. Transport Canada, 2002 3. Litman, 2008)

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>>>>>>

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

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.

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

- 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

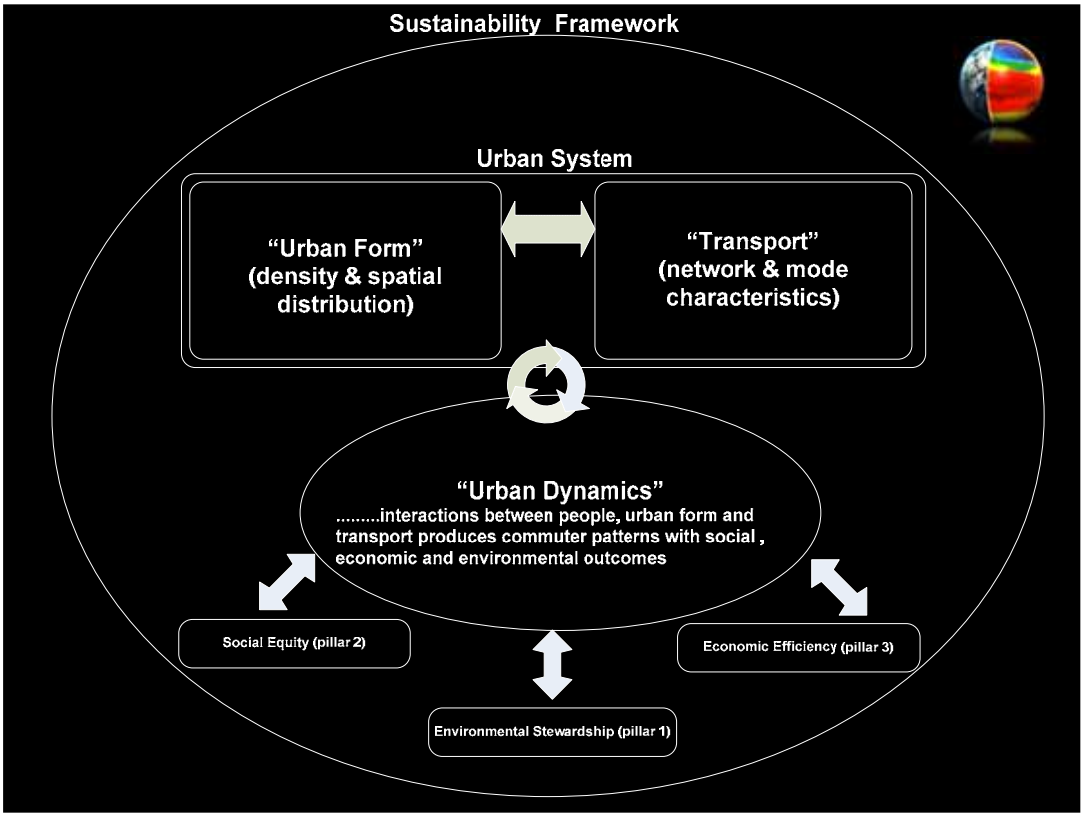
Improving the visibility of these connections for community and decision makers alike will increase the opportunity for better choices and community ownership of the options that are to be progressed.

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.



In a new approach to sustainability analysis , a sustainability framework is 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.

Figure summarises this framework, 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 Figure 2. Each pillar has a feedback to the "Urban Dynamics" and consequently the "Urban System". This is indicated by the double headed arrows in the figure.

Figure 3.24 Traffic noise in Dortmund region

(source: Spiekermann and Wegener, 2003, p. 14; http://www.ltcon.fi/propolis , Jan 2005)

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

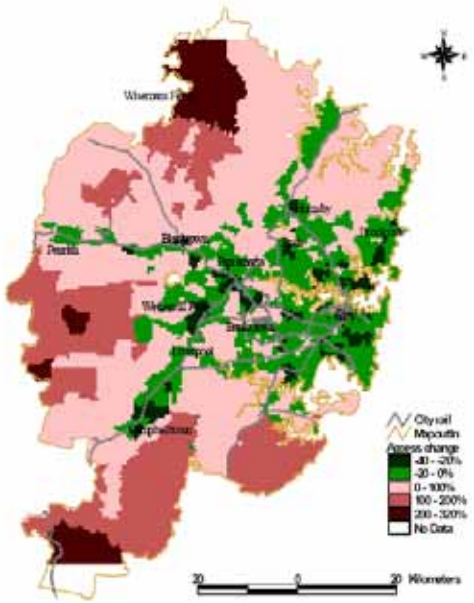
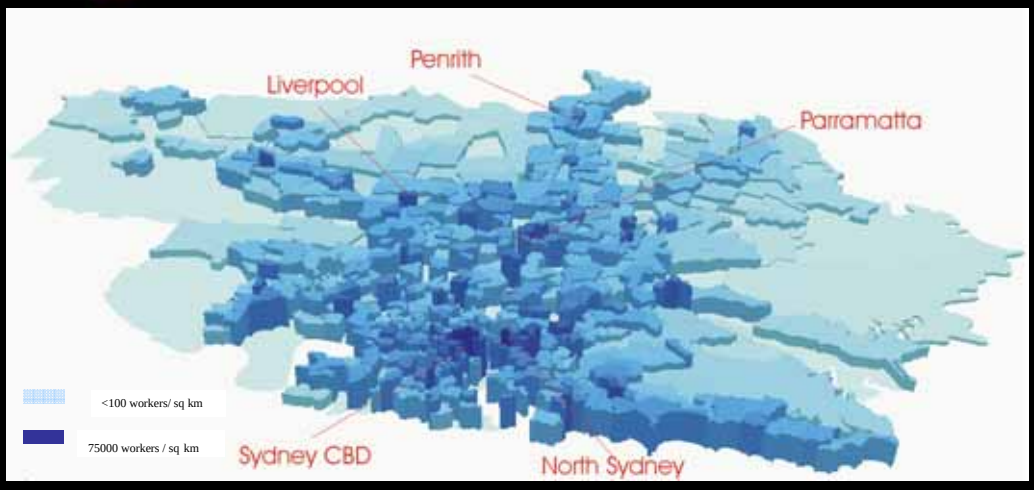
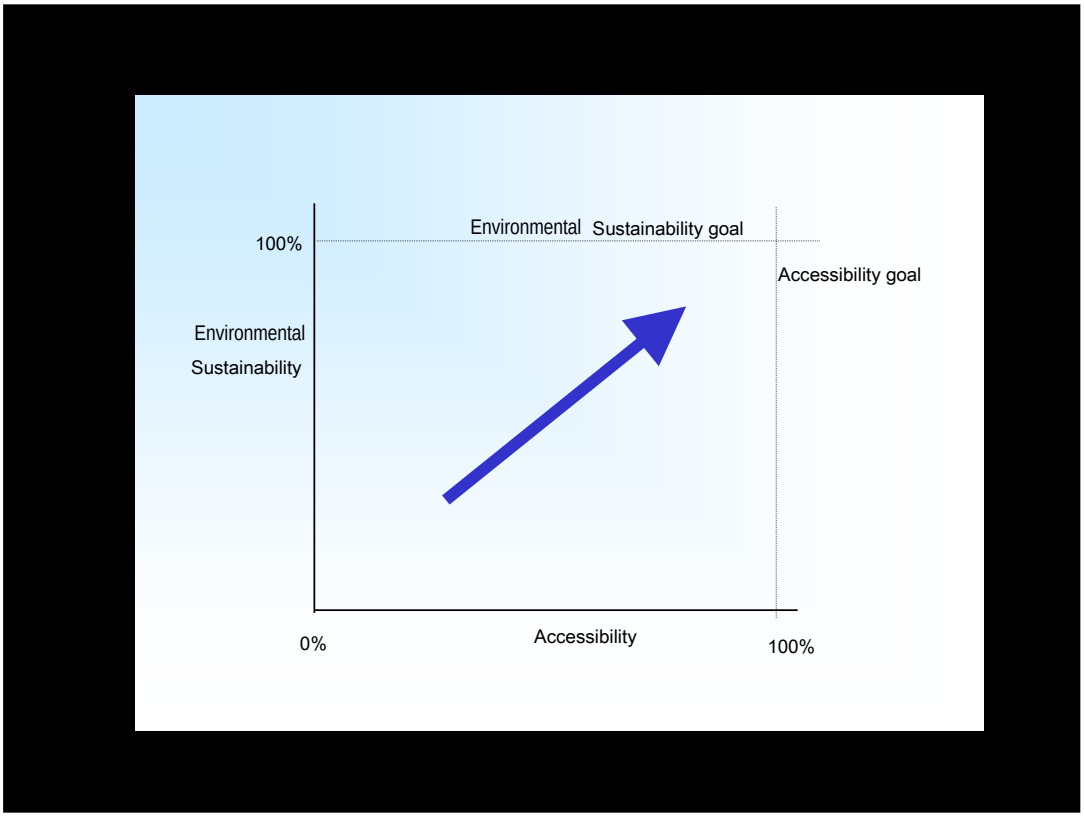


Figure 3.12 Percentage Change in Residential Accessibility Employment Sydney 1981-96

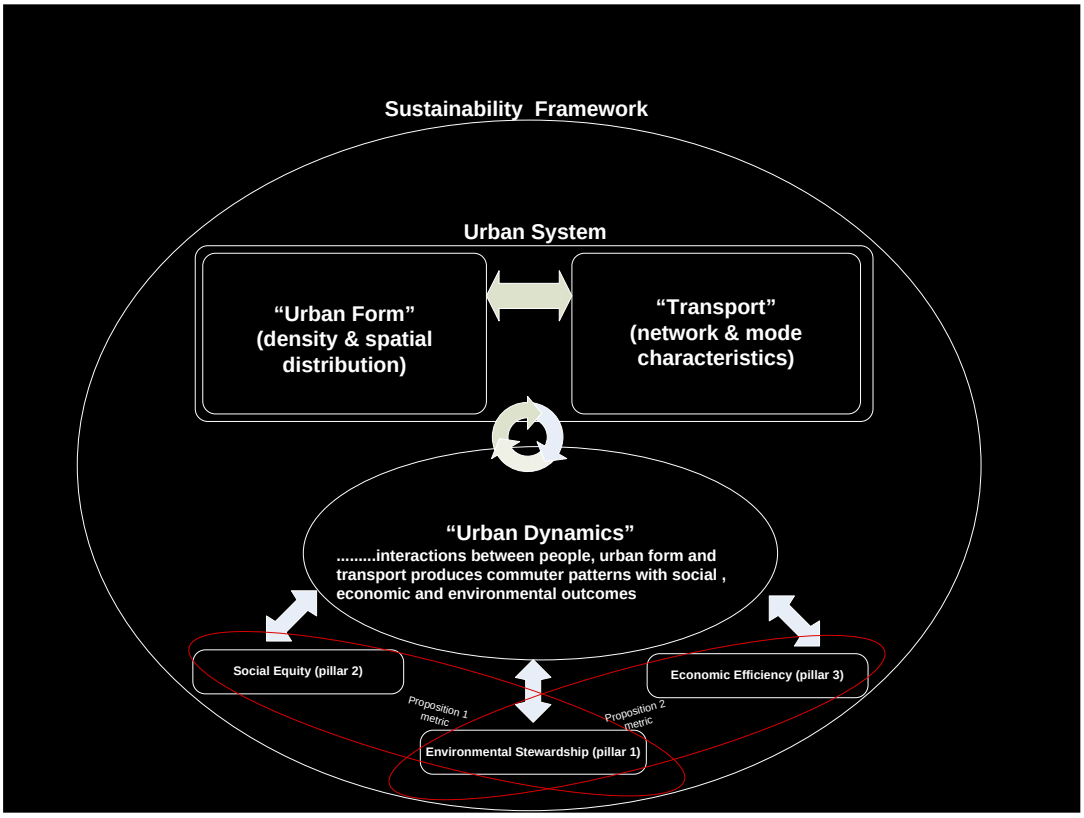


1981 to 2001 change in employment density

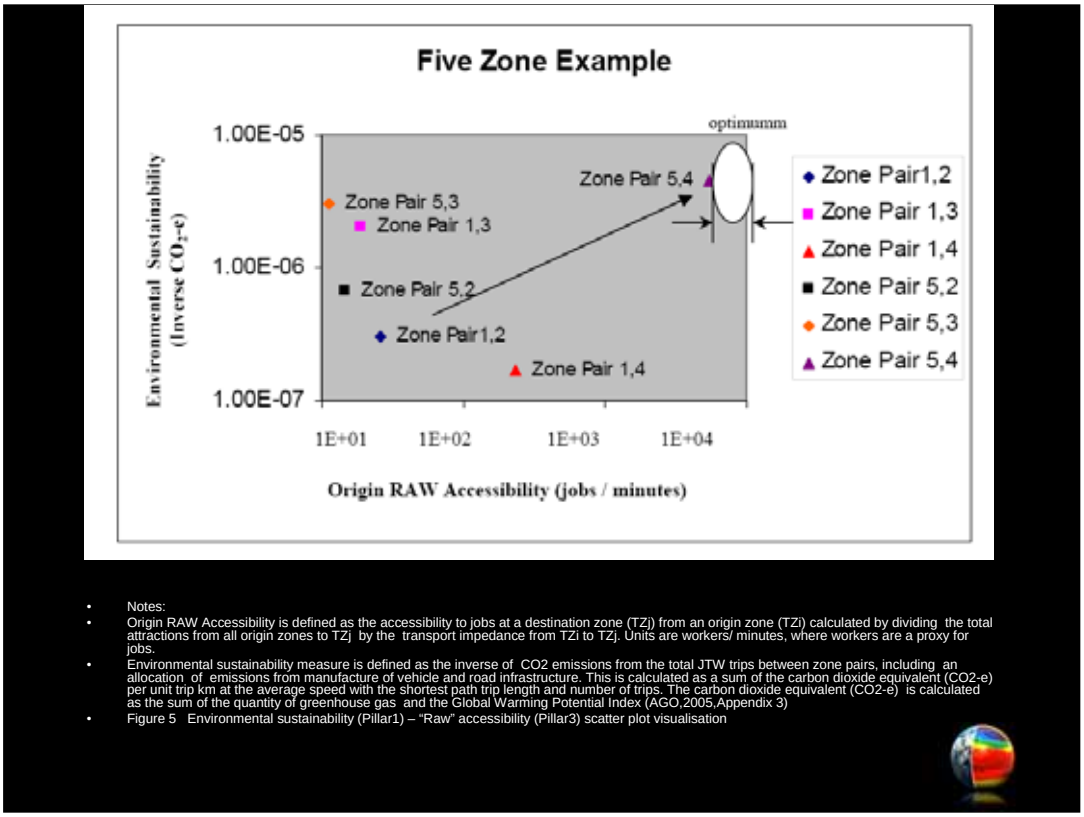


sustainability metrics, using visualisations in “environmental sustainability – accessibility space” were generated. These visualisations display a social spatial equity form of accessibility in a metric indicating the accessibility to jobs for workers from their place of residence. Visualisations for 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.

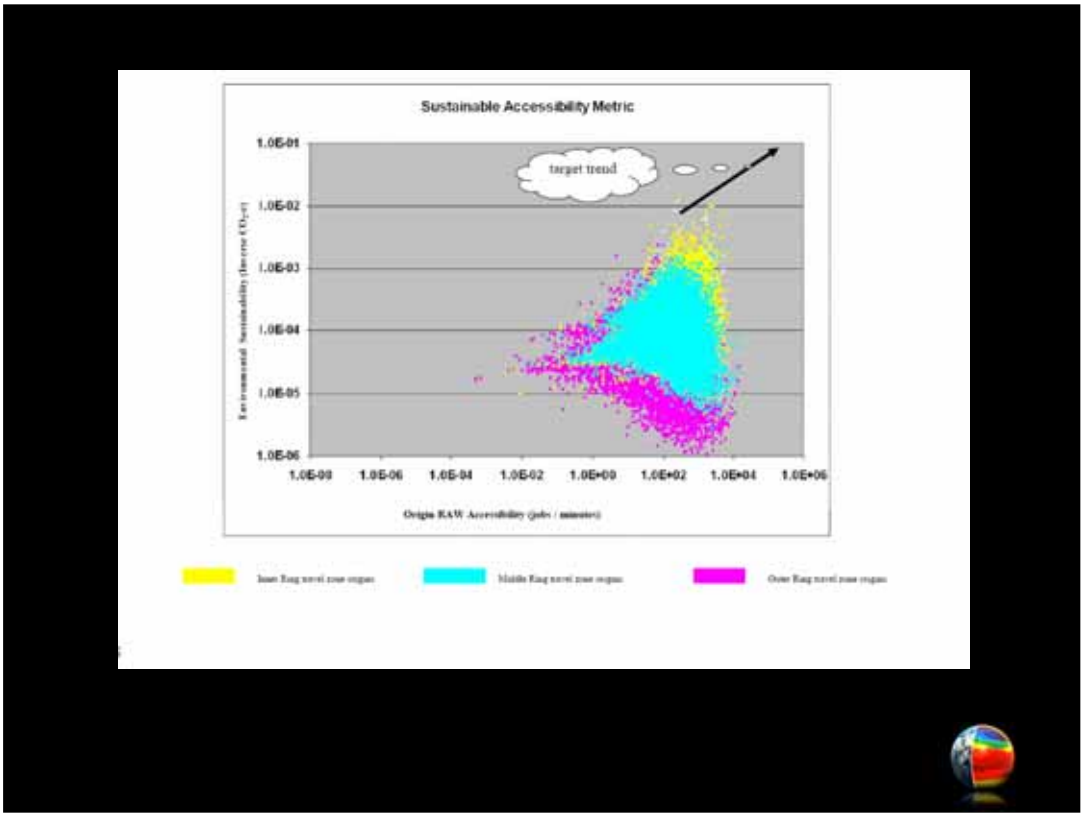


Shows interaction between system elements

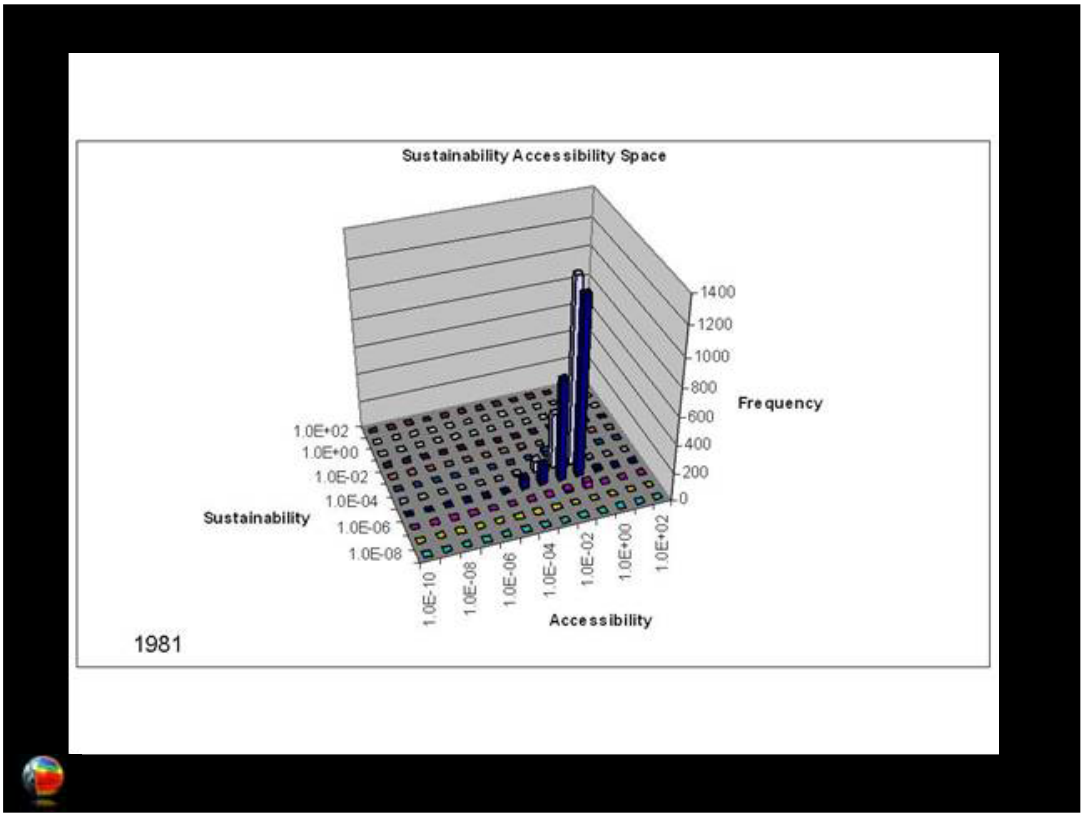


- Notes:
- Origin RAW Accessibility is defined as the accessibility to jobs at a destination zone (TZj) from an origin zone (TZi) calculated by dividing the total attractions from all origin zones to TZj by the transport impedance from TZi to TZj. Units are workers/ minutes, where workers are a proxy for jobs.
- Environmental sustainability measure is defined as the inverse of CO2 emissions from the total JTW trips between zone pairs, including an allocation of emissions from manufacture of vehicle and road infrastructure. This is calculated as a sum of the carbon dioxide equivalent (CO2-e) per unit trip km at the average speed with the shortest path trip length and number of trips. The carbon dioxide equivalent (CO2-e) is calculated as the sum of the quantity of greenhouse gas and the Global Warming Potential Index (AGO,2005,Appendix 3)
- Figure 5 Environmental sustainability (Pillar1) – "Raw" accessibility (Pillar3) scatter plot visualisation

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.

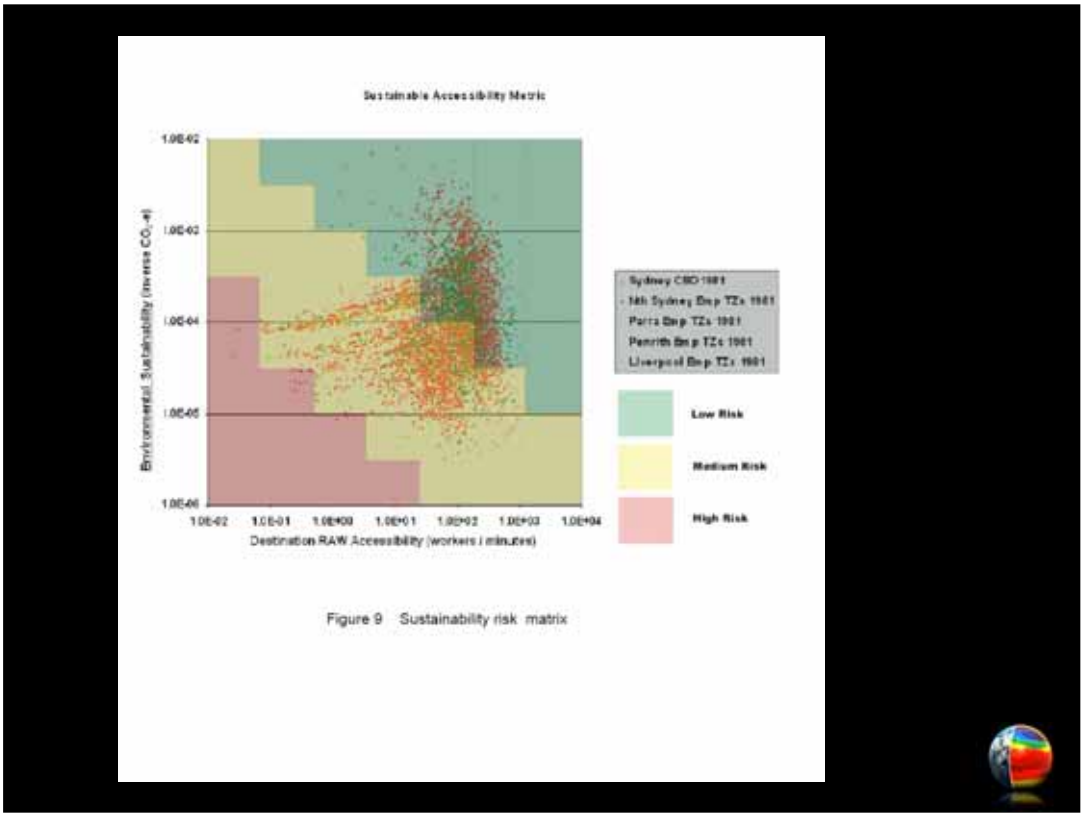


Figure 9 Sustainability risk matrix

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.

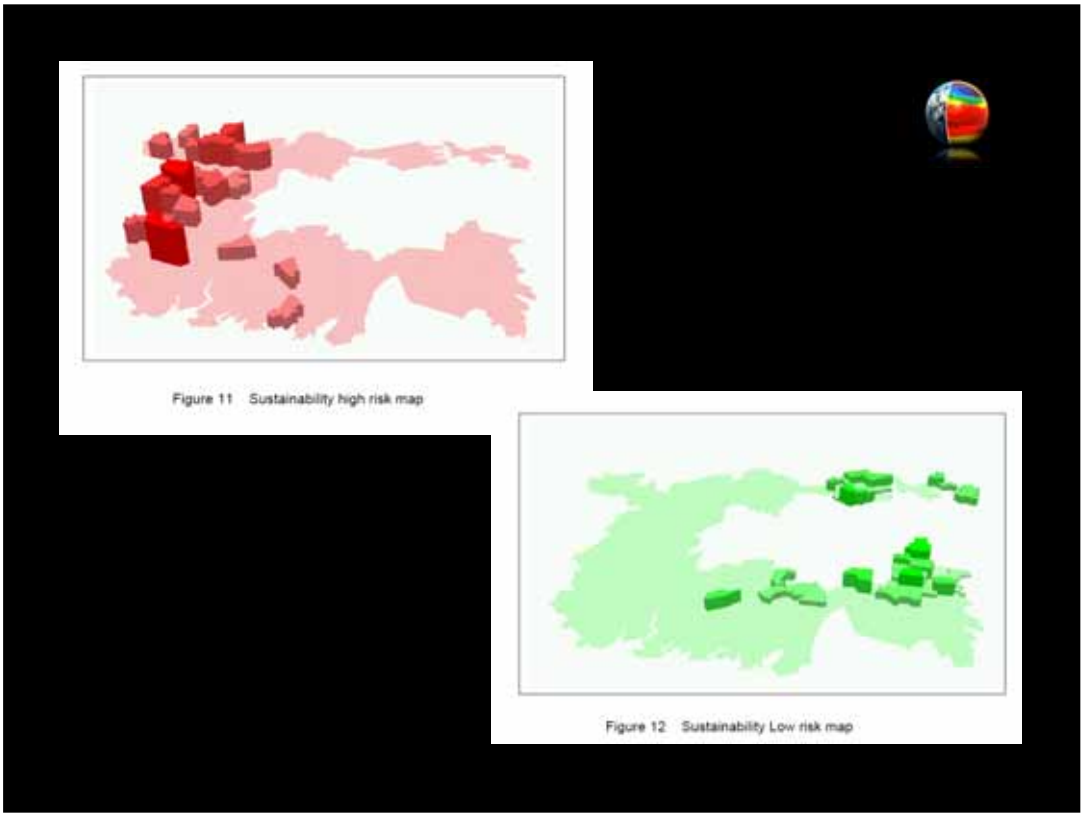


Figure 11 Sustainability high risk map

Figure 12 Sustainability Low risk map

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.

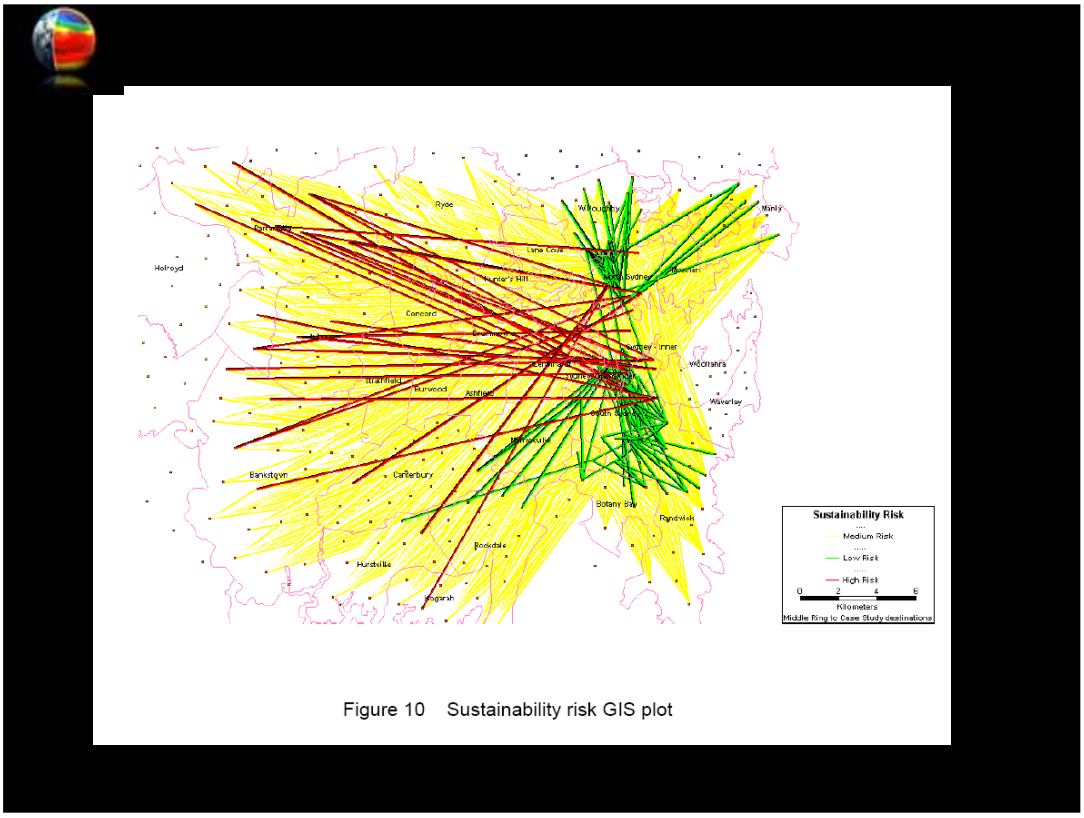
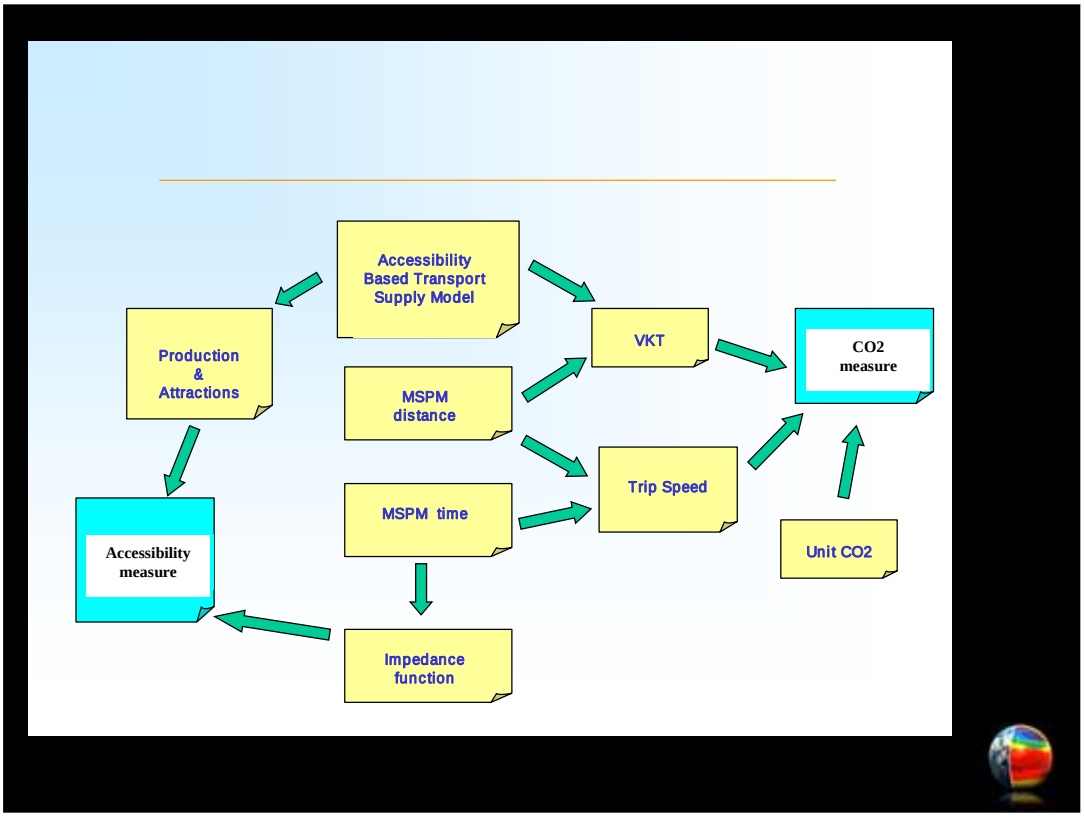


Figure 10 Sustainability risk GIS plot

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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Next Week, - Case study:
"a high speed limited stop guided transport system"