UBC Social, Ecological, Economic Development Studies (SEEDS) Student Report

The ground beneath us: managing soil at UBC for improved drainage and reduced compaction

Tim Philpott

University of British Columbia

Sustainable Soil Management, SOIL 502

July 14, 2010

The ground beneath us: managing soil at UBC for improved drainage and reduced compaction

Traditionally, concepts of soil quality are applied when managing agricultural or forest ecosystems, while soils in urban settings rarely receive the same level of management. Humans in urban spaces often interact with soils daily, most commonly in parks and open spaces. Urban soils are expected to serve many functions: as a medium for human use, drainage, medium for vegetation etc., however; these functions cannot be met without adequate management. As a result of poor management, many urban soils are degraded.

Soils at the University of British Columbia exhibit symptoms of poor management and can serve as a case study for addressing soil quality concerns for urban soils. This report will identify key functions of soil on UBC campus, propose indicators to asses soil quality, and will make suggestions for soil remediation.

Context – UBC Public Realm Plan

In May 2009, UBC Campus and Community Planning released a report highlighting the poor condition of the public spaces (public realm) on campus. The report acknowledges “20% of the public spaces have a ‘bleak’ landscape character, while 72% of the spaces need improvement,” (UBC, 2009). The plan is ambitious – it seeks to revitalize public space on campus using design principles suited to all seasons of the wet west coast climate. What the plan lacks, however, is specific mention of soil management, which should be incorporated to prevent future degradation.

Soil type

When addressing soil quality concerns, it is common to start the assessment by addressing the inherent soil quality, which is outlined by the soil type. Soils at UBC are part of the Bose soil management group. The parent material consists of 30-160 cm of glaciofluvial deposits, overlain with a strongly cemented glacial till in some areas (Luttmerding, 1981). Bose soils have a low water holding capacity, are moderately well to well drained and are rapidly pervious in the upper layer. Where the cemented layer exists (~100 cm), drainage and rooting depth are impeded. The soil is a podzol and has a high sand and gravel content (Luttmerding, 1981).

Soil function at UBC

Soils on UBC campus have several functions: drainage, nutrient cycling, filtering and buffering, medium for human use and maintenance of vegetative growth (Appendix 1 details these functions). All these functions are critically important and interconnected. Daily, most students, staff and faculty are concerned with soil functioning as a medium for human use (recreational areas, pathways), and this function is most important to preserve. If the soil is in some way degraded (eg. poorly drained), its function for human use will be compromised. The soils on UBC campus also provide a medium for landscaping, and thus provide the means for overall campus aesthetic.

Assessment

An assessment was done for UBC campus along Main Mall. The goal of this assessment was to propose indicators that can easily quantify the above functions or subset of functions. In particular, the indicators used measure some aspect of soil physical properties.

Upon inspection, soils along Main Mall were visibly degraded. Pedestrian walkways were poorly drained (Figure 1A), poor landscape design led to severely compacted and poorly drained improvised walkways (Figure 1B), severe compaction occurred around ornamental trees (Figure 1C), and poor drainage was evident in the playing field ('bowl,' Figure 1D). Poorly drained areas were often centred around areas of compaction. Compaction contributes to poor drainage by reducing porosity (increasing bulk density) and is caused primarily through foot traffic and maintenance vehicles driving over soil. Additionally, higher water content increases severity of compaction (Brady and Weil, 2002). Ultimately, mechanisms of soil degradation at UBC are human and vehicle traffic and inappropriate landscape design.

As the soils around UBC function primarily as a medium for human use, the visibly degraded quality of the soil will impact this function. The playing field at the south end of Main Mall is often used by school children; however, the field is poorly drained with obvious negative impacts on the growth of the grass. Poor drainage near walkways also forces pedestrians around puddles, which in turn causes increased compaction for adjacent soils.

Easily measured soil physical properties that helped in assessing soil quality were bulk density and penetration resistance. Bulk density values greater than 1.6 g cm^{-3} are considered severely compacted (Brady and Weil, 2002). Penetration resistance is measured with a penetrometer, a device designed to mimic plant roots. A soil is considered compact if more than 30% of readings are >2000 kPa within the first 40 cm (Duiker, 2002). Samples were taken for three study areas: in the 'bowl' at the south end of Main Mall, on the lawn adjacent to the MacMillian building, and in areas protected with ground cover. The results are shown in Table 1 and 2.

Bulk density was only measured in the bowl and along Main Mall. The values do not exceed 1.6 g cm^{-3}, and are not considered compact by this method (Table 1). However, the penetration resistance values indicate compaction for all three sites with penetration never exceeding 40 cm without a resistance reading >2000 kPa (Table 2). This method is developed for agricultural settings in tilled soil, and may not be appropriate for an urban soil. However, comparing these values is useful as the ground-covered site had the lowest penetration resistance and was best protected from foot and vehicle traffic compaction.

Another method for assessing the function of soils on campus would be to develop visible indicators of soil degradation. This might include identifying areas of poor drainage, bare soil, and restricted vegetation growth. These visual indicators could then be compiled in a GIS format to help highlight areas of concern.

Figure 1: Soil landscapes along Main Mall. A) Poor drainage, B) Improvised path and compaction, C) Compaction around ornamental trees, D) poor drainage in playing field.

Table 1. Bulk density values along main mall (MM) and the playing field (Bowl). Values in parentheses are standard error.

Sample	Bulk density (g/cm^3)	Average
MM1	1.05	0.96 (0.15)
MM2	1.10	
MM3	0.88	
MM4	0.79	
Bowl1	0.90	0.97 (0.09)
Bowl2	1.01	
Bowl3	1.08	
Bowl4	0.90	

Table 2. Depth to compacted zone (in) for main mall, bowl and ground covered area. Values in parentheses are standard error.

	Depth to compacted zone (in)
Bowl	6 (1.6)
Main Mall	3 (0.9)
Ground cover	9 (2.1)

Challenges and Remediation

Compaction seems to be the main challenge for UBC soils, and remediation should focus on addressing this aspect of soil quality. Reducing stress is the first step to remediation: proper routing of pedestrian and vehicle traffic away from soil and prevention of corner cutting though use of corner fences or hedges. The UBC Public Realm Plan proposes to address this issue by restricting vehicle and redesigning Mail Mall with a pedestrian focus (UBC, 2009). Some areas of severe compaction, such as around the Oak trees along Main Mall, require more drastic approaches for remediation. Solutions to these compaction problems may include (Kuser, 2007):

- Radial trenching. Trenches are dug around a tree trunk and filled with soil and organic material to deliver nutrients.
- Mulch Applications. Application and maintenance of a 10 cm mulch layer that will slowly rebuild a healthy surface soil.
- Compressed air treatment. Injection of compressed air or water to create fractures and decrease bulk density.
- Mechanical breakup. Tillage of soil with equipment (such as a subsoiler).
- Soil amendments. Rotary tillage of low-density supplements into compact soil.

Ultimately, the soil on UBC campus should be managed for its intended use. Large areas of lawn should expect to be areas of recreation and should be managed to meet this need. Proper aspects of turf management should then be applied, such as having soil depth >50 cm to improve drainage, avoidance of surface depressions, prevention of thatch build-up and subsurface drainage where appropriate (French, 1986). Also, given that most students are on campus during the wet winter, there should be adequate drainage to prevent further compaction. Soil depth will alleviate this issue, but subsurface drainage should be installed if the soil is not deep enough to prevent surface pooling.

The UBC Public Realm Plan is an attempt to revitalize the open spaces on campus, but there are some institutional challenges that need to be addressed:

- Development and construction are prioritized before landscaping and there is limited funding for proper soil management.
- Lack of financial resources leads to a lack of human resources, which limits the ability of UBC Landscapers to avoid soil health problems.
- UBC uses outside consultants in project management rather than using faculty experts who are better acquainted with UBC-specific problems.
- Season of high use is during the Vancouver's wet season.

UBC should address these issues in order to alleviate the soil management issues on campus. The UBC Public Realm Plan should incorporate a healthy maintenance budget to ensure adequate management of any design changes or remediation that takes place during the revitalization of the campus landscape.

Conclusion

The urban soils on UBC campus are in a degraded state, a condition common to soil in urban settings. Being degraded, the function of these soils, being mainly as a medium for human use (recreational, pathways) and to serve an aesthetic role, is compromised. UBC administrators have addressed this issue through development of the Public Realm

revitalization strategy, but greater attention must be focused on maintaining the long-term sustainability of soil functions at UBC through proper soil management. Incorporation of soil management into the Public Realm plan will prevent future soil degradation and will extend the life of any landscape features that are added to UBC's landscape.

References

Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. (13th edition). Upper Saddle River, NJ: Prentice Hall.

Duiker, S.W. (2002). Diagnosing soil compaction using a penetrometer. Penn State College of Agricultural Sciences Agricultural Research and Cooperative Extension. University Park, PA: The Pennsylvania State University.

French, B. (1986). Design and Management of Grass Based Turf: A seminar presentation to Vancouver Board of Parks and Recreation Staff. Victoria BC: Land Resource Consultants, Ltd.

Kuser, J.E. (2007). Urban and Community Forestry in the Northeast. New York, NY: Springer.

Luttmerding, H.A. (1981). Soils of the Langley-Vancouver Map Area. Report No. 15, British Columbia Soil Survey. Volume 3, Decription of the Soils. Kelowna, BC: Province of British Columbia, Ministry of Environment.

University of British Columbia. 2009. UBC Public Realm Plan for the Vancouver Campus. Retrieved January 30, 2010, from www.planning.ubc.ca/smallbox4/file.php?sb4ab9199c6c463