

The role of urban planning and design in responding to climate change: the Brisbane experience

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Abstract

Purpose – The purpose of this paper is to discuss the responses from the urban planning and design professions in Brisbane to the impacts of climate change and the implications of the 2011 flood. In the past decade, the ramifications of climate change have already left a scar on some of the urban regions round the world. The Australian continent has been regarded as one of the most affected regions in terms of climate change implications. The 2011 Queensland floods of historic proportion, which came after a decade of extreme drought, raised many questions about the future development of cities. For the past decades, Queensland's economy was largely based on property-led development. The flood plain land situated along Brisbane River has been developed and overburdened with building infrastructure contributing to the magnification of the flood events.

Design/methodology/approach – The research methodology is based on identification of the problem and the major objective. To address the objective, this study concentrated mainly on the use of qualitative research methods. The major qualitative research methods include literature review, qualitative analysis and observations. Brisbane, the capital of the Australian state of Queensland, has been selected as the case study area.

Findings – The paper revealed strong regional and city-wide planning directives addressing climate change which has not yet been fully been translated at the local-neighbourhood level.

Originality/value – This paper provides a deep insight analysis and evaluation of the design and planning measures currently used to combat the impacts of climate change.

Keywords Adverse impacts of climate change, Urban planning and design

Paper type General review



Climate change in urban areas

In recent years, there has been an ongoing discourse on whether climate change and global warming are natural phenomena or a product of human-induced activities. However, a large majority of scholars and scientists believe that humankind has changed the environment radically, and factors such as globalisation and urban growth accelerate the pace of global warming (Savage, 2010; Gore, 2009). In recent years, there has been a spate of extreme weather patterns which affect major urban centres around the world. Severe droughts have taken place in Texas, Australia, Russia and East Africa. Deadly heat waves hit Western Europe in 2003 and Russia in 2010, and hundreds of tornadoes have swept across the USA. Nashville, Tennessee, has recently experienced

a “millennium flood”, bringing twice as much rain as any recorded figure. Extreme rains have caused flooding in Thailand, Queensland and the Philippines, submerging parts of Bangkok, Brisbane and Manila. In July 2011, the biggest dust storm ever recorded in the city, rolled into Phoenix Arizona, reducing visibility to zero and creating a mile high wall of dust. In 2011, the cost of weather disasters was estimated at \$150 billion worldwide, a 25 per cent increase from the previous year. Weather disasters recorded in the 15-year period 1996-2011 have doubled in comparison to an identical 15-year long period 1980-1995 (Barriopedro *et al.*, 2011; BBC News, 2010, Miller, 2012). More recently, Typhoon Haiyan in the Philippines has brought “nuclear style” devastation to the city of Tacloban (BBC News, 2013).

Hurricane Katrina in 2005 showed how little resilience a city the size of New Orleans has when confronted by extreme weather. The ability of New Orleans to withstand winds and waves from Katrina was reduced by the loss of wetlands and mangroves around the Gulf shores and by inadequate infrastructure provided by the levees. New Orleans was one of the first modern cities to be destroyed by climate change-induced phenomena (Newman *et al.*, 2009).

The problem of climate change phenomena impacting urban areas in the past decade has become more visible and frequent (Miller, 2012). The major objective of this paper is to identify how urban planning and design are addressing the implications of climate change at different scales of intervention, and to further determine the effectiveness of planning and design strategies and policies. Brisbane, which is the capital of the Australian state of Queensland, severely impacted in the past years by the climate change, is used as a case study. The case study approach is used by Yin (2003), who indicates that it allows for a better understanding of the physical, social and economic phenomenon. The research adopted a multi-dimensional and complex approach in the urban planning and design analysis. Qualitative research methodology in data collection involves conducting extensive literature review of climate change, its phenomena and responses from communities and governments. In addition, applied methods include documentary research and policy analysis. The major portion of this study is based on secondary data sources, such as planning documents and policies, and on information from the professional literature and journals.

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Response from urban planners and designers

Urban planning focuses on land use policy, broad scale urban problems and implications of urbanism, while contemporary urban design is aimed at making places for people and producing a high-quality and functional urban environment (Kozlowski, 2010; Carmona *et al.*, 2010). Although slowing the growth rate of greenhouse gas emissions and then reversing it in the next decade will require a concentrated global effort, urban planning and design will play a key role in combating climate change.

As a result, addressing the impact of climate change has become one of the major challenges for professional urban planners and designers, architects and landscape architects as well as scholars and academics in urban design and planning. Development and planning of cities in the age of climate change requires innovative thinking and a holistic approach to policymaking (Droege, 2010; Brown, 2010). Based on

literature review and primary and secondary data sources, the response from urban planners and designers can be split into three categories:

- (1) Preparation of urban policies, strategies and guidelines for government agencies and the private development industry that ensure constructive transformation of the energy, transport and urban infrastructure, promote water sensitive projects, encourage the reuse of building materials, propagate compact and diversified development, give preference to physical, economic and social urban regeneration schemes and promote the greening and landscaping of cities (Droege, 2010; and Cheesbrough, 2010).
- (2) Taking direct action as a response to natural disasters resulting from climate change and delivering a set of design guidelines and policies for affected areas (Mississippi Renewal Forum, 2008).
- (3) Providing an advocacy role in government panels and initiating and conducting research at universities and research centres (Lehmann, 2010, Andresen and Francis, 2010, and Nolon, 2008).

Preparation of policy guidelines and strategies addressing climate change and convincing public and private clients of the importance of introducing more intelligent and sustainable approach to urban development has been high on the agenda for the past decade. According to Farr (2008), the challenge for global architecture is to ensure that all new buildings and major renovations are designed to meet an energy performance standard of 50 per cent of the regional average of derived fossil fuels. Farr argues that by 2030, all buildings should be carbon neutral. In terms of urban planning and design, the major focus should be placed on delivering “high performance infrastructure”. High-performance infrastructure refers to core best management practices (BMPs) applicable to typical sections of the public right of way, encompassing streets and sidewalks, underground utilities, storm water infrastructure, landscapes and streetscape elements. The BMPs can be implemented incrementally through the upgrade of individual infrastructure components over time. Local municipalities must maximise benefits in using best practices in all public works projects (Farr, 2008).

Renowned Malaysian architect, Ken Yeang has introduced an innovative approach to ecological master planning based on the ecological concept of urban planning and design as environmentally benign and seamless bio-integration of four infrastructures. The four infrastructures comprise: the green infrastructure including all the green natural areas; the blue infrastructure including sustainable drainage and water conservation system and the overall hydrological management; the grey infrastructure including roads, drains and sewerage utilities; and the red infrastructure including the built environment, the enclosures and hardscapes, as well as the basic human activities. The integration of these four infrastructures provides the basis for eco-master planning and for designing ecological urban environments.

A good example of a direct response from the design and planning profession to climate change generated disasters is the case of Hurricane Katrina in 2005. As a response to the devastation of Hurricane Katrina, the Governor of Mississippi established the Commission on Recovery, Rebuilding and Renewal. One of the first initiatives of the Commission was to organise a week-long charette where prominent architects, urban planners and designers and engineers met with community leaders

and local developers and produced a set of policies, strategies and smart design codes for future development in coastal towns ravaged by Katrina. The design codes were also prepared for immediate housing for workers and the displaced residents. A Planning Framework for the Mississippi Gulf Coast was based on a Transect concept[1] ([Mississippi Renewal Forum, 2008](#)).

Universities, research centres and institutes have provided sufficient ground and stimulus for research into the field of urban planning and design for climate change. Substantial research into the field of climate responsive design and planning was carried out by the Centre for Sub-Tropical Design at the Queensland University of Technology. The major objective of the research was to identify the local sub-tropical character of the region and, based on the major findings, develop a set of design and planning guidelines for sub-tropical design of buildings and spaces between buildings. The guidelines took into consideration issues, such as topography, open space diversity, local building traditions and the use of native vegetation. The major findings of the research were published in the form of a handbook design manual targeting the local planners, designers, developers and decision makers ([Centre for Subtropical Design, 2010](#)).

Case study: Brisbane, Queensland, Australia

Throughout the twentieth century, Australian cities have been growing rapidly. Suburbs have sprawled into former bushland areas, significantly increasing the chance of bushfires, and residential development has been encouraged along waterways and canals, raising the vulnerability of new neighbourhoods to floods, wave surges and sea storms. Management of the urban environment in Australian cities has been on the priority list for all levels of government, including the federal, state and local, in the past two decades ([Smith and Scott, 2006](#)). In recent years, much emphasis has been given to climate change and its possible implications for major Australian urban centres.

Among Australian states, Queensland is the most vulnerable to the impact of climate change ([Gurnaut, 2008](#)). This has been accentuated in recent years by natural phenomena, such as the seven-year long drought in the southeast corner of the state, the 2011 Flood and Cyclone Yasi in the northern coastal regions ([Department of Natural Resources and Water, 2007](#)). Since 1994, sustainable development principles have been included in a range of Queensland legislative and planning instruments ([Department of Infrastructure and Planning, Queensland Government, 2009a](#)).

Southeast Queensland is the fastest-growing region in Australia attracting an average of 55,000 new residents per annum. The population of Southeast Queensland is around 2.5 million, covering an area of 22,000 km² and including 11 regional and city councils. The current climate in SEQ is sub-tropical and typically features hot rainy summers and mild, dry winters ([Department of Infrastructure and Planning, Queensland Government, 2009a](#)). The coastal zone of the region is characterised by sandy beaches and sand islands scattered across Moreton Bay. The region also features 18 river catchment areas and mountain ranges in the western part. Major cities of the region include Brisbane with a population of 1.6 million (Brisbane Statistical Division) and Gold Coast with a population of 500,000. Brisbane, the capital of Queensland, was settled in the 1800s, and the core of the city was developed around the Brisbane River. When the city grew, the river and ancillary creek flood plains were all developed ([Centre for Subtropical Design, 2010](#); [Brisbane City Council, 2012c](#)).

The rapid growth of the Southeast Queensland Region and the impacts of climate change require sustainable urban development which responds to local climatic conditions and character. Urban policies addressing climate change and promoting low-energy urban forms and low-energy building design, requiring an integrated approach to urban planning and design, have been adopted at regional, municipal and local levels ([Centre for Subtropical Design, 2010](#)).

At the regional level, the Southeast Queensland Regional Plan contains a whole section dedicated to sustainability and climate change. One of the priority objectives of the Regional Plan is to reduce Southeast Queensland's carbon footprint by one-third by 2020, mainly through reduced car and electricity use. Regional policies addressing the impact of climate change focus on strict development control of areas exposed to flooding, storm tide, coastal erosion, bushfires and landslides. The policies also require the preparation of local strategies aimed at minimising vulnerability to heat waves and high temperatures, intensive rainfall, cyclones, severe winds and storms. ([Department of Infrastructure and Planning, Queensland Government, 2009b](#)).

Local and regional councils across Southeast Queensland have responded to requirements of the Regional Plan by addressing climate change in planning schemes and local planning instruments and by drafting local climate change strategies ([Gold Coast City Council, 2009](#)).

Brisbane developed a city-wide climate change and energy action plan in 2007 that could be a benchmark for similar studies. The plan was developed by a taskforce comprising university scholars, business representatives and NGO leaders. The taskforce conducted a series of community engagements before presenting its final report. The final report includes 31 recommendations across 8 strategy areas, including leadership and partnering, decision-making, communication, planning, sustainable transport, preparedness for change, diversification of natural resources and research. It sets a goal of zero greenhouse emissions by 2050 with households being carbon neutral by 2020. Steps to achieve this include strong regulations on energy efficiency, investment in renewable materials and a very strong emphasis on transit oriented development (TOD) ([Newman *et al.*, 2009](#); [Brisbane City Council, 2007](#)).

One of the most effective city-wide documents in addressing climate change is the Brisbane Streetscape Design Guidelines. The Brisbane Streetscape Design Guidelines provides advice to a range of users for streetscape upgrades across the city. A hierarchy of streetscape types has been developed to suit the predominant land use type and anticipated pedestrian usage. The document provides guidance on elements and materials for footpath upgrades and landscaping treatment along the frontages for all new developments. The long-term aim is to create a sub-tropical street environment in Brisbane ([Brisbane City Council, 2011a](#)).

At the local level, the New Brisbane City Centre Master Plan promotes the Brisbane River as the main geographical feature of the city. Strong emphasis is placed on providing outdoor entertainment and living areas, sub-tropical streets and tree-lined boulevards, and design solutions for the built form encouraging sky-terraces and green rooftops. A green web running through the heart of the city and linking two major urban parks, the Roma Parklands and the Botanical Gardens, was proposed ([Brisbane City Council, 2013f](#)).

In contrast to the City Centre Master Plan, the notion of climate change in other neighbourhood local plans prepared for the inner city parts of Brisbane is rather

superficial and addressed in a rudimentary manner. A review of five draft local neighbourhood plans for Milton, South Brisbane Riverside, Toowong-Auchenflower, Bulimba and Kangaroo Point Peninsula, reveals a lack of detailed ecologically sustainable design guidelines for the buildings and the public spaces (Brisbane City Council, 2013a, 2013b, 2013c, 2013d, 2013e).

Recent political changes in Australia (the conservative Liberal-National coalition winning the Queensland State elections in 2012 and the Federal elections in 2013) introduced a new approach to addressing climate change. The new Federal government abolished the carbon tax introduced by the previous Labor administration, while the Queensland State government dismantled the Office of Climate Change (Sydney Morning Herald, 2013). In Queensland, the focus has shifted to issues in favour of the economy and competitiveness. This is evident in the new City Plan for Brisbane, where none of the five major planning themes refer directly to climate change or building a resilient and fully sustainable city (Brisbane City Council, 2015).

Response to the Brisbane flood of 2011

The floods of 2010-2011 that ravaged the entire state of Queensland were unprecedented, creating a multi-billion dollar infrastructure catastrophe. According to a report prepared by Price Waterhouse Coopers (2011), the floods impacted around 70 per cent of the State and affected almost 60 per cent of Queensland's population. The total damage to the State's public infrastructure, businesses and buildings was estimated at around 5 billion dollars. Many urban areas were inundated, including the central parts of Brisbane, Toowoomba, Ipswich and Rockhampton (Price Waterhouse Coopers, 2011).

Brisbane experienced major floods in 1893 and 1974. The Brisbane River flows directly through the central parts of the city, so any flooding has a profound impact on the central city urban environment. Following the 1974 flood, the Wivenhoe Dam was built in 1984 and located 80 km upstream from Brisbane. Wivenhoe Dam was constructed to mitigate future severe floods and prevent smaller ones (Barry, 2011). According to Barry, the dam's reservoir in 2008 bottomed out at 17 per cent at the height of a prolonged, almost seven-year-long drought. As a result of the intense rains that followed the drought, which was brought about by a strong La Niña[2], in the final days prior to the Brisbane Flood, the water volume reached 1 million mega-litres, twice that of Sydney Harbour. The 2011 Brisbane Flood could have been partially mitigated if SEQ Water (the government agency managing the distribution and storage of water in the Southeast Queensland Region) had been quicker to respond and had gradually released the water downstream. Large amounts of water were released only a few days before the flood, which only contributed to the magnitude of devastation (O'Brien, 2011). According to Brisbane City Council (2012a), the flood affected 22,000 homes, 7,600 businesses and damaged the infrastructure, transport, assets, waterways and community facilities. The total recovery costs were estimated at \$400 million (Brisbane City Council, 2012a).

Brisbane City Council responded quickly to the devastation caused by the flood by preparing an Action Plan for the Flood Recovery and Temporary Local Planning Instruments (TLPI) to guide development and building on flood prone land as well as to provide directions for repairing and renovating houses destroyed by the flood (Brisbane City Council, 2012b). The TLPI covers the inconsistency and inadequacy of the current Planning Scheme regarding flood affected areas. The interim town planning regulations

allow owners and developers to increase the height of the buildings by raising the ground level above the designated flood level. The new provisions require the location of essential services (electricity, telecommunications and fire services) in higher sections of the building to avoid interaction with water. The Temporary Local Planning Instruments also address the construction of retaining walls and impose, where necessary, the use of resilient building materials ([Brisbane City Council, 2012b](#)).

The response from Brisbane City Council by introducing interim planning regulations and building design guidelines was effective but superficial and short term. A city battered by a natural phenomenon that caused severe consequences in the economic, social and cultural fronts needs more comprehensive long-term and bold solutions, strategies and policies that address the natural setting and features, specific local conditions, the unique topography and scenic amenity of the city. The current neighbourhood plans such as the Toowong – Auchenflower Neighbourhood Plan, the Bulimba Neighbourhood Plan and Milton Neighbourhood Plan do not sufficiently address the implications of climate change or emphasise on the possible implications of another flood event ([Brisbane City Council, 2013c, 2013d, 2013f](#)).

On a city-wide scale, Brisbane City Council prepared the River's Edge Strategy that guides the Council's planning to enhance the river's recreational and economic development opportunities for the next 10 years. The River's Edge Strategy catchment area includes the stretch of the Brisbane River from the University of Queensland at St Lucia through to Northshore Hamilton, encompassing both sides of the river. The Strategy secures a majority of the River edge for recreational and leisure purposes, and further identifies a series of future potential projects. If successfully implemented, then this strategy can become another milestone in creating a more sustainable and climate responsive built environment ([Brisbane City Council, 2013g](#)).

Another city-wide attempt to mitigate the flood problem is the Flood Smart Future Strategy 2012-2031. The Strategy that ensures sustainable planning, economic development and smart growth is achieved in the city's food plain areas. The document is based on four principles targeting community well-being balancing social, economic and environmental objectives, promoting responsible development appropriate to the risk of flooding and the use of integrated flood management tools.

An ambitious and cutting-edge research project, attempting to identify the optimal future vision of the sub-tropical city of Brisbane in the context of climate change, was conducted at the University of Queensland by [Andresen and Francis \(2010\)](#). The aim of this project, called Sedimentary City: Brisbane, was to search for the natural environment of the city and determine the future image of the sub-tropical Brisbane of tomorrow. The entire process included preparation of map layers to undertake an analytical view of today's city environment and its future based on the trajectory of the current city planning scheme. The next step was unfolding the city's development chronology and finally producing an optimal vision of subtropical Brisbane of tomorrow. The project was divided into three stages; Envisioning 1, 2 and 3. Selected scientists, artists and poets were invited to contribute in mapping the identity of the city.

In the Envisioning 1 Stage, the city's green public spaces were identified, by excluding from the aerial view of the city's perceived green environment all private areas, cemeteries, sports ovals, etc. The outcome resulted in a map of today's green public spaces visually and physically fragmented, unconnected to the city and to the wider ecology of the natural environment. The next step was to identify the future image

of the city by following the recommendations of the current Brisbane's Planning Scheme promoting unlimited heights for the buildings in the Central Business District, tall buildings along the River, urban consolidation, infill development and an expanded urban infrastructure. The outcomes were two future scenario visions of the city centred around two alternative weather cycles, El Nino and La Nina:

- (1) The inferno city which is a direct result of an extensive El Nino period characterised by a long drought. The city is illustrated as a scorched and radiant city layer where the sub-tropical green landscaping has been replaced by a concrete jungle.
- (2) The flood city which is a direct result of an extensive La Nina period characterised by heavy downpours, frequent storms and wave surges. Major parts of central city and urban areas along the Brisbane River are inundated by a series of major floods.

In the Envisioning 2 Stage, an attempt is made to find the natural environment of the first indigenous settlement by analysing and unfolding past historical maps. This part of the process was done by analysing and editing the earliest survey maps to reveal in each case its underlying palimpsest. The map of the first settlement was constructed from all the palimpsests and supplemented by details from the surveyor's field books. The analysis and superimposition of various map layers helped to draft a map of the first settlement where the watershed of the river remained intact and residents lived in a symbiotic relationship with the natural environment. It should be added that the first township of Brisbane established by the British in 1824 was above the flood plain to avoid direct confrontation with the forces of nature. However, throughout the nineteenth and the twentieth century, this natural floodplain was transformed and overburdened with buildings and infrastructures. The streams and creeks, once part of the natural watershed, were buried in pipes or covered by hard surface concrete.

In the Envisioning 3 Stage, the map layer of the first indigenous settlement is superimposed on the future inferno and flood city. The result is an optimal sub-tropical city of the future where the former watershed of the Brisbane River is reinstated. Citizens of the consolidated city live within easy range of the creek side pathways and of the riverside greenways. The reinstated flood plain landscapes and the public green open spaces offset the intensity of the consolidated city.

The Sedimentary City Project finds an alternative solution to future flood security by promoting green-space amenity in the ancient river floodplain of the first settlement of Brisbane. The research and recommendations by Andresen and Francis set the grounds for a new innovative thinking characterised by in-depth analysis of the city's layers, identifying the natural features that govern the eco-system and providing sustainable outcomes for future development. Integrating the natural and the built environments is a good response to the impacts of climate change and a step forward in achieving a more resilient city. The major findings of this research should be considered in any planning strategies and policies for the city.

Major findings

Review of the regional, city-wide and local-neighbourhood planning documents in the Southeast Queensland Region revealed that there is a strong emphasis on climate change at the regional level, and effective climate change strategies are being prepared

at the city-wide level. However, the climate change theme in the new statutory city plan, local and neighbourhood plans is rather superficial and the issue is addressed in a rudimentary manner. [Table 1](#) identifies all major regional, city-wide and local-neighbourhood planning documents and strategies and indicates their effectiveness in combating the implications of climate change.

The State government identified two major reasons for the vague response in the local and neighbourhood plans in Brisbane to the climate change strategies. First, there is no formal process of collaboration and joint administration between the two levels of governance, and second, there is no effective cohesion between different scales of planning intervention.

According to [Gilham \(2002\)](#), it is almost impossible to implement or administer a regional policy unless a group of local authorities agrees to work together in a formal process. Currently, in Southeast Queensland, there is no formal process for coordination and cooperation. Unlike the regional plan and policies, which in nature are strategic planning documents with long-term objectives, the local plans are statutory documents with short-medium term objectives, specific codes and requirements heavily bounded by the provisions of the Queensland Sustainable Planning Act ([Department of State Development, Infrastructure and Planning, 2014](#)). In identifying a vision for a resilient city, [Newman *et al.* \(2009\)](#) have listed seven overarching themes. One of the themes emphasises the cities and regions working together in a collaborative manner to achieve a vibrant local economy and a unique sense of place. This smooth collaboration and bipartisan working approach needs to be reinforced in the Southeast Queensland Region.

It is essential to ensure cohesion between various planning scales of intervention to achieve an effective local planning response to state government objectives. The different scales of urban design and planning interventions are explored by [Frey \(1999\)](#). They amplify interdependence and scope. Frey argues that a development/planning framework for the city or conurbation must co-ordinate the development of individual districts within the city and determine the general development structure. Frey further emphasises the importance of achieving cohesion between various scales of intervention. In Southeast Queensland, there is lack of cohesion between various levels of planning. Although the local plans have to respond to state and regional strategies and policies, the professional planning teams responsible for drafting state government planning policies are not directly involved in the preparation of the local plans. It is imperative for regional and state bodies to be directly involved in the preparation of local-neighbourhood plans to ensure better interpretation of state directives and policies at the local level.

Conclusions

Stockholm, the capital of Sweden, is commonly regarded as the “greenest” city in the world. The city introduced an environmental program as early as the 1970s and in the late 1980s launched a comprehensive city plan promoting cohesion between all levels of planning. In response to regional and city-wide objectives, the local plans have adopted a concept of symbio-city which is based on synergies between sewerage, waste, energy, water supply, land use and public transport ([Metzger and Olsson, 2013](#)). Such sustainable planning policies at all scales from regional to local significantly contribute to creating a city resilient to the impact of climate change. Brisbane and the Southeast

Planning document, strategy, guidelines	Scale of intervention	Scope of policies addressing climate change	Effectiveness in addressing climate change
Southeast Queensland Regional Plan	Regional	There is a whole section dedicated to addressing climate change in the region	Effective as it provides guidelines for all local authorities in the region
Subtropical Design in Southeast Queensland: A Handbook for Planners, Developers and Decision Makers	Regional	The whole document based solely on a university research project provides sub-tropical guidelines for the built form and public realm in the SEQ Region	Very effective document in sending a message to the development industry on the necessity of addressing climate change in future developments
Brisbane Peak Oil and Climate Change Strategy	City-wide	The document prepared with a task force of experts sets a target for zero carbon emissions by 2050	Effective document as it informs the city wide planning scheme currently under preparation and other city-wide strategies
Brisbane Street Design Guidelines	City-wide	The whole document provides detailed guidelines for sub-tropical landscaping of streets in Brisbane	Very effective document as it will significantly contribute to greening the streets of subtropical Brisbane
The River Edge Strategy	City-wide (central and inner city only)	The document does not directly address climate change but provides guidance for establishing a sense of place and identity along the Brisbane River	Effective document as it contributes to directly preserving and enhancing the riparian amenities in central and inner city Brisbane, which is an important element in climate responsive design and planning
The Brisbane Flood Smart Future Strategy	City-wide	The Strategy contains a comprehensive strategy addressing flood management, an integrated approach to smart planning and building in the flood plain land	Effective document as it provides clear guidance on flood mitigation and management
Planning document, strategy, guidelines Milton Neighbourhood Plan	Scale of intervention and type of document Local neighbourhood	Scope of policies addressing climate change Addresses design for buildings and public space in general Design requirements for dwellings on flood prone land merely duplicate the provisions of the TLP1	Effectiveness in addressing climate change Weak in addressing climate change. Although targeting flood prone land, the climate change theme is not the main driver of the document. Although the area was flooded, the document does not provide sufficient detailed guidelines for climate responsive built forms and the public realm
Kangaroo Point Peninsula Neighbourhood Plan	Local neighbourhood	Addresses the design and buildings and the public realm. However, lacks a section dedicated to sub-tropical and sustainable design	Weak in addressing climate change. The issues regarding climate change and ecologically sustainable development is not sufficiently emphasised in the document
South Brisbane Riverside Plan	Local neighbourhood	Addresses the design and buildings and the public realm; however, lacks a section dedicated to sub-tropical and sustainable design	Weak in addressing climate change. The issue regarding climate change and ecologically sustainable development is not sufficiently emphasised in the document

(continued)

Table I.
Effectiveness of
planning documents,
guidelines and
strategies in
addressing climate
change

Table I.

Planning document, strategy, guidelines	Scale of intervention	Scope of policies addressing climate change	Effectiveness in addressing climate change
New City Centre Master Plan	Local district	Promotes sub-tropical streets and boulevards, outdoor space activities and sub-tropical building design	Effective documents as it portrays a clear sub-tropical vision for the Central City supported by a set of illustrative design guidelines
Bulimba Neighbourhood Plan	Local neighbourhood	Includes general design provisions for buildings and outdoor spaces. However, lacks a section dedicated to sub-tropical and sustainable building design	Weak in addressing climate change. Although targeting flood prone land, the climate change theme is not the main driver of the document. Promotes more public space along the River but lacking in specific guidelines
Toowong-Auchenflower Neighbourhood Plan	Local neighbourhood	Includes general design provisions for buildings and outdoor spaces but lacking sections dedicated to sub-tropical and sustainable building design	Weak in addressing climate change. Although targeting flood prone land, the climate change theme is not the main driver of the document. Promotes more public space along the River; however, lacks in specific guidelines
Brisbane City Council, 2015	City-wide statutory plan	Includes policies addressing flooding, coastal hazards, potential bushfires and water conservation	Climate change and building a resilient and sustainable city are not one of the major themes of the plan

Queensland Region, one of the most vulnerable areas in the world as far as the impact of climate change is concerned (Gournaut, 2008), as yet cannot display similar achievements in policies addressing sustainability and climate change.

In 2013, Brisbane was hit by another massive flood of a lesser magnitude than the 2011 event. However, 3,500 properties in the City Centre and inner city areas were affected. This latest phenomena is a reminder that the adverse impact of climate change are likely to be a permanent feature for the Southeast Queensland and Brisbane environments (Australian Broadcasting Corporation, 2013). Nevertheless, the local authority has not increased the emphasis on climate change in the local-neighbourhood plans, and the new statutory City Plan has not included planning for climate change as one of its leading planning themes. The outcomes of the research carried out by Andersen and Francis (2010) have not been reflected in any local and city-wide planning documents. The current State Government has also shifted the clock backwards by closing the Office of Climate Change.

Climate change is a global issue requiring an urgent response from all levels of government, the design and planning professions, scientists and researchers, the development industry and the community. The other important issue is introducing comprehensive programs aimed at developing awareness among the community on the possible adverse impact of climate change. Internationally, it is recognised that human activities such as the burning of fossil fuels and dispersed land uses are responsible for a continuing and rapid increase in the level of greenhouse gases.

Recent research on climate change in urban areas has indicated that the amount of weather-related disasters is on a rapid rise. With current and often uncontrolled development, some cities are headed for collapse. The lessons learned from Brisbane indicate that promoting fast-track development for economic gain and ignoring the natural features and local climatic conditions can result in grave consequences. The short-term economic gains are often outweighed by much higher recovery costs.

The case of the 2011 Brisbane Flood and the response to a natural disaster revealed that mediocre design and planning measures may be effective for the short term but urban environments located in climatically vulnerable settings require long-term solutions. These long-term solutions have to be supported by in-depth analysis of the local conditions and comprehensive studies of the natural settings and local climate. Effective and climate-responsive urban planning and design must ensure that all environments, including the natural environments, are considered in the process. A flawless bio-integration of the urban development and the natural habitats are a recipe for creating cities which are more resilient to the impacts of climate change. Climate-responsive solutions to our cities must start from wider regional and municipal strategies. Addressing the adverse impact of climate change should be a fundamental precept of all regional, city-wide municipal and local plans, as well as neighbourhood plans and larger site master plans.

Regional and city-wide municipal plans must address climate change by identifying preferred land uses, transport corridors, an interconnected network of green spaces. Strategies for areas sensitive to climate variations should be formulated at this scale. Local and neighbourhood plans must respond to regional and municipal plans by listing implementation actions aimed at greening the city and enhancing the public realm. Design codes for development addressing issues such as thermal comfort, energy

efficiency and water conservation must be included. Separate detailed master plans should be prepared for areas susceptible to extreme weather conditions.

Future design solutions must be flexible and be able to adapt to the pressures of climate change ensuring stability and robustness in the environmental, economic and social infrastructures. Combating climate change with planning and design measures must be conducted through consensus, mutual understanding and cooperation among all stakeholders, including the community and the development industry.

Notes

1. Transect is a geographical cross-section of a region that reveals the sequence of environments.
2. Nowadays, the term El Niño refers to the extensive warming of the central and eastern Pacific that leads to a major shift in weather patterns across the Pacific. In Australia (particularly eastern Australia), El Niño events are associated with an increased probability of drier conditions. In contrast To El Nino, the term La Niña refers to the extensive cooling of the central and eastern Pacific Ocean. In Australia (particularly eastern Australia), La Niña events are associated with increased probability of wetter conditions. (Bureau of Meteorology: Climate Glossary) www.bom.gov.au/climate/glossary/elnino.shtml

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