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Water quality and quantity investigation of green roofs in a dry climate

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ABSTRACT

Low-energy pollutant removal strategies are now being sought for water sensitive urban design. This paper describes investigations into the water quality and quantity of sixteen, low-maintenance and unfertilized intensive and extensive green roof beds. The factors of *Slope* (1° and 25°), *Depth* (100 mm and 300 mm), *Growing media* (type A, type B and type C) and *Species* (P1, P2 and P3) were randomized according to a split–split plot design. This consisted of twelve vegetated green roof beds and four non-vegetated beds as controls. Stormwater runoff was collected from drainage points that were installed in each area. Samples of run-off were collected for five rainfall events and analysed for water retention capacity and the water quality parameters of NO_2, NO_3, NH_4, PO_4, pH, EC, TDS, Turbidity, Na, Ca, Mg and K. The results indicated significant differences in terms of stormwater water quality and quantity between the outflows of vegetated and non-vegetated systems. The water retention was between 51% and 96% and this range was attributed to the green roof configurations in the experiment. Comparing the quality of rainfall as inflow, and the quality of runoff from the systems showed that green roofs generally acted as a source of pollutants in this study. In the vegetated beds, the intensive green roofs performed better than the extensive beds with regard to outflow quality while in the non-vegetated beds, the extensive beds performed better than intensive systems. This highlights the importance of vegetation in improving water retention capacity as well as the role of vegetation in enhancing pollutant removal in green roof systems. In addition growing media with less organic matter had better water quality performance. Comparison of these results with national and international standards for water reuse confirmed that the green roof outflow was suitable for non-potable uses such as landscape irrigation and toilet flushing.

1. Introduction

It has been reported by the United Nations (2011) that in 2010, for the first time in history more than half of the world's population lived in urban rather than rural areas. This report also anticipated that most of the world's population growth will take place in the urban areas in the next four decades. This will result in urban areas becoming larger with increased impervious areas, which in turn will lead to many environmental problems. These impacts are in the form of changing hydrology, climate change, water and food

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scarcity and urban heat island effects (Gill et al., 2007). Also, increased flooding and deteriorating water quality in receiving waters are particularly associated with these ongoing changes. Climate change consequences have recently appeared more in the form of extreme rainfall events in the UK, New Zealand and in many parts of Europe (Carter, 2011) and North America. Generally in areas with dry climates, such as Australia, increasing urban temperatures and urban heat island effects are one of the most important issues. In the high rainfall regions in the Northern Hemisphere as well as in New Zealand, because of flooding problems, reducing peak flow rates and delaying the runoff time of concentration have been critical research issues.

One of the solutions to these problems is adopting new stormwater management strategies such as Low Impact Development (Voyde et al., 2010), Sustainable Urban Drainage Systems (SUDS) (Stovin, 2010), Low Impact Urban Design and Development (LIUDD) (Van Roon, 2005) and Water Sensitive Urban Design (WSUD) (Beecham and Chowdhury, 2012). In particular, introducing green infrastructure through WSUD is one of the possible solutions to reduce the harmful impacts of urbanization while providing additional amenity and water quality benefits for communities and the environment

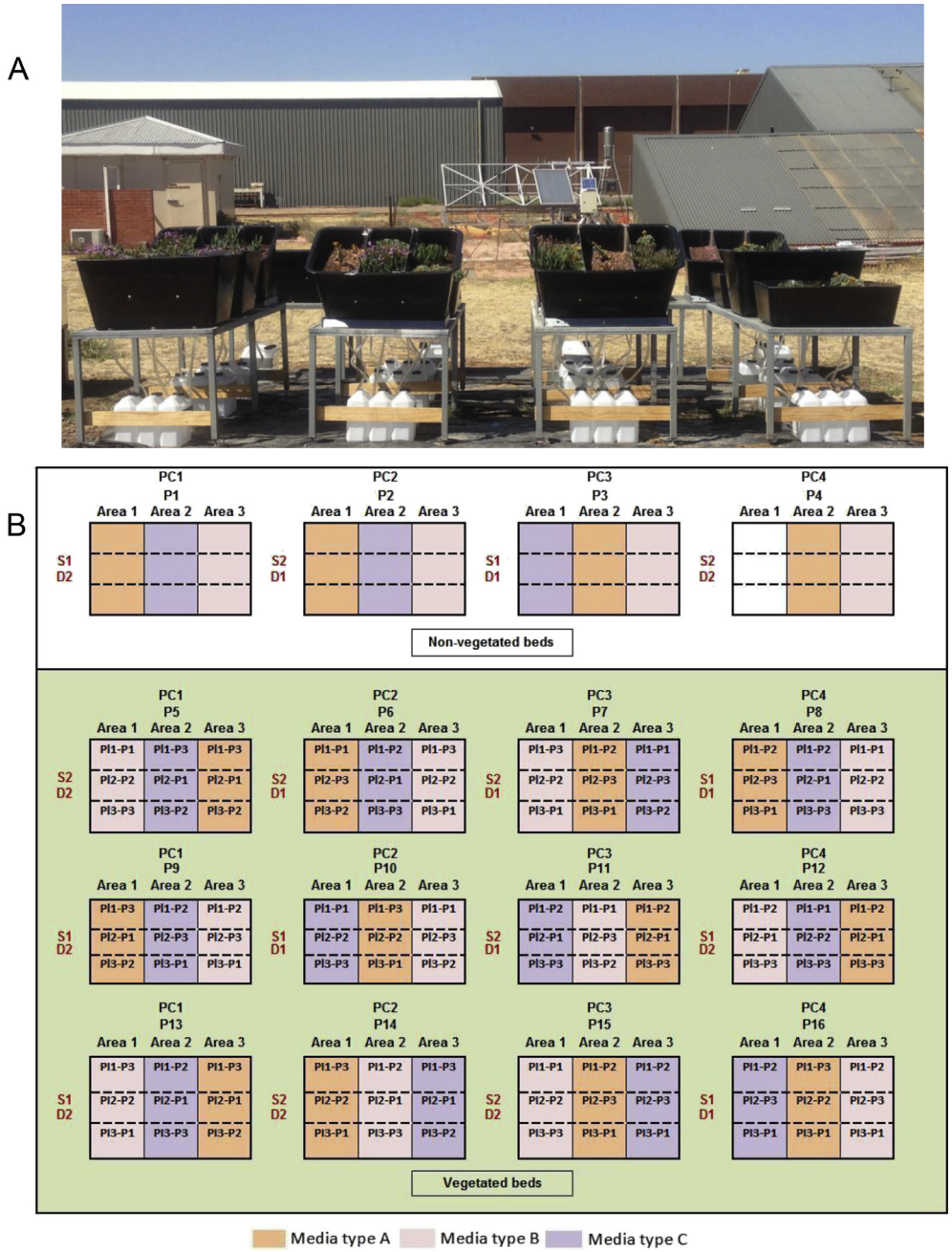

Fig. 1 – (A) Green roof bed configurations, (B) Statistical experimental layout, PC (platform columns), Area (area), P (platforms), S (slope), Pl (plots), and D (media depth) and P (plant species).