Assessing riparian vegetation and creek channel condition in a rapidly changing urban space: a case study from Blacktown LGA

Michael Dean[1], Carl Tippler[2],

1. Blacktown City Council, Blacktown, NSW. Email: mcdean@mac.com

2. Department of Environment and Geography, Macquarie University, NSW, 2019. Email: carl@ctenvironmental.com.au

Abstract

With a current population of over 300,000 residents, Blacktown is New South Wales' most-populous local government area (LGA). This number is set to increase to beyond 500,000 over the next 15 years. The majority of new urban growth will be centered in the Eastern Creek and South Creek catchments, which currently support peri-urban and rural landscapes. Waterways located within and downstream of the growth centres will likely be negatively affected by the increased urbanisation. To document and assess the impact of urban growth, stream condition prior to development (i.e., baseline) must be assessed. Here we use a rapid assessment of riparian vegetation and the creek channel (RRA) to assess the condition of 389 sites across the Blacktown LGA and determine the time required for assessment. We found that the RRA ranked sites from 'excellent' to 'highly degraded' indicating the metric is sensitive to the range of local conditions. The RRA method allowed an average of 11 sites assessed per day including time to take photographs and enter data into user-friendly technology (iPad). Uploading RRA data to a spatial database can assist in site prioritization for stormwater management and waterway rehabilitation, and can help link different data sets (eg. RRA with water quality or macro-invertebrates). Knowledge of stream condition prior to future development will allow management to assess the impact of development and the efficacy of management interventions.

Keywords

Blacktown, creek channel condition, urbanization, rapid riparian assessment

Introduction

Blacktown Local Government Area (LGA) is the primary location for rapid urban expansion associated with the NSW Government-planned North West Growth Centre (NSW Department of Planning 2006). The current population of the LGA is 325,000; however, by 2030, this is projected to increase to beyond 500,000 (BCC 2015). Current and future urban expansion is driving rapid transformation in land use from rural and peri-urban to medium and high density residential and industrial.

With urban expansion across the LGA and in particular the North West Growth Centre, Blacktown Council is acutely aware of likely impacts to waterways within the South and Eastern Creek catchments, which are major tributaries of the Hawkesbury-Nepean River. Urbanisation is known to cause significant detrimental impacts to aquatic and riparian ecosystems, such as loss of native riparian vegetation (Groffman et al 2003), colonisation of invasive weed species and changes to soil chemistry (Grella et al 2014), and channel bank and bed erosion (Walsh 2000, Vietz et al 2014). Additionally, urbanisation is inextricably linked to degraded water quality (Tippler et al 2012), loss of native fauna and aquatic habitat (Roy et al 2003) and changes to hydrology and hydrography (Feminella and Walsh 2005). As a result of past urbanisation and agricultural practices, most waterways in the Blacktown LGA exhibit some level of degradation (Blacktown City Council 2014).

To quantify the extent of creek degradation in the Blacktown LGA the Council employees completed an LGA-wide creek condition assessment (Blacktown City Council 2005). This took place during 2004/05 and surveyed a variety of riparian and creek channel attributes at 300 m intervals covering major tributaries within the Blacktown LGA. The assessment was the most detailed creek study undertaken to date and revealed that waterways throughout the LGA were moderately to highly degraded, displaying altered channel geomorphology, degraded riparian vegetation communities and reduced water quality (Blacktown City Council 2005).

The 2004/05 survey held the promise of providing valuable information to guide the strategic management of waterways in the Blacktown LGA. However, the documentation and reports resulting from the study were somewhat complex and voluminous, and did not readily translate into operational outcomes. Also, the assessment team were not retained in waterway management roles, and the significant effort required to resurvey and analyse creek condition mitigated against follow-up survey to monitor progress or change. As a consequence, the majority of current waterway management practice is not guided by quantitative data (pers comm Blacktown City Council 2015).

In accordance with the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (NSW Department of Planning 2006), significant development is now underway across the Blacktown LGA. In line with the local government's role of managing waterways, the Council highlighted the need to update current understanding of waterway condition across the LGA, in particular creeks located within growth centres. As result, an updated assessment of creek condition was undertaken.

Figure 1. Aerial photo of urban development (right of photo) displacing rural pasture land use (left of photo) adjacent to an assessment site on Little Creek in the Blacktown LGA.

The objective of the 2015 Blacktown creek assessment was to collect baseline condition data on waterways across the entire LGA so that the Council can assess the impacts of urban development and track the effectiveness of new investment in stormwater management. Accordingly, the survey method was designed to be cost effective, repeatable, consistent and rapid. This paper outlines the development, method and application of the 2015 Blacktown Riparian and Creek Channel Health Assessment. This rapid assessment takes only minutes to complete per site, enabling data to be collected over a large area in a short time-frame.

Methods

Study sites

Assessment sites were positioned at approximate/minimum 600 m intervals along drainage lines to represent discreet sample reaches (per Findlay et al 2011), with occasional adjustment of site locations to account for land use boundaries and/or access issues. Approximately 400 assessment sites were selected (Figure 2) as representative from around 3430 candidate locations at 100 m steps along creek lines re-drawn and mapped for the project. The latter were generated from current air-photo series and matched to Blacktown waterway asset and NSW Land & Property Information survey data (LPI 2015). For maximum coverage, creeks were assessed from headwater reaches to their confluence with adjoining creeks or to LGA boundary. All channel configurations along drainage lines, including fully piped, open concrete and grass drainage channels, restored creek sections and natural waterways were assessed in all land use types. Assessment of highly modified creek types provides a baseline for potential future daylighting and water-sensitive urban design naturalisation. Similarly, assessment of creeks in rural, peri-urban and remnant woodland areas provide a baseline for water-sensitive urban design restoration following development in the Growth Centre Precinct.

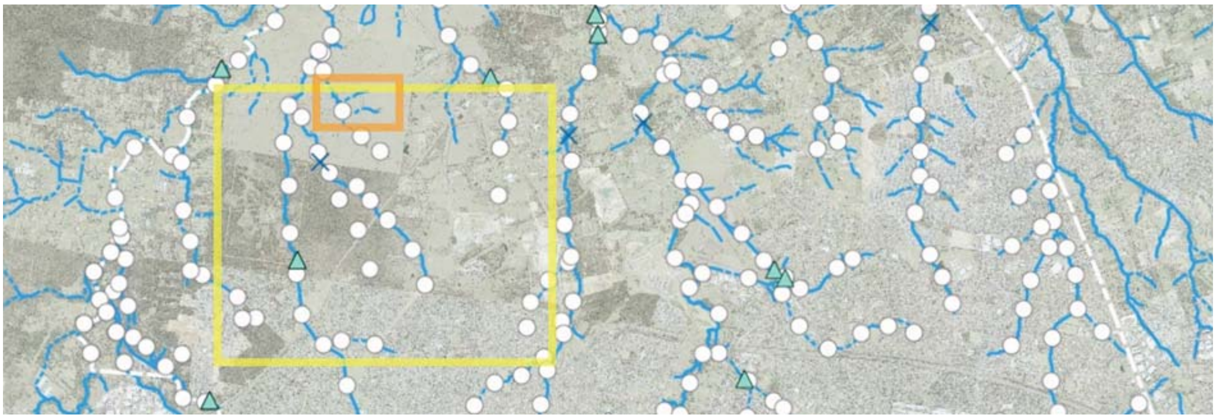

Figure 2. Map showing mid-LGA slice of riparian and creek channel assessment sites across Blacktown. RRA sites are indicated with white circles, water quality sites with aqua triangles, flow monitoring sites with blue crosses. The area within the orange rectangle is detailed in Figure 1, and the area within the yellow rectangle is detailed in Figure 3.

Rapid Riparian Vegetation and Creek Channel Field Assessment

We implemented a rapid method to assess riparian vegetation and creek channel condition at sites in the Blacktown LGA. The method was based on the Rapid Riparian Assessment (RRA) technique developed and detailed by Findlay et al (2011) and trialed at Ku-ring-gai Council in Northern Sydney.. The RRA provides a more robust discrimination of stream reaches than other riparian assessment methods, such as that implemented in the comprehensive 2004/05 survey (Findlay and Taylor 2005).

Assessment includes qualitative and quantitative data for site area (based on left and right bank percentage of nine types of land use and six additional observations); channel, depositional and erosional features (14 characteristics); and an assessment of riparian vegetation (based on left and right bank percentages of 14 vegetation structure classes plus measurement of riparian buffer width and observation of weed density).

The riparian component of the RRA was modified for this study to make it applicable to the vegetation communities of Western Sydney and Cumberland Plain. Specifically (i) addition of pasture, peri-urban and greenfield construction land uses (not present in Ku-ring-gai); (ii) omission of tall/open forest and littoral complex vegetation structure classes (per Specht 1981) that are not present in Blacktown; and (iii) addition of three non-standard vegetation structure classes designated to account for difficulty classifying early and mid-growth states of replanted riparian vegetation, following water-sensitive urban design and wetland implementations commonly employed in Blacktown LGA. The non-standard vegetation classes should assume more standard Specht characteristics when mature.

Data Capture and Storage

For data collection, results analysis and mapping, an integral component of the creek assessment was the implementation of currently available, low cost and user friendly technology which included iPad, mobile phone camera, both with mobile GIS, mobile database clients and desktop GIS. Using this technology allowed paperless on-ground assessment of waterway condition, updating site locations and data on-the-fly, user friendly database development and update, geo-referenced site photography and video records.

To build a comprehensive catalog of visual aspects of creek condition, upstream/downstream site views, site feature details, native and exotic flora and fauna were photographed. Panoramic image sets were recorded to produce a 360º spherical image using Google Street View software (Google 2015). A .GPX track was recorded using GeoTagr mobile app (Galarina 2015) to provide redundancy for geo-referencing. Daily image sets were dropped onto Cartographica GIS (ClueTrust 2015) to produce corresponding geo-referenced shapefiles based on image EXIF metadata and spatially joined to site assessment records to include in a comprehensive creek assessment database (FileMaker 2015).

The database software was also sufficiently flexible to allow iterative development as field work proceeded without compromising data integrity. For the second stage of the study (covering the southern area of the LGA) the channel feature component was augmented to include additional parameters for aquatic habitat based on NSW Key Fish Habitat (KFH) criteria (DPI Fisheries 2007 and 2013) as several of Blacktown's waterways are mapped KFH.

Time taken for Rapid Assessment

Assessing the creek site and entering data via iPad was typically completed in 5-10 minutes, recording site details via photograph and panoramic photosphere took a similar time, or up to 20 minutes for a complex site. Two people undertook these tasks simultaneously. Generally, access to and travel between sites was the primary time constraint on the daily assessment rate. In rural areas, walking the creek line on foot, or in bushland areas with thick undergrowth, between 7-10 sites were completed each day. In suburban areas with vehicle access to drainage easements, the rate increase to 10-19.

With significant travel time to and from Blacktown, available field time was approx. 6 hours per day. Overall 389 sites were assessed over 35 field days. Average rate was 11.1 sites per day, discarding two days cut short by weather brings the average to 11.5.

By contrast, assessment of a 20x20 metre vegetation plot and 50 metre transect in the same landscape by the same team (including accredited assessors) takes 90-120 minutes using the NSW BioBanking Assessment Method (OEH 2014) allowing 2-4 sites completed per day.

To minimise observer variation one external consultant was commissioned to conduct all field surveys. Data collection could be undertaken by one person, but field safety considerations (driving, navigation, field orientation, risk of injury or snakebite, personal safety in depressed socio-economic suburbs) means two people are optimal. Approximately 275 kilometres of creek line was assessed in total.

Automated Condition Scoring and Mapping

Each assessed reach (site) was assigned a condition category, per Findlay et al (2012), ranging from 'excellent' to 'degraded'. Calculation of standardised attribute and feature scores and corresponding overall creek site condition were included in the Filemaker Go mobile application template. This approach allowed automated calculations and on-the-spot allocation of site condition while in the field. Data were later uploaded to a FileMaker desktop database where further interrogation of data were possible.

For each assessment site a 50 metre site point buffer generating a 100 metre diameter circular evaluation area was plotted. This configuration obviates the need to align square plots with direction of creek run and streamlined both visual assessment and GIS confirmation of land use categories via manual or machine-API. Creek condition scoring was progressively auto-generated as site assessments proceeded and displayed spatially in traditional red/orange/yellow/green chromatic site colour coding. Site assessment points were coded via spatial join to creek asset reach lines via data shared between relational database and GIS tables. With all assessment criteria, attributes and scores available in the GIS data tables any selection or combination of assessed criteria and score can be displayed for catchment planning and other purposes.

Results

Prior to field work total of 400 sites were selected for assessment via desktop study. These covered 275 km of creek line, across 22 watercourses. Eleven sites were inaccessible due to construction or other access issues and therefore 389 sites were assessed in total.

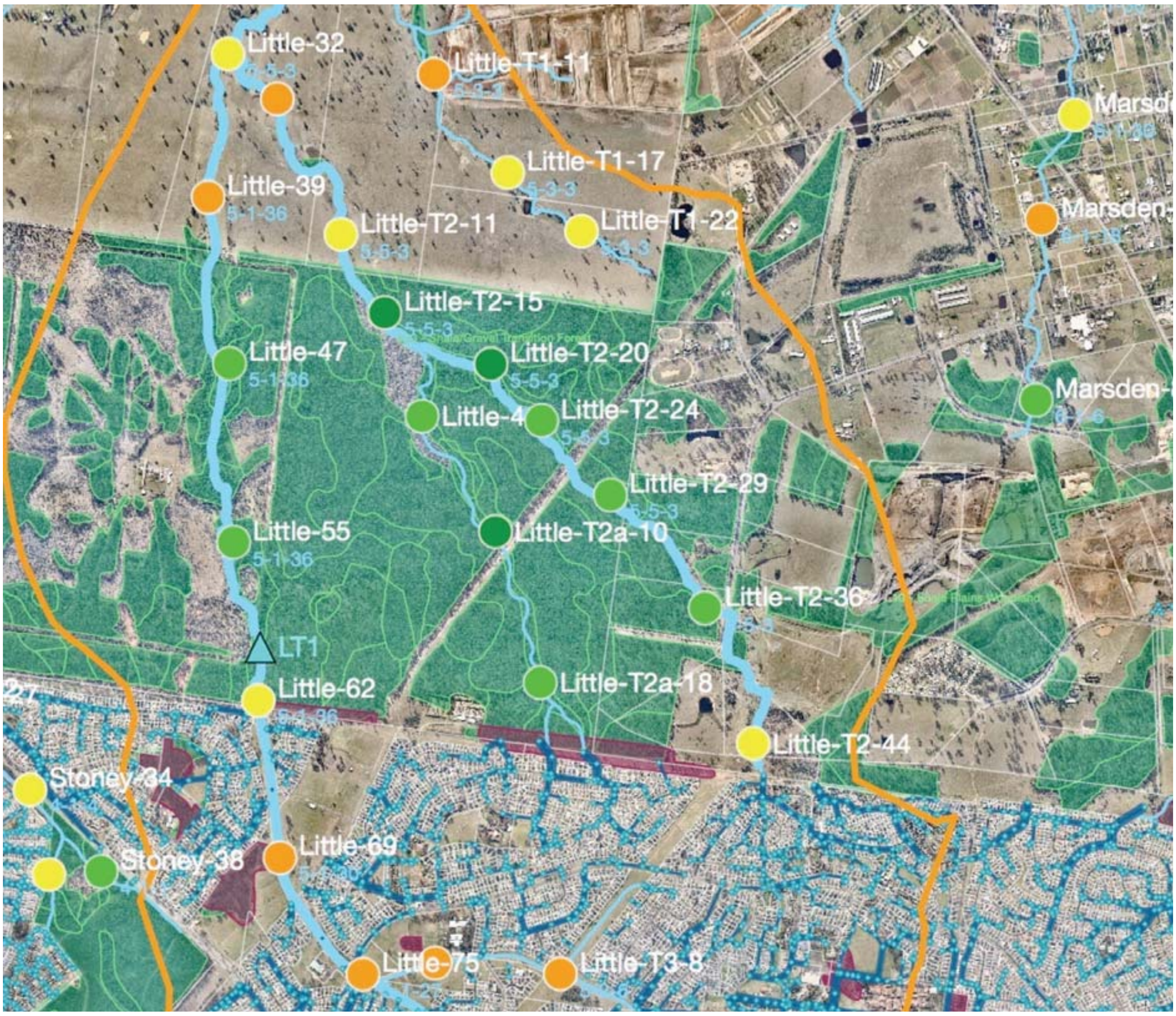

Figure 3. Creek site condition across a range of landscape types (rural, construction and peri-urban) in the Blacktown LGA. Creek condition at each site is denoted by colour, where dark green = 'excellent', light green = 'good', yellow = 'fair' and orange = 'degraded'. Note, 'very degraded' sites are not shown.

The RRA assessment revealed that sites spanned the full continuum of condition, from ‘severely degraded’ to ‘excellent’. The majority of sites were in ‘poor’ (n=163), or ‘fair’ (n=89) condition. A moderate number of sites were ‘degraded’ (n=47) or ‘good’ (n=81) and few sites were severely degraded (n=6), or ‘excellent’ (n=3).

All three sites with ‘excellent’ condition (see Figure 3) were located within a single sub-catchment that had an almost intact Cumberland Plain Woodland chain-of-ponds landscape. Sites of ‘excellent’ condition were located downstream from sites with ‘fair’ or ‘poor’ condition (see Figure 5), and provide a reference or ‘best case’ condition for Blacktown waterways of this type. The majority of ‘good’ and ‘fair’ sites were located in peri-urban and rural sub-catchments or along better-preserved creek corridors. However, agricultural clearing sometimes resulted in ‘poor’ site ratings in peri-urban or rural areas, including several on lower Little Creek, South Creek and Marsden Creek within the Growth Centre Precinct. Sites within established urban sub-catchments were typically ranked as ‘poor’ or ‘degraded’. The six ‘severely degraded’ sites were located on concrete-lined channels with no riparian vegetation or buffer area. A sequence of ‘good’ sites were located in the recently urbanized, but restored reaches of Second Ponds Creek.

Discussion

The rapid riparian and creek channel condition assessment applied in this study provides a cost-effective approach to the challenge of collecting a large volume of environmental data needed for sub-catchment planning and targeted creek restoration and rehabilitation.

We found that the RRA ranked sites from ‘excellent’ to ‘highly degraded’ indicating the metric is sensitive to the range of local conditions. In the Blacktown LGA the majority of sites had poor or fair riparian and channel condition consistent with the rural (cleared) or suburban (developed) land use of the area. Perhaps surprisingly, the LGA contained three sites considered to be in ‘excellent’ condition (see Figure 3). These sites were all located on tributaries of Little Creek (sites coded Little-T2 and T2a in Figure 3) within a parcel of remnant vegetation and are likely to represent the best remaining example of a Cumberland Plain Woodland chain-of-ponds (Bligh Tanner 2015, Hoban et al 2016).

Sites on the main channel of Little Creek, also located in the remnant vegetation patch, were impacted by increased flows from urbanised catchment upstream and displayed some undercutting and moderate-high weed and litter impacts. These sites were in overall ‘good’ condition. The ‘excellent’ sites on two tributary branches with very limited urbanisation upstream displayed good complexity, unconfined meanders and absent erosional impacts along with low weed impact and high vegetation structure. Relative impacts of upstream imperviousness are detectable (Veitz et al 2014) but physical and landscape characteristics including intact riparian zone and good vegetation structure provide protection (McBride and Booth 2005) allowing high flows to fully engage the floodplain, with in-stream wetlands moderating flow velocities and vegetation root structure and shading provide tensile strength and prevent bank soil desiccation.

Influence of physical characteristics and landscape become most apparent when these watercourses cross into cleared paddocks downstream, and immediately manifest moderate to high erosion and depositional impacts with loss of vegetation, driving condition ratings down to ‘fair’ or ‘poor’ (Figure 3)..The RRA scores reflect all these characteristics and impacts.

Future industrial development will impact the upstream subcatchment that contains the ‘excellent’ sites, however Blacktown is devising a strategy to protect the ecological and geomorphic integrity of the waterway, including transfer of increased flows to a downstream subcatchment (Bligh Tanner 2015) currently in ‘fair’ to ‘poor’ condition (sites coded Little-T1 in Figure 3).

Importantly, the RRA provides a snap-shot of current stream condition, which can be used to assess the impact of future development and the success or otherwise of different management interventions. Blacktown Council plan to re-assess condition every four years. To further integrate creek assessment into the broader Council framework, results from the ongoing assessment of waterway condition will be used by Blacktown as an indicator (riparian health and waterway health are two of 60) for 'quadruple bottom line' reporting as part of the NSW Government Integrated Planning & Reporting Framework (DLG 2012).

A key advantage of the RRA is the time efficiency and ability to generate a spatially-rich data set that can guide management. For example, this study revealed that two people could survey an average of 11 (range 7-19) sites per day using this method. This contrasts with detailed qualitative flora surveys, or macro-invertebrate monitoring which typically only survey a maximum of four to six sites per day. The RRA process collects rich, multifaceted data relating to creek and riparian condition and supports the development of a highly flexible GIS database that allows Council to apply complex decision making criteria to creek restoration projects. Indeed, the RRA data will be most informative when combined with additional data sets such as vegetation and impervious surface mapping, alongside water balance, pollutant export, stream hydrology, erosion and water quality modelling.

The RRA provides a robust, cost effective approach that negates the need for highly technical staff and equipment and allows the integration of results with a range of other environmental data to guide future catchment planning, track changes to waterways due to urban growth and strategically target creek restoration projects. The broad scale and holistic approach to catchment management applied by Blacktown is designed to support a less reactive approach to waterway management and enable better-targeted decision making for future catchment planning and creek restoration.

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