

Growing by Place: Identifying Building Height Limits Using Skyline Thresholds

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Abstract: The vertical growth of coastal cities, the importance of visual connection to surrounding landscape values, and the lack of quantifiable approaches to controlling building heights have driven our inquiry for this paper. Guiding city form through protection of selected view corridors to features of high landscape values (HLV) provides a planning and urban design approach with the opportunity to define non-intrusive building heights. We present an adaptive new tool to identify and map constraints associated with views, in order to define building height thresholds and inform densification scenarios. The skyline threshold tool provides a repeatable and adaptable method applicable to any urban setting where views to landscape features are important to character and scenic amenity and where such views are potentially at risk of being obstructed by tall buildings.

Keywords: Height limits, skyline, skyline threshold, place character, Visual Impact Assessment

1 Introduction

Sense of place matters to all people regardless of their age, gender and race, and has done so throughout human history. It enhances our activities and deposits important ‘memory traces’ (LYNCH 1960, RELPH 2007, AL-KODMANY 2017). In urban areas, a sense of place provides reassurance, security and stability in rapidly evolving cities (SOUTHWORTH & RUGGERI 2011). Nurturing the existing sense of place in changing cities is a critical step in shaping memorable messages of the culture, climate, history and landscape while at the same time responding to physiological and psychological needs (LEFEBVRE 1992; GEHL 2010).

This concept is relevant to Australia’s indigenous relationships to the landscape where land, language and culture are interconnected (LOWAN 2009). The nexus between localised ‘place-based’ experiences and the regional landscapes is also critical in protecting the association with ‘home’, attachment to place, familiarity and satisfaction (CHOY et al. 2010). The connection between local places and the wider regional landscape provides links to heritage and context, which are difficult to maintain in urban areas that are undergoing significant growth and rapid change.

In particular, in coastal cities with proximity to ocean beaches, the affinity for and views to water have attracted people and resulted in development pressures in coastal centres (GREEN 2010). These areas have tended to be places with high natural amenity which adds to their uniqueness and attractiveness. The continuing challenges of infill densification pose threats to these attractive coastal settings and put them at risk of losing their distinctive landscape character and sense of place by ignoring the natural topography and allowing tall buildings to ‘overpower’ distinctive views.

Protection of view corridors to manage city form and transformation has been a common approach in many cities around the world. This approach is effective in protecting local sense of place, and can also inform designers about creative built form integration with the grain of the place, such that there is a ‘conversation’ with the surrounding setting rather than standing alone with little or no landscape context. However, concern has been expressed that criss-crossing the city with view cones could make development difficult and preserve cities as ‘museums’ (HOLLIS 2015), hence a balance is required which focuses on view corridors of city-wide significance.

The City of the Gold Coast in South East Queensland, Australia is an example where these challenges are addressed in the planning scheme (City Plan), including a relatively recent Building Heights Overlay. The City occupies a uniquely attractive natural setting between the coastline and the hinterland mountains but is also a vibrant and dynamic holiday destination whose character and international tourist image have evolved through constant change. The city has a generally linear urban form, with a distinctive high-rise ‘spine’ along parts of its world-famous coastline, and rapidly expanding residential suburbs, contrasting with forested ridgelines and river valleys behind. The Gold Coast community takes pride in its built form and distinctive setting, with the natural headlands and rivers and background mountains. There are currently multiple view corridors to landscape features important to the character and scenic amenity of the city, for both residents and visitors.



Fig. 1: a) Existing photo from South Nobby Lookout as a designated city-wide view corridor; b) Example of photomontage representing superimposed maximum building heights under the Building Height Overlay in the local planning scheme (City Plan, Nov 2018)

The Gold Coast is continually renewing its built form and is likely to undergo significant change involving increased density and height with the planned extension of a light rail corridor in the southern part of the city (Figure 1). Various landscape and character studies undertaken for Gold Coast City Council in recent decades have identified ‘timeless’ or long-established aspects of its character that are important to the attractiveness and liveability of the city and important to preserve through the protection of city-wide view corridors.

The Gold Coast Scenic Amenity Study (2010) combined Visual Exposure and Scenic Preference mapping to identify areas of high scenic amenity. Whilst the Gold Coast Landscape

Character Study (2014) provided a genuinely fresh approach to Landscape Character Assessment and assessed landscape character across the Gold Coast, incorporating landscape heritage and integrating urban and non-urban character, to identify elements for protection and enhancement. This was followed by the Landscape Values Study (2018) which integrated the key outcomes of these studies and identified the city's landscape value through scenic amenity, valued landscape character types and significant landscape features (Figure 2). It identified places and landscape features which require view protection as High Landscape Value (HLV) which includes areas with High Scenic Amenity such as forested hillsides, forested ridges, headlands and water (including estuaries and ocean).

These studies have resulted in landscape protection measures in Council's planning schemes, but, community concerns remain about the pace and scale of change and potential to lose valuable landscape features of the city (its 'Gold Coast-ness'), or intruding upon views considered important to the city's sense of place. In particular, planned increases in residential density and height of built form constitutes a threat to this 'sense of place', both city-wide and locally, by potentially obscuring views towards HLV features.

Hence, this paper addresses contemporary issues facing many coastal towns and cities in Australia which are located within sensitive landscape settings, by providing an innovative framework for defining building height thresholds for shaping future city built form that respects the broader landscape settings by protecting view corridors from built form intrusion. The background to the development of the methodology is outlined, and the Gold Coast case study demonstrates a detailed process that can be applied to other cities and landscape settings to develop view protection measures.

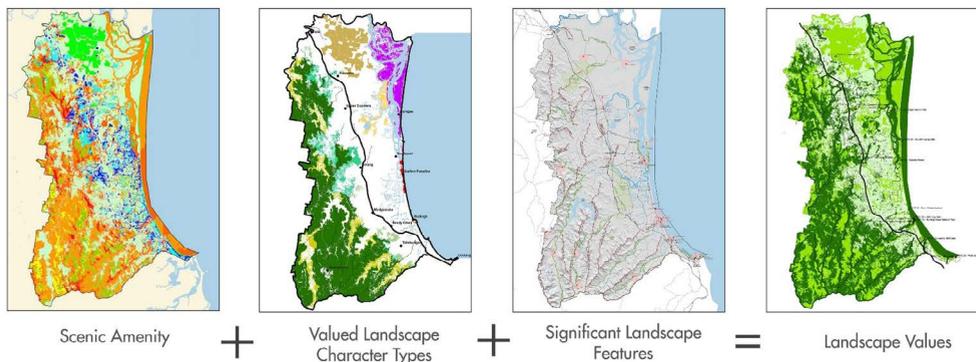


Fig. 2: Landscape Values as a combination of attributes (CITY OF GOLD COAST, RPS & CARDNO 2018, p. 11)

2 Methodology

A review of 'view corridor intrusion' approaches to landscape assessment and protection in Australia and overseas, such as the London View Management Framework (2012), Edinburgh Design Guidance (2017) and Portland's Scenic Resources Protection Plan (2017), indicates a high degree of location specificity – none provided an appropriate 'off-the-shelf' and objective method for defining building height thresholds to avoid view intrusion impacts.

Consequently, a new approach has been presented in this paper following intensive trialling of various mapping and modelling approaches. Most significantly, this approach utilises latest advances in ‘urban skyline threshold’ theory (TARA et al. 2019), GIS modelling techniques using ArcGIS, LIDAR data and a virtual city model available for the Gold Coast, which have become available only in recent years.

The proposed methodology provides a framework and new methods to define a desirable form of future urban growth and development so as to protect views to HLV features. This approach can be adapted to any place where proposed building heights have the potential to obstruct important views. It is applicable to both proactive land use planning and reactive (project-specific) Landscape and Visual Impact Assessment studies to inform design and development control.

The proposed methodology includes the following steps:

1. Identification of landscape elements and values, in particular, HLV features;
2. Identification of view corridors and visual constraints:
 - a) Identification of public viewpoints and view corridors based on a rationale (i. e. number of viewers, primary view corridors, high visual exposure areas);
 - b) Mapping of selected view corridors and viewshed modelling;
 - c) Photographing and recording the GPS location and field of view within each view corridor;
 - d) Triangulating of view corridors surrounding the potential development site(s);
 - e) Identification of visual constraints within each view corridor which for this study involved determining the visible ‘closest ridge’ skyline for each viewpoint.
3. Undertaking building height threshold modelling from selected view corridors;
4. Identification of the intersection of all thresholds and translation of these into ‘non-intrusive building heights’.

The critical step of this methodology involved the identification of height thresholds for future built form within the study area, above which the building form would incrementally intrude upon, and ultimately obstruct, views to HLV features. The limits of ‘non-intrusive’ building heights within view corridors or the height at which built form intrudes into a view towards distant landscape features and would impact on the visible skyline, was identified using the Skyline Threshold analysis technique in ArcGIS. The skyline barrier represents a surface or threshold defined by a viewpoint and collection of sightlines to the skyline.

The Skyline Threshold analysis expands the concept of visibility from a two-dimensional plane (ie. viewshed diagrams) to a three-dimensional (3D) space or visual bowl surrounding a given viewpoint (TARA 2017). This enables visual relationships of proposed building heights and the surrounding landscape and thresholds to be defined as a result of this analysis in 3D GIS (TARA et al. 2018, TARA et al. 2019). The modelled skyline threshold can be modelled based on the defined angle of view corridor and identified constraints within the view corridor. The visual constraint can be a vegetated ridgeline or physical structure visible in the background of a view. The non-intrusive building height on the intervening development area between the viewer and feature can be defined by this skyline threshold analysis. Any building height below this threshold will not intrude into views identified as important to city character and sense of place, allowing view protection measures to be implemented (Figure 3).

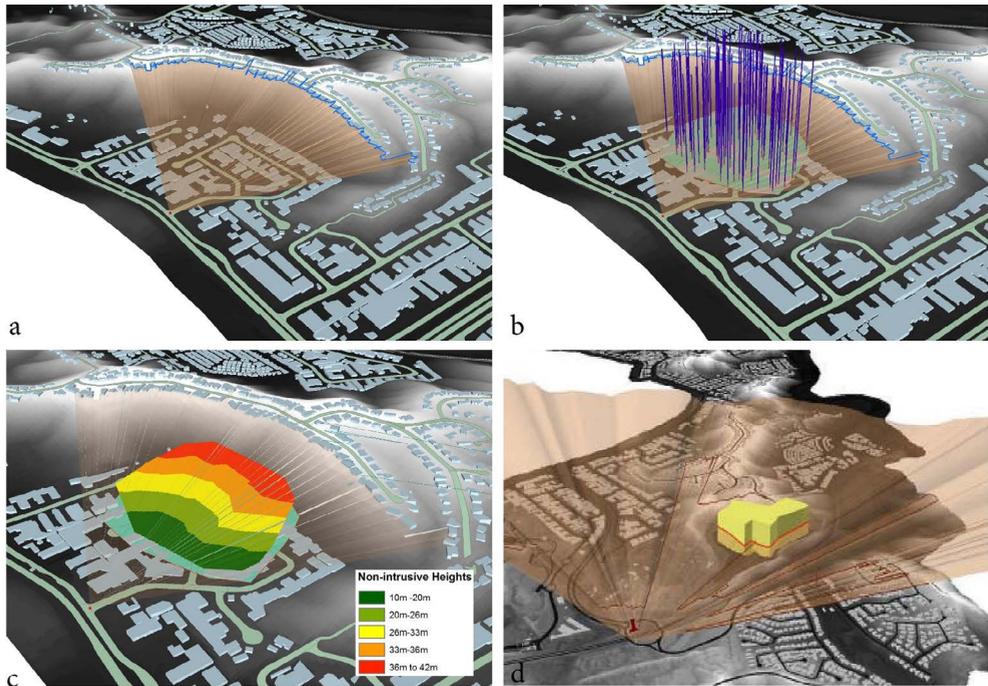


Fig. 3: a) Example of a visible skyline from a sample viewpoint to a ridgeline with the Skyline Threshold; b) The process for identifying the non-intrusive building height limit involved intersecting the skyline threshold identified in the previous step; c) 3D example of raster modelling to show the maximum possible heights to avoid intrusion into the skyline; d) Example of skyline threshold analysis in 3D GIS to show modelling of the intersection between the skyline threshold and proposed building envelope to identify the height limit (level of intrusion).

2.1 Concept of ‘Closest Ridge’ as a Building Height Intrusion Parameter

Visual constraints that define the level of building height intrusions can vary from one locality to another, depending on the surrounding landscape context which can be experienced from the urban environment. This can include distant views to an ocean horizon from elevated viewpoints or sightlines to landform ridgelines and headlands which form the visible skyline to an area.

In the Gold Coast, previous studies identified important visual constraints such as ridgelines, headlands, gateways and other landscape features. Vegetated ridgelines were selected as HLV features for this study as they form a layered backdrop to the city and visually frame parts of the city at a local and regional scale. The ‘closest ridge’ was selected as the main parameter for building height intrusion rather than a more distant ridgeline because:

- Forested ridges which are relatively close to the observer appear ‘green’ with (generally) some detail of vegetation visible; whereas distant mountain ridges often appear as shades of ‘misty blue’, with no visible details;

- The ‘closest ridge’ and associated forested hillslopes are more important to local character, scenic backdrop, landscape setting and district identity than those at a relatively greater distance which tend to be associated with a distant and different place; and
- Protection of views to the closest and lowest visible ridgeline or headland would nevertheless result in the protection of views to the middle ground and distant ridgelines as shown in Figure 4.
- A non-intrusive building height limit can be considered as slightly below the identified skyline threshold (six metres in this study) (Figure 5).

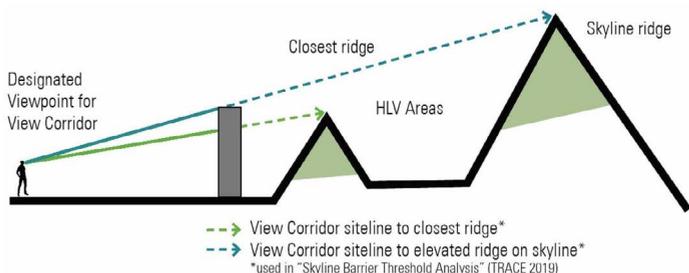


Fig. 4: Diagram of skyline barrier modelling used to assess potential view intrusions to the closest ridgeline

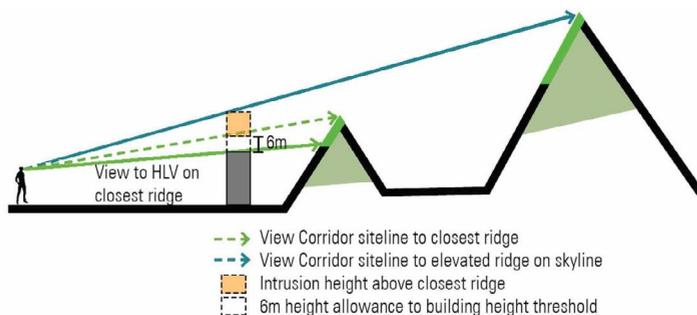


Fig. 5: Diagram of the process to identify non-intrusive building height (6 m below the sightline threshold)

3 Shaping on the Ground

3.1 View Corridors & Visible Features

Through fieldwork and collaboration with Council officers, sixteen local and citywide view corridors were identified within the Gold Coast to represent areas sensitive to building height that provide views towards distinctive Gold Coast landscape elements and features. The selection of views was aimed at triangulating of view corridors within areas (or precincts) designated as the ‘Height Sensitive Areas’. Viewshed modelling was undertaken for each view corridor which was combined into composite viewshed map with all the view corridors in order to demonstrate the full extent of coverage as shown in Figure 6. This mapping indicates

the visibility of a number of valued landscapes areas which are important at a local scale including views to forested ridgelines, coastal headlands and beaches. The Field of View (FOV) of view corridors was photographed and recorded during the site visit to assist with skyline threshold modelling.

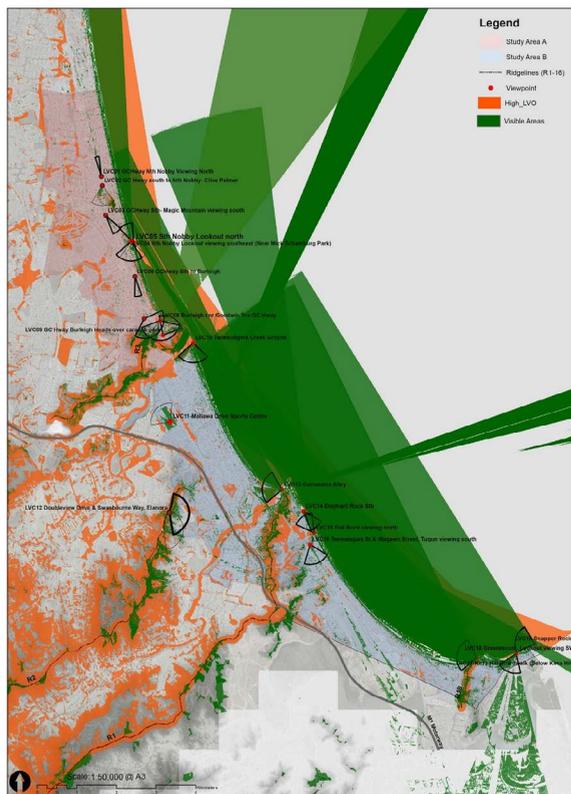


Fig. 6: Combined viewshed analysis from identified city wide and local view corridors within the study area. Areas in green represent areas visible from view corridors.

3.2 Height Threshold Modelling

The potential intrusion into view corridors from building height within view corridors involved:

- Determining suitable criteria for building height intrusion into views to HLV areas;
- Undertaking skyline threshold modelling to identify the potential intrusions of building height within selected view corridors;
- Identifying height sensitive areas and Non-Intrusive Building Height Limits.

The height threshold modelling is conducted for all 16 view corridors separately. Figure 7 displays a threshold modelling from a nominated view corridor from a South Nobby lookout. Skyline variations were modelled for existing views to close and distance range ridgelines and headlands which were compared with the change of skyline by the maximum Building Height Overlay. A non-intrusive height limit was identified by intersecting the skyline barrier threshold with the maximum building height (the black line shown in Figure 7b).

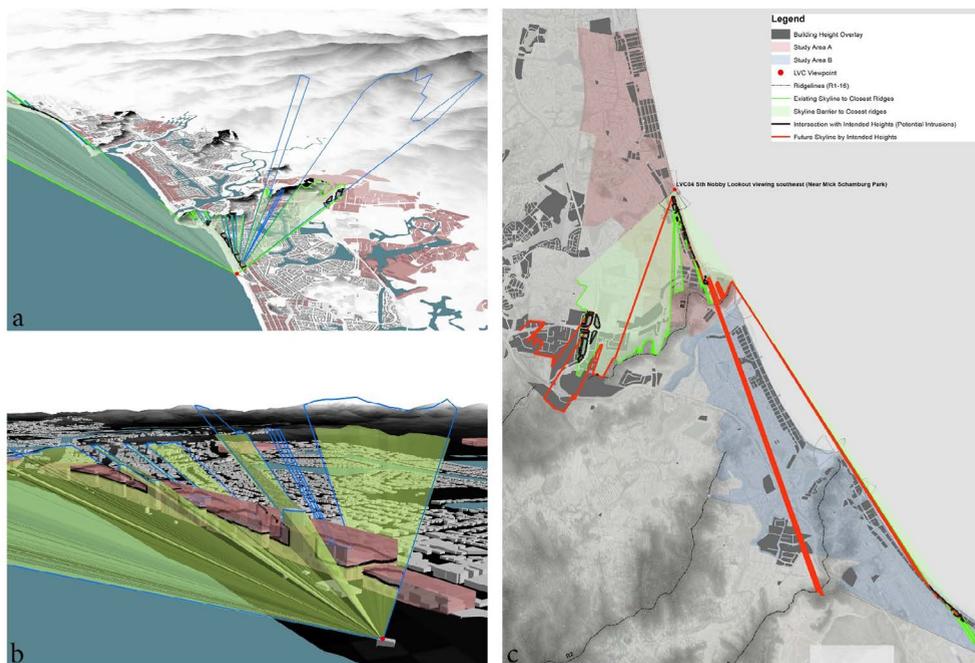


Fig. 7: a) Example of height threshold modelling from South Nobby Lookout with various skyline scenarios; b) Zoomed-in view of Inset A from a lower elevation showing the identified height threshold to avoid view corridor intrusion; c) Example of skyline threshold modelling from South Nobby Lookout and engagement of view with closest and distant ridgelines and headlands (plan view).

Figure 8 highlights the result of threshold modelling from a selected viewpoint and association with the vegetated ridgeline by different schemes. This crucial step allows for the retention of trees above the ridgeline and provides a suitable height to protect the distant sightline to the backdrop. This important consideration provides a conservative approach for determining skyline thresholds and is innovative for the field of LVIA. Figure 8c presents the non-intrusive building height to minimise view intrusion to the forested local ridgeline as the result of threshold modelling.

Results of all threshold modelling were combined in order to identify ‘Non-Intrusive Building Heights’ which respects all view corridors across the whole study area (Figure 9a). This resulted in the formation of non-intrusive building forms and heights (Figure 9b). The key mapping outcomes of this study identified that in some areas, the building heights allowed under the local planning scheme (City Plan, Nov 2018) would extend above the identified height thresholds and significantly reduce views to these HLV features of the closest ridgelines. This was illustrated in a ‘Height Sensitive Area Map’ (HSAM) and ‘Non-Intrusive Building Height Map’ (NIBHM) (Figure 10). The HSAM identifies that in part of the study area the current building heights allowable under the current planning scheme (Building Heights Overlay) would intrude into views to HLV features. The NIBHM identified the building height below which view intrusion would not occur for buildings within the Height Sensitive Area.

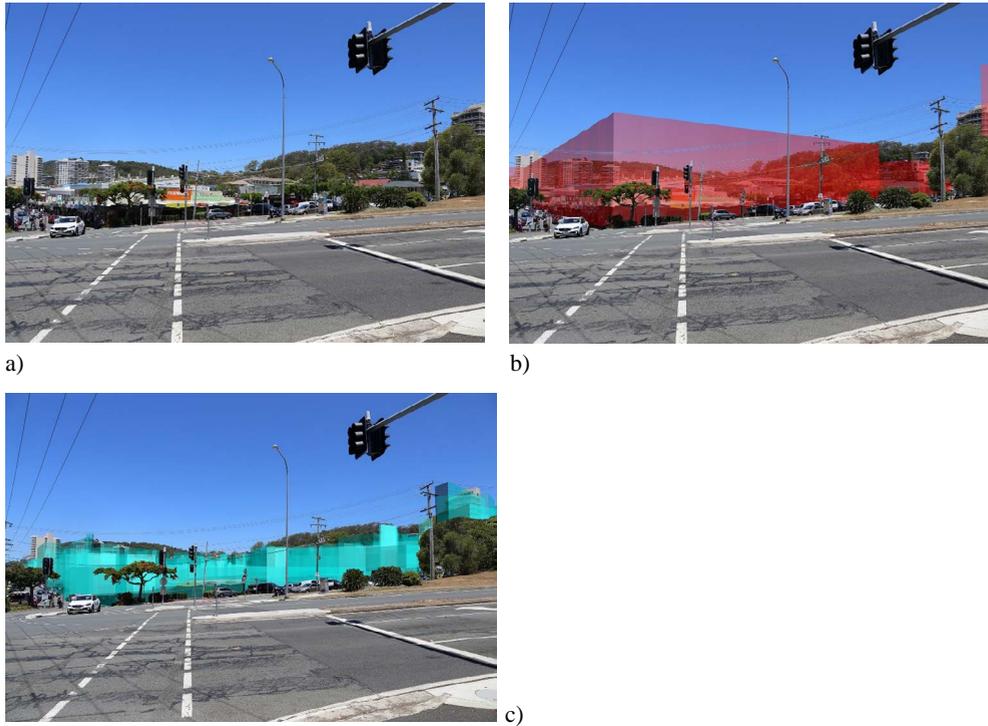


Fig. 8: a) Existing photo from Burleigh Heads; b) Example of photomontage representing superimposed maximum building heights Overlay in the local planning scheme (City Plan, Nov 2018); c) Example of non-intrusive building height to reduce view intrusion to the forested local ridgeline.

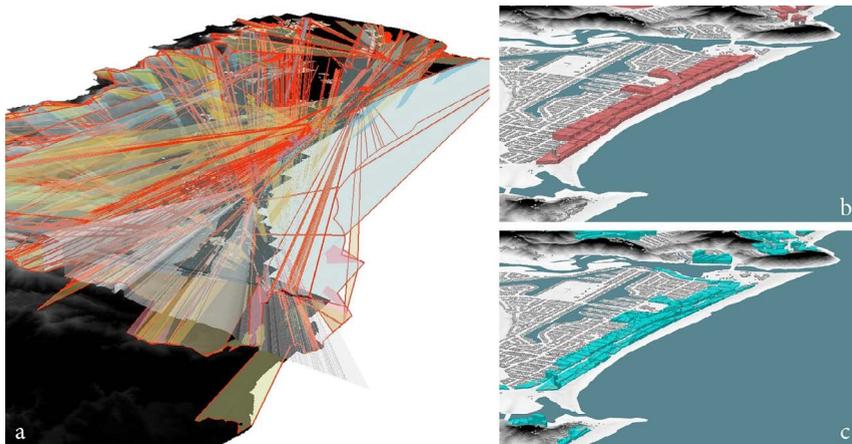


Fig. 9: a) Example of cumulative threshold modelling from 16 view corridors; b) 3D illustration of Maximum building heights; c) 3D illustration of Non-Intrusive Building Heights defined by intersecting all building height thresholds

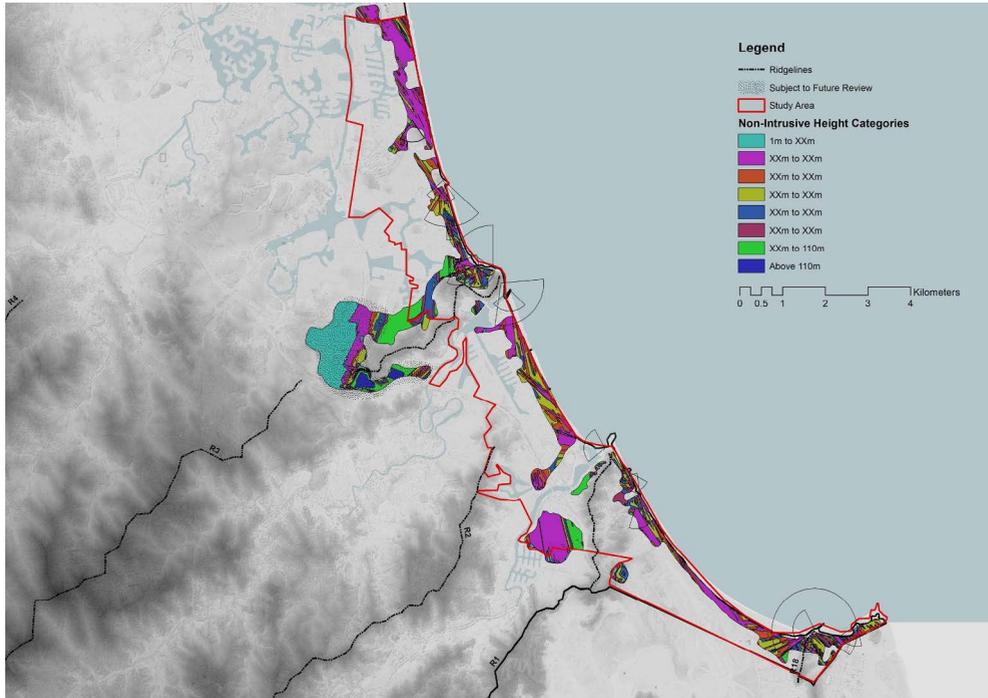


Fig. 10: Non-Intrusive Building Heights Map resulting from all modelled height thresholds

4 Discussion

The method demonstrated in this paper goes beyond previous methods to restrict building heights and intrusions. It provides a quantifiable and mappable approach with a toolbox in the context of landscape protection. The methodology to review building height has been endorsed by the Council and building height limits generated by the skyline threshold modelling is considered as a layer for being used to determine a future City Plan Building height amendment. The implications of this study to review the Building Height Overlay in the current City Plan (2015) is ongoing and relies on the timing of City Plan amendment processes.

In the absence of appropriate controls, the impacts on current landscape values will continue unfettered and developments will result in a gradual yet accumulative impact on these values. The proposed method through skyline threshold analysis provides a rigorous methodology to define building heights cadastrally to ensure the protection of important natural features and views which are critical to the image of the City. This can result in the development of future controls into the planning scheme to mitigate visual impacts of building heights and protect landscape values.

5 Conclusion

This paper outlines the methodology used to identify building height constraints for future urban growth and development in the southern Gold Coast so as to protect views to High Landscape Value features important to the character, identity and image of the city. It provides an innovative framework for development control, by defining built form height thresholds with respect to view corridor intrusion, thereby helping to shape future city environments that respect their broader landscape settings and are proportionate and subordinate to distinctive views. This new urban design ‘tool’ will assist architects, planners and developers with identifying and mapping constraints associated with views in order to define building height thresholds and city form. It will facilitate site-sensitive urban design by enabling developers and architects to be more aware of site constraints so that they can design built form more appropriately, although the ‘skyline threshold’ tool can also be used to challenge height restrictions on a site-by-site basis.

This repeatable methodology is applicable to coastal urban centres with views in several directions to multiple landscape features that are important to the character and scenic amenity and where such views are potentially at risk of being blocked by tall buildings. This method is applicable to landscape assessments in informing planning schemes and building height strategies. Most importantly, this new ‘tool’ for guiding building envelope design will assist with the better design of our urban built form. The potential of this method is not only limited to building heights but is applicable to other development proposals such as wind farms or landfill developments where height constraints are critical visual concerns. It may also be used as an aid by local authorities to guide in the decision-making processes of future development in critical sensitive locations.

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