Chapter 35
Options and Strategies for Balanced Development for Liveable Cities: An Epilogue

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Abstract This chapter provides a snapshot of what is covered in the preceding chapters on options and strategies for balanced development leading to liveable cities. The chapters are organized under nine sections, including peri-urbanization; culture and social economy; land use planning; water security; wastewater and irrigation; urban agriculture and food security; impact of climate change and adaptation; legal, policy and institutional framework; and integrated urban development. The chapters under these sections cover a broad range of issues for the planning of future cities and peri-urban regions with respect to (1) balanced urban development policies and institutions for future cities; (2) understanding the effects of land use change, population increase, and water demand for the liveability of cities; (3) long-term planning needs and transboundary approaches to ensure secured future for generations ahead; and (4) strategies for optimal land, water, and energy uses for viable and liveable cities. The book emphasizes integrated planning for future development of liveable, resilient, and sustainable cities and peri-urban areas.

Keywords Peri-urbanization • Social economy • Land use planning • Water security • Wastewater irrigation • Urban agriculture • Food security • Climate change • Integrated urban development

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35.1 Introduction

Thorbeck (2012) defined an urban area as an area that has the characteristics of a city, meaning it has buildings and towns that define the urban landscape. He defined a rural area as an area that combines natural and human characteristics, meaning buildings and towns are components of open landscapes and ecosystems. Both urban and rural areas aim to embrace quality of life. Haughton and McGranahan (2006) explain that “urban ecology has become multi-scalar, extending from individual urban systems to systems of cities and towns, and from ecosystems within urban settlements to urban settlements as ecosystems, to the way in which cities and towns shape ecosystems beyond as well as within urban boundaries.”

Migration of people from rural areas to urban areas is a global phenomenon and is occurring at an accelerating pace, particularly in developing countries, such as Brazil, China, Egypt, India, and Mexico. People are moving for economic advancement, in search of jobs, better educational opportunities, easy access to needed health services, availability of transport services, particularly airports, cultural, entertainment and recreational amenities, and potential for start-up businesses. Currently, the world population is over seven billion and there is almost an even split of the population living in rural and urban areas. It is estimated that by 2050, the global population will increase to about ten billion. Much of the increase will occur in urban population largely because of migration. The migration is leading to urbanization, with the result that urban development is moving into the countryside, eliminating much of the best farmland surrounding cities. It is therefore of utmost importance that urban design and planning undergo a new thinking such that areas of transition from rural to urban and land use at the urban/rural edge in the peri-urban landscape are managed from both urban and rural perspectives in order to shape, manage, and preserve the ecosystems that people depend upon. In many countries, some of the highly valued natural resource assets, such as biodiversity, native vegetation, wetlands, and waterways, occur in peri-urban landscapes. Peri-urban agricultural production is important globally and its value will rise in view of the impacts of climate change, energy costs, rising world population, and changing patterns of food consumption.

Urban centers are the highest centres of anthropogenic activities causing the build-up of Green House Gases (GHG), such as CO$_2$ and methane, leading to increased global temperature. Cities are major consumers of fossil fuels with over 80% of the global consumption. Urban areas represent sites of high consumption of energy and production of waste. Global sustainable development is therefore tied to the management of growing urban influence.

Rivers situated in peri-urban landscapes constitute the prime natural resource base for the urban construction industry. Studies show that while the river is the source for water supply for many cities, it is the sectors doing sand and clay mining for the construction industry and dumping waste that are causing social and environmental degradation. Plausible remedial measures are the integration of fair and effective intervention by government authorities, and stakeholder education with technical measures and economic instruments.
35.2 Peri-Urbanization

Thomas Sieverts (2003), the Berlin-based planner, calls the peri-urban lands the ‘in-between lands.’ The implication here is that urban-rural landscapes can be a new form of city that intermingles built-up areas and rural landscapes. He has been advocating the development of a new cultural landscape in which food production, recreation, and ecological balance create new relationships with built-up areas. This leads to the development of new urban agriculture associated with hybrid urban forms which innovatively combines architecture, landscape, infrastructure and high technology farming. Rural urbanism may retrieve lands for urban agriculture. Hence, urban agriculture may contribute to sustainable, climate-optimised, urban development.

Rural areas around the world are undergoing profound demographic, economic, cultural, and environmental change, creating considerable challenges and stress for their residents and on the ecosystems upon which they depend for their livelihood and quality of life. Critical global issues, such as climate change, renewable energy, water resource protection, food security, and healthy human development, have begun to receive much attention these days nationally and internationally. The peri-urban landscape is of particular concern, because urban expansion has historically required large amounts of land for developing infrastructure and public services.

Peri-urban areas are attractive for living in a semi-rural setting. However, sometimes people and nature come into conflict, as birds, animals and plants often do not respect property boundaries or intrude into the lives of residents in the interface areas. Thus, it becomes a challenge for public land managers and local governments to manage such conflicts. Further, in order to help resolve land-use issues in the peri-urban landscape and improve the quality of life and the economies of people living and working in both rural and urban areas, it is important to incorporate the connection of urban and rural futures in rural design.

Archaeological evidence points to the pivotal role that peri-urban zones once played in the survivability of ancient urban centres. Over the last three to four decades, accelerating urban growth and associated transitional changes have posed major challenges to the development of resilient cities that are capable of absorbing climatic, economic and environmental shocks. Industrialisation and market interdependence have altered urban fringes, increasing environmental impacts, such as the loss of natural resources and environmental buffers which are now regarded as essential for urban resilience. Further, environmental change and increasing socio-economic inequality are generating new priorities, as peri-urban zones consolidate, erode and shift outwards. An argument can therefore be advanced for a hybrid approach to the planning and design of peri-urban interfaces, that draws on integrated, agropolitan-type perspectives embedded in a resilient, locally appropriate regional-urban focus within broader socio-spatial and geo-economic framework.

One of the consequences of urbanization is the increase in pollution, containing trash and litter, sediment, suspended solids and emulsified hydrocarbons. These pollutants pollute urban runoff. The removal of contaminants from urban runoff waters is vital to preserving the health of urban communities that live in contact with and around the receiving waters.
35.3 Peri-Urban Culture and Social Economy

By bridging science and society, transdisciplinarity permits the translation of knowledge into useful and relevant information for planners and decision-makers. There are a multitude of socioeconomic realities that demand different and specific political approaches to sustainable peri-urban territories. The social economy of peri-urban areas considers identities and lifestyle issues, such as age, family patterns, living and working conditions, and economic characteristics, such as main economic activities, economic organization and structuring, and attractiveness. The influence of a metropolitan area is expressed by continuing investments in peripheral areas that offer sources of labor and natural resources, such as land. The presence of industries, services, logistics and distribution platforms, enterprises, housing, and chain-stores constitutes a manifestation of this influence. Further, the peri-urban landscape can be a hybrid territory promoting the coexistence of a rural-agriculture matrix where distinct activities coexist defining distinct degrees of specialization/diversity of the economic fabric.

The increasing tendency to urbanisation is now a reality. The high growth rate of the urban population increases the demand for agricultural commodities on one hand and widens the demand for land for the construction of houses, roads and other civil amenities on the other hand. With expanding urban areas, the adjoining rural areas are transforming to peri-urban areas in terms of facilities, amenities, and lifestyle. This transformation is tremendously increasing the value of land in peri-urban areas for cities. This culminates in the changing scenario of land utilisation, change in farming system, and composition of household income in peri-urban areas.

35.4 Peri-Urban Land Use Planning

Peri-urban areas are undergoing radical change in much of the world, displacing traditional agriculture and reducing the capacity of cities to adapt to non-linear change. It is important to relate rural and urban land supply and demand; develop land use planning techniques for limiting rural land development and transferring demand for rural land to regional settlements; establish stronger statutory planning measures in order to stem the loss of peri-urban agricultural land; and develop a range of strategies to strengthen the resilience of city food systems. Urban resilience is best maintained through a regional approach which connects urban and peri-urban systems. Maintaining the natural resource base for food production around cities would become an increasingly important part of city planning.

Engaging landholders in natural resource management is a challenge in any landscape, and is inherently more difficult in peri-urban landscapes. Current paradigms employed for engaging peri-urban landholders in natural resource management are in many cases based on conventional methods. However, the design and delivery of engagement must be modified in order to be effective in peri-urban landscapes.
Maintaining the rural character of peri-urban landscape is a significant challenge, especially when permitting sustainable agriculture, horticulture and forestry. The Western Sydney Parklands is an example of urban park system located in Western Sydney with a view to develop a master plan for future land uses, called the Western Sydney Parklands Plan of Management 2020. The Parklands is a 27 km long public open space corridor of approximately 5200 ha. This plan includes a commitment to provide 10% (or about 500 ha) of the Parklands for urban farming. The objective is to develop an approach for converting fallow public land to productive space by providing commercial growers a secure tenure in the Sydney basin. The implementation of the master plan will have a number of vexing challenges, including legislative and regulatory processes; environmental; and social issues.

### 35.5 Urban Water Security

Urban wetlands and water bodies play a pivotal role in influencing the urban environment, for they reduce overheating of the environment and function as natural water purification systems. Their significance notwithstanding, urban wetlands are either diminishing or shrinking from their original shape and size due to the pressures mounting from the housing sector and unplanned urbanisation.

Natural wetlands act as nature’s own purification plant. In the presence of different plant species they purify the wastewater in a natural way by reducing the COD content of water, oxygenation, elimination of pathogens, ammonium degradation, degradation of nitrate, and removal of phosphates and heavy metal. It is observed that the filling up and shape modification of water bodies from their original shapes significantly affect the urban micro-climatic cooling capacity and natural water purification potential. Several studies indicate that pollution of an urban water body due to human induced land use is correlated with its shape and complexity. Water bodies with simple geometric shapes are related to human induced land use, whereas natural water bodies are mostly of complex geometric shape. Water bodies with complex geometric shapes can reduce the magnitude of water pollution. Relationships have been found between water quality of urban and peri-urban water bodies and shape complexity, micro-climatic temperature and land use around water bodies.

Urban wetlands enhance habitats for birds and fish, and help establish a thriving ecosystem which would also enhance recreational activities like bird watching. Wetlands also help recharge groundwater which in turn reduces the vulnerability to earthquakes. Urban land use has a direct impact on urban microclimate that results in Urban Heat Island Effect. Urban water bodies play an effective role in micro-climatic cooling of the urban area. Urban wetland areas serve as ‘landscaped water parks’ that can be used for water purification and micro-climatic cooling, leisure and park amenities. Urban cooling can help reduce the growing energy crisis in cities. Further, the wetlands can help deal with the recycled urban waste water by natural means.
Growth and density of population and urbanisation influencing groundwater indicate that large cities may soon face a groundwater crisis, if the population influx is not retarded. The reduction in the influx can be accomplished by improving economy and infrastructure in the adjoining regions, thus making large city centers less attractive for the migrating population. Further, the construction activity, especially in recharge zones, should be prohibited in order to ensure future groundwater sustainability.

In most peri-urban communities of developing countries, shortages of domestic water supply relative to demand are a common feature. This is because most of these peri-urban communities usually fall outside the physical boundaries of urban water supply. Thus, the people who live there are forced to consume water from doubtful sources that may contain pathogens found in human faeces. Apart from consuming water from doubtful sources, most of these inhabitants travel long distances to collect water or pay dearly to purchase it from water vendors.

Three factors that impede a safe water supply in peri-urban communities are open defecation near the water source, dominant type of land use near water sources, and contaminated refuse dumps found in most of these peri-urban communities. There should be water policy documents by governmental bodies to prohibit these unsafe practices.

In the developed world recent years have witnessed a dramatic increase in exploration and production of coal seam and shale gas in peri-urban areas using both the hydraulic fracturing (fracking) technique of gas production and the method of extraction of naturally occurring groundwater by pumping it from coal formations to release coal seam gas. This has given rise to growing concerns about water security. In order to maintain and increase the natural resource base as well as the need to protect and sustain the supply of potable and agricultural groundwater in peri-urban areas, one important issue is whether the increasing popularity of fracking in peri-urban and semi-rural areas poses a risk to the quality of groundwater supply as well as its contamination. The other issue of concern is whether the extraction of groundwater from coal seams where fracking is not needed has a major impact on groundwater depletion and what the risk is and how the risk should be managed.

Fracking involves pumping of ground water, sand and chemicals under high pressure into layers of coal or shale to create fissures or cracks that force gas to the surface, where it is collected and processed. The technique impacts water supplies in two main ways. First, it requires large quantities of water at the pumping stage and it is alleged to produce vast amounts of contaminated groundwater containing chemicals known collectively as BTEX, methane gas and excessive amounts of salt. The evidence based on the development of drilling sites using fracking in many areas suggests that environmental concerns may not be given as much consideration as they should be, particularly because compliance with environmental risk assessment is not rigorously specific.
35.6 Wastewater and Irrigation

Because of its reduced treatment cost relative to seawater desalination and imported surface water, the supply and sustainable use of recycled water may play an important role in enhancing urban water supplies in many water-scarce parts of the world. Despite significant benefits of recycled water, there are several concerns related to environmental and health risks. If not properly managed, recycled water may deteriorate soil health in terms of increased salinity and sodicity, heavy metal accumulation and decreased hydraulic conductivity of soil. However, there are ways to reduce risks of recycled water due to urban irrigation, including national and state-wide standards of recycled water quality for urban irrigation, sustainable urban water management strategy, and pollutant control framework.

The need for irrigated agriculture is increasing day by day and the largest water withdrawals from renewable water resources are for irrigation. On the other hand, the available water resources are decreasing and non-conventional water resources for irrigation are therefore needed. However, the volume of wastewater being treated and used is limited due to the lack of adequate data and knowledge and/or negative effects of improper wastewater management (i.e. use of untreated wastewater). Although a study of wastewater irrigation from crops, soil, groundwater, health, irrigation equipments, modern technologies, and other environmental aspects is useful, management studies in comparison with other aspects can lead to more reliable and more extensive findings and finally a better decision on using wastewater for irrigation. There are challenges and prospects that may help decision making for the use of wastewater in irrigation.

There is, however, the question of the effect of reuse of wastewater in the peri-urban area on the quality of soil, vegetable crops and groundwater in reference to heavy metal contamination. Heavy metal accumulation in groundwater irrigated vegetables has been found to increase with increasing contamination of these metals in the groundwater at different locations. However, the metallic accumulation in vegetable crops, such as cauliflower, cabbage, brinjal, spinach, tomato and radish, irrigated by groundwater at many locations have been found to be within the maximum permissible limits as prescribed by World Health Organization (WHO). For wastewater irrigated spinach, tomato and radish the accumulation of Fe, Zn and Cd has been found to cross the maximum permissible limits. In particular, urban wastewater irrigated spinach has been found to have accumulated Fe, Zn and Cd to a great extent (more than the maximum permissible limit) and is most unsafe for human consumption.

35.7 Urban Agriculture and Food Security

Industrial agriculture is becoming part of the food system that is the dominant mode of feeding many cities. However, this food system has caused crises in public health in the form of rising incidence of non-communicable disease linked to diet; and
crises in environmental health stemming from industrial agriculture and the food processing and distribution network. It is therefore argued that changes in the law and policy for the urban food system should be brought about by framing and communicating health and ecological problems, and alternatives, such as urban agriculture, should be promoted as a response to this food system crisis.

By working together with state and local planners and agricultural practitioners, it may be possible to develop a new paradigm to identify high quality agricultural lands. This may combine land capability or suitability for horticulture and dry land cropping and grazing with irrigation supplies, rainfall and yield information. It can then rank large tracts of “similar” lands according to their versatility for a range of agricultural land uses. This information can also be used in land use planning.

Peri-urban areas are emerging as strategically important built environments that should integrate appropriate food efficient design and planning. In order to understand food responsive design and form specific characteristics of new residential neighbourhoods in peri-urban areas, three key food urbanism approaches can be considered: (1) Developing a strong evidence base; (2) understanding community aspirations; and (3) formulating appropriate planning policy and recognising trans-disciplinary connections of food efficient design and planning. These considerations would be vital for building resilient communities of the future.

Peri-urban agriculture, especially livestock and vegetable farming, has deep roots in the food system. However, agricultural land in these areas is increasingly at risk from urban encroachment, which is likely to adversely affect the city’s food security. Population growth, artificial distortions to the value of land, the booming construction industry as well as the creation of recreation and leisure facilities have escalated the competition for land in peri-urban areas between agricultural use and urban-type developments.

35.8 Impacts of Climate Change and Adaptations

Climate change presents many challenges for local governments. In many areas, the future climate is likely to include more hot days, less rainfall and runoff, and increased frequency and intensity of extreme events, such as drought, flash flooding and wildfire. It is, therefore, important to identify, analyse and evaluate climate change risks and develop an adaptation plan that would assist planning for likely impacts of climate change.

Climate change impacts are exacerbating the number and extent of disasters. Rapid population growth, poor urban management, and non-implementation of various policies are creating a peculiar situation for many countries. Scarcity of water resources is already at an alarming situation and climate change impacts will exacerbate it. It is found that in many developing countries local officials have low level of education and are poorly trained. Local officials are ill-equipped for preparing any climate change adaptation plan to reduce future flooding. Local officials are unaware of the use of geographical information systems and their importance in
planning. When prompted, the GIS-prepared climate change maps can be helpful in raising the climate change awareness among public and these maps should, therefore, be prepared.

Climate change affects food production, with particular reference to urban agriculture and the associated impacts on food security. The value of urban agriculture to the health and nutrition of developing and developed countries needs to be assessed.

There are international, including urban, aspects, such as agricultural disruption, economic disruption and logistical disruption to food availability, food access and food quality as a result of natural disasters remains an under-investigated topic. Climate change is affecting (and will affect) global food production and hence global food security. Urban agriculture plays a significant role in maintaining and improving the health of city dwellers, particularly those disadvantaged. Climate change is likely to impact more severely urban environments with associated negative effects on food security. Existing research programmes are not addressing these aspects of climate change and deserve attention.

Social, economic and environmental impacts on urban and peri-urban Indigenous communities inhabiting coastal areas need to be highlighted. These impacts include loss of community and environmental assets, such as cultural heritage sites, with significant impacts on their quality of life and the establishment of potential favourable conditions for the spread of plant diseases, weeds and pests. Opportunities do not readily exist for engagement with climate change adaptation policy and initiatives and this is further exacerbated by acute shortages of qualified/experienced indigenous members that could represent their communities’ interests in climate change adaptation forums. The evidence emerging from research shows that consideration of the future by many communities, even with the overlay of climate change and the requirements for serious considerations of adaptation, are significantly influenced by economic aspirations which are seen as fundamental survival strategies for their communities.

There are a number of local-specific issues that emerge from climate change, such as potential for indigenous involvement in the industry utilising wild plant species that may suffer from changes in species availability; concern about changes associated with peri-urban and urban development which appears to be escalating micro-environmental changes; peri-urbanisation as a major environmental change which threatens cultural assets; and indigenous communities that need to be represented in climate change adaptation forums and be more directly involved in land and sea care projects.

Climate change awareness is an imperative to achieve sustainability in developing countries. Lack of awareness is a significant barrier to climate change adaptation. Raising climate change awareness at the local level is critical, as climate change impacts are exacerbating the number and extent of disasters in different parts of the world.

The development of an adaptation plan must be founded on a risk management approach to climate change at the local peri-urban government level. The approach can help build capacity in climate change, adaptation and the process of undertaking a risk assessment and define the area of operation, influence and responsibility in
regard to adaptation actions, and the role of other external stakeholders. Further, it can help integrate the risks and associated adaptation options directly into the existing risk register system and understand the relativity of climate risks to non-climate risks that the local government may have to face, such as land use change, increasing proportions of absentee landholders and an ageing demographic.

35.9 Legal, Policy and Institutional Challenges

Voluntary collective action is essential for natural resource governance. In a peri-urban setting, a complex behavioural and institutional matrix, the net balance of incentives and disincentives, and the support and impediments determine the likelihood of effective governance. Coupled with governance, each problem has biophysical and social characteristics that intersect with the character of the community. Taken together, there is the need for a realistic understanding of what will make collective action feasible, and design of institutional arrangements to manage the totality of the behavioural setting and the reality of the problem being addressed.

Real estate is a major driver of the economy in many countries of the world, developing as well as developed. It is one of the main barriers to the development or implementation of zoning and planning regulations that would make urban agriculture more than a fortuitous and temporary use of space. Moreover, many urban societies are undergoing a paradigm shift in social thought and action towards valuing heritage, public space, social cohesion, and accessibility to leisure and cultural activities, recognising that these factors can enhance urban liveability. The landscape approach has potential in addressing multiple features of urban/peri-urban areas. The gentrification is one of the drivers of the city development, causing de-territorialisation and incongruous land use coexistence.

There are major challenges posed by the spatial expansion of urban areas. Urban spatial expansion can be defined as having two general features. The first is the territorial expansion of urban activities outside the cores of urban areas. The second is the urban expansion that includes all the changes that occur in the urban system defined on the basis of population both within urban areas and in the national urban system. An example of changes in the urban system is the ongoing increase in population and spatial expansion of the secondary cities in the urban hierarchy.

In the contemporary era the interpretation of urban expansion is influenced by the following arguments. First, the globalisation is leading to the increasing integration of mega urban regions into the global economy. This encourages policies that are designed to create more efficient and productive urban areas that capture income from investment in industrial production, improvements in the built environment and higher-order services. Many of the policies focus on investment in improving transportation systems, digital networks, providing services, such as sanitation, energy and the amenity spaces.

Second, populations located in urban spaces are adapting, accommodating and resisting the environmental, economic and social consequences of globalization.
The reshaping of urban spaces driven by globalisation should be positioned in a more interactive and local paradigm that emphasizes the contextual setting.

Third, the telescoping transitions are being driven by accelerated transactional flows of people, commodities, capital and information between and within countries. The international components of this transactional revolution are generally referred to as part of a new era of globalisation in which foreign investment, encouraged by national states, is an important component.

Fourth, the transition is best seen as a process of transformation of national and urban space in which interaction, networks and linkages reflect a new urban reality and permeates both rural and urban areas. This is leading to a rapid change in the conventional polarising between rural and urban spaces. A network of international, national, regional and local linkages provides a dynamic spatial framework in which flows of people, commodities, information and capital drive both the rural-urban transformation and changes within the urban system.

The reality of transcending networks means that the restructuring of rural and urban spaces is occurring simultaneously, particularly in the transaction networks that are focused on mega-urban regions and corridors that link the urban system. Globalism is embraced at the national level but it acts at the local level. In this way, urbanisation is made up of the interaction among individuals and households at the national scale, provincial scale, urban scale and individual scale. This idea is captured well by Forbes (1997), “Macro-representations of globalisation subsume the internal dynamics of urban development, the subtleties of local politics, the resilience of urban patterns of life, the tensions embedded in fractured social structures, the multiple strands of modernity and the resistance to the imposition to change.” It is important to emphasize that the urbanisation is driven by a complex array of social, economic and political processes. There are processes of both “articulation” with global flows in certain urban spaces (and social groups)” and “disarticulation” in others where “global spaces” are intertwined with “local spaces.” In many mega-urban regions of Southeast Asia urban space has been reconfigured into articulated networks of interaction between middle and upper class dwellers, while excluding “much of the intervening or peripheral spaces from accessing networks, because the networks pass through the spaces without allowing local access.”

### 35.10 Integrated Urban Development

It is now being increasingly realised that peri-urban areas surrounding metropolitan cities and regional towns are highly dynamic regions characterised by unique social, environmental and economic changes. A peri-urban region is a diffused territory existing between the urban and rural townships, and river systems in such regions are often used as a source of urban water supply. The urban regions extract significant supplies of water for domestic, industrial and agricultural purposes, while the river system is also used to discharge treated and sometimes untreated municipal effluent originating from urban townships.
The peri-urban landscapes are continuously expanding to accommodate the communities who are migrating into diffused territories in search of a better lifestyle and mostly work in nearby townships, creating a range of competing and conflicting land use issues. As a result, the health of many peri-urban river systems in Australia and other parts of the world has gradually deteriorated over the last decade. Being key river users, the life cycles of aquatic species and social activities of humans are severely impacted by the deteriorating state of peri-urban river systems.

In the face of competing water users and urbanisation, managing and sustaining peri-urban river systems are huge challenges. It is desirable to understand how the management of a river system evolves and the role played by government agencies, communities and other stakeholders in the sustainability of the river system. Hence, a framework to assess future management proposals for protection and remediation of the river system can be developed. There should be a multidisciplinary approach to planning for development of peri-urban areas, which can consider ecosystem services and disservices and if development is occurring at the expense of coastal wetlands.

Wetlands can serve as bastion for mosquito production that affects residents and impose costs on individuals and government from both health and management perspectives. Most coastal peri-urban areas, including adjacent wetland sites, retain legacy infrastructures and landforms that degrade wetland functions and often exacerbate the mosquito hazard. Rehabilitating coastal wetlands can improve wetland function, while also reducing the mosquito hazard. Coastal wetlands are almost always overlaid with a number of different zones and ownership boundaries that increase the complexity of both mosquito management and wetland rehabilitation actions. It is recommended that land use planning frameworks incorporate a trigger for both assessment of adjacent coastal wetland ecosystem function and restoration of wetland ecological processes that includes provision for habitat based source control of mosquito hazard and coastal wetland rehabilitation.

Designing sustainable urban development is a multi-dimensional and multi-disciplinary challenge that can benefit from next-generation modelling tools to achieve high performance outcomes and integrated assessments. An information modelling platform can be developed for assessing alternative urban development scenarios. The modelling platform can allow simulation of various transition and future scenarios at the precinct level. The platform can extract data to assist in developing and assessing the performance of different components (land use, individual buildings and infrastructure related to energy and water supply and use, waste management and transport systems). A key aspect of the development is the design of a sustainable precinct that is affordable, provides a greater level of amenity and incorporates biolink corridors and natural open spaces critical to the preservation of native biodiversity. The platform can also be used to optimise the selection and design of sustainable and resilient energy, water and waste infrastructure and its integration with existing infrastructure.
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