



Higher Diploma in Conservation and Tree Management

Crown and stem patterns of *Acacia confusa* on urban slopes of Hong Kong

Prepared by

Tse Tze Kwan
Ng Sze Wing
Wong Yat Hong
Wu Po Ling
Yiu Hau Lam



Table of Contents



01

Introduction

- Background
- Objectives

02

Literature Review

- *Acacia confusa*
- Slope types
- Phototropism

03

Methodology

- Study sites
- Data collection

04

Results

- Parameters and inclinations of *Acacia confusa*

05

Discussions

- Implications of phototropism
- Enhancement methods

06

Conclusions

- Summary
- Limitations
- Further study



01

Introduction

- Background
- Objectives



Slopes in Hong Kong

(Source: https://hkss.cedd.gov.hk/hkss/eng/sis_info.aspx)

Background

>60,000 slopes in Hong Kong

(Buildings Department, 2020)

Large scale afforestation in last century (1950-70s)

Goals: control soil erosion, improve water supplies

Pioneer exotic species: *Acacia confusa*

(Corlett, 1999)

Background

More slope tree accidents in Hong Kong in recent years → Public concern increases

(明報，2016年6月12日；東方日報，2020年6月6日)

Acacia confusa

Major species on slopes of Hong Kong

Lifespan: 50-70 → aging issue

(Highway Department, 2019)

→ Chosen to be the study target



〈兩樹倒塌壓兩車 東頭村道一度封路〉(明報，2016年6月12日)



〈斜坡塌5米樹擊傷3途人〉(東方日報，2020年6月6日)



Background

Form & structure of a tree ↔ Local environment

Forest slope trees → bending stem and asymmetric crown for more **Light!!!**

(Getzin & Wiegand, 2007)

Title → Crown and stem patterns of *Acacia confusa* on urban slopes of Hong Kong



Objectives



1

Investigate the correlation among crown, stem parameters of *Acacia confusa* and slope properties



2

Explore the implications of phototropism of *Acacia confusa* on slope



3

Discuss possible enhancement methods on slope vegetation and management.



02

Literature Review

- *Acacia confusa*
- Slope types
- Phototropism

Acacia confusa



Acacia confusa

Originated in Taiwan

Family: Mimosaceae

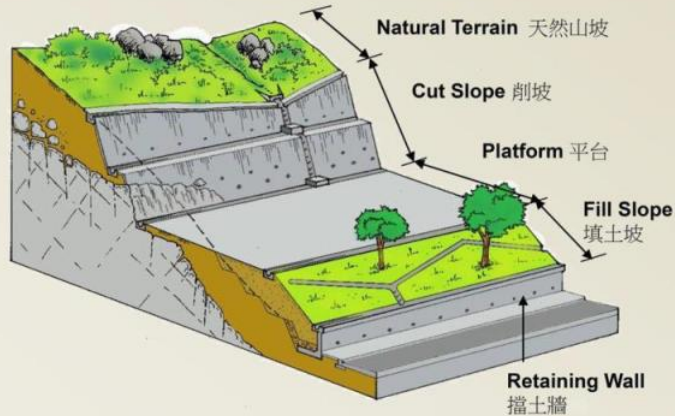
Height: 6-15 m

Flowering period: March to October

Fruiting period: August to December

(Hong Kong Herbarium, n.d.)

Slope types



Types of slope
(Source:

<https://www.facebook.com/hkss.geo/posts/18468750386773>



Phototropism

Mechanism to maximize photosynthetic productivity

(Lam & King, 2005)


Ability of a plant to reorient the organ and grow towards/opposite a light source

→ Enable the leaves to optimize the light capture

(Liscum et al., 2014)

Forest slopes: trees inclined to downhill than uphill direction (less competitive)

(Lang et al., 2010)



Phototropism

Phototropins perceive incoming blue light

Step 1



Formation of lateral auxin gradient

Step 3



Bending of hypocotyl to the light source

Step 5



Step 2

Trigger the signal transduction chain



Step 4

Trigger signalling networks → control cell elongation

(Hohm & Preuten & Fankhauser, 2013)



03

Methodology

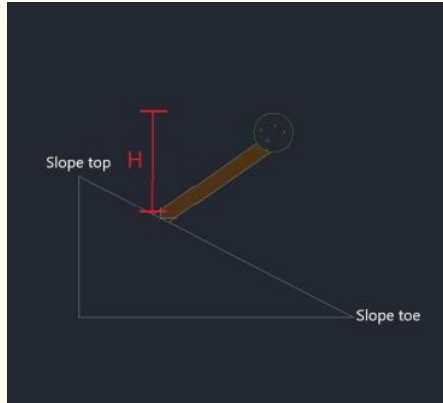
- Study sites
- Data collection

Study sites

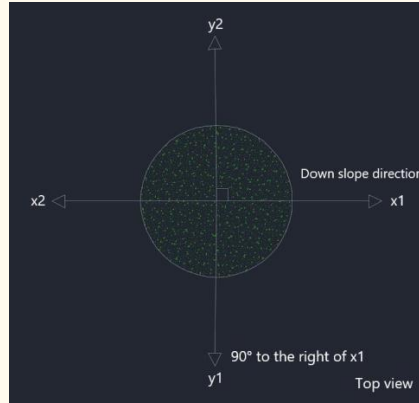
11 registered slopes visited, 275 *Acacia confusa* recorded



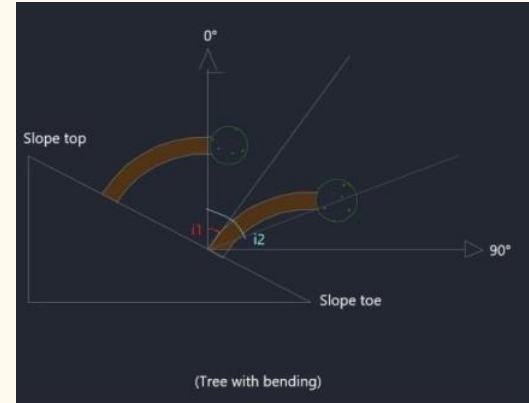
Data collection



Height



Crown spread

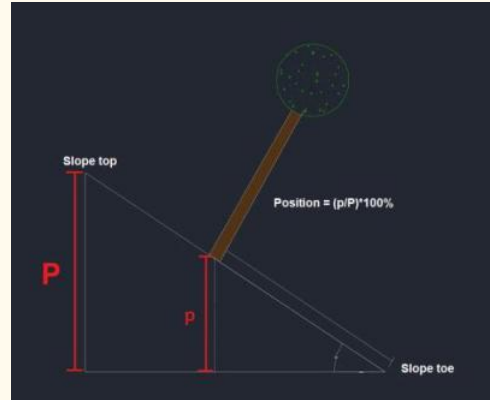


Stem & crown inclination

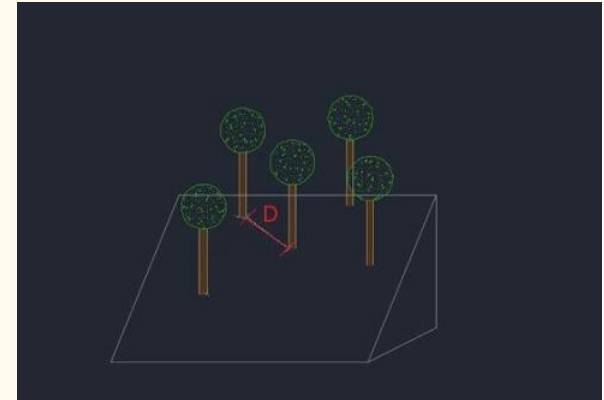
Data collection



Live crown ratio



Position on slope



Distance to neighbouring tree

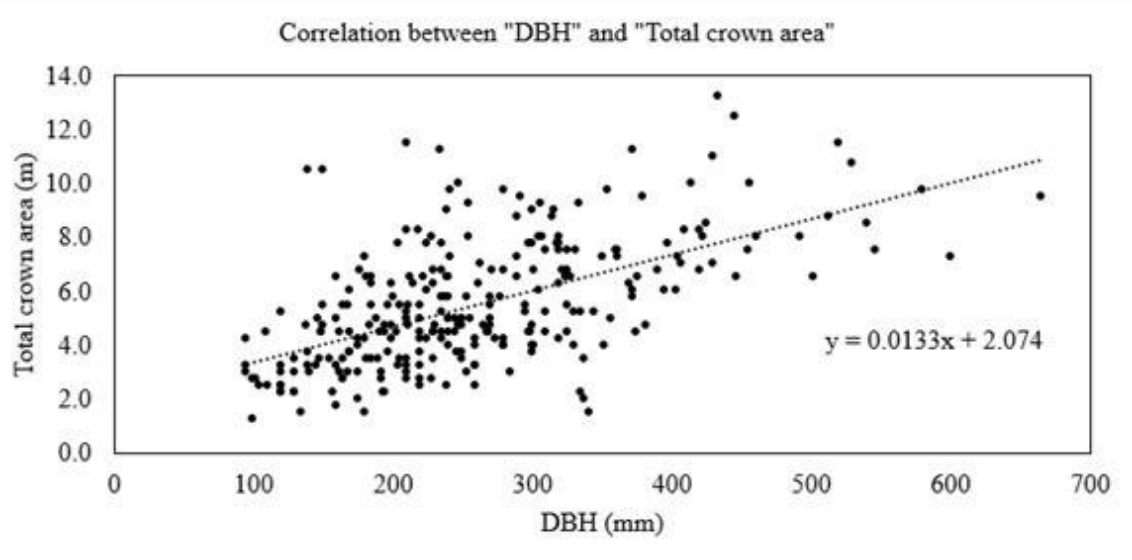


04

Results

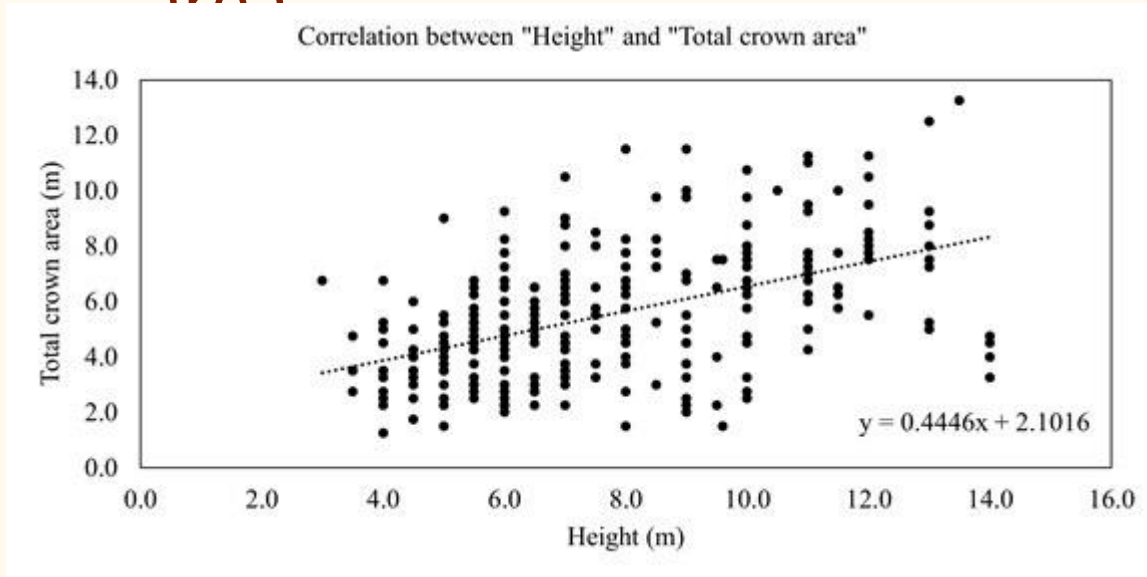
- Parameters and inclinations of
Acacia confusa

Correlation between DBH & Total crown area



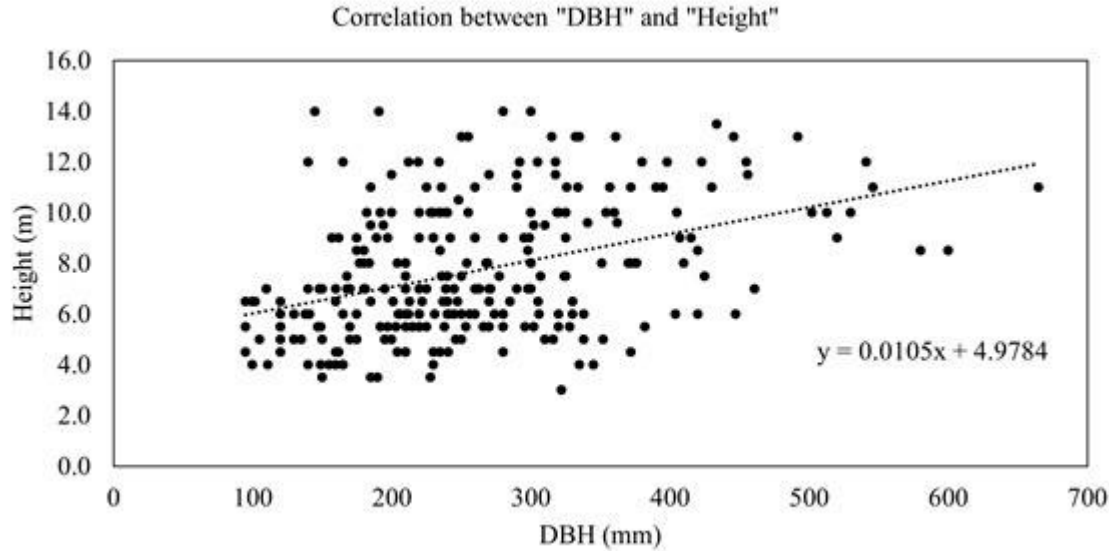
Moderate positive linear relationship
 $r=0.577$, $p=0.000$

Correlation between Height & Total crown area



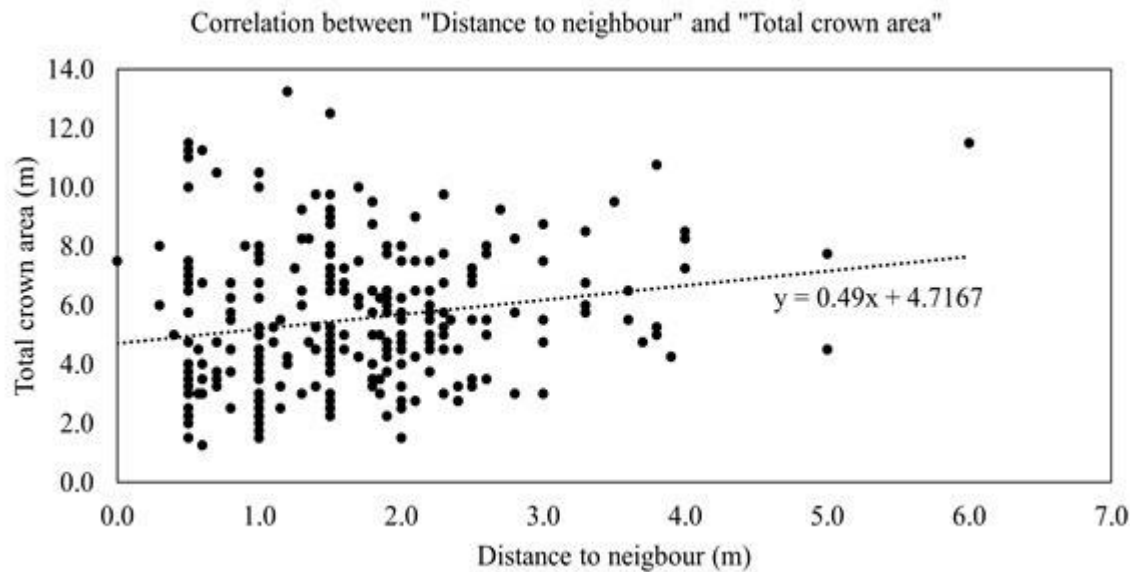
Moderate positive linear relationship
 $r=0.497$, $p=0.000$

Correlation between DBH & Height



Moderate positive linear relationship
 $r=0.407$, $p=0.000$

Correlation between Distance to neighbour & Total crown area



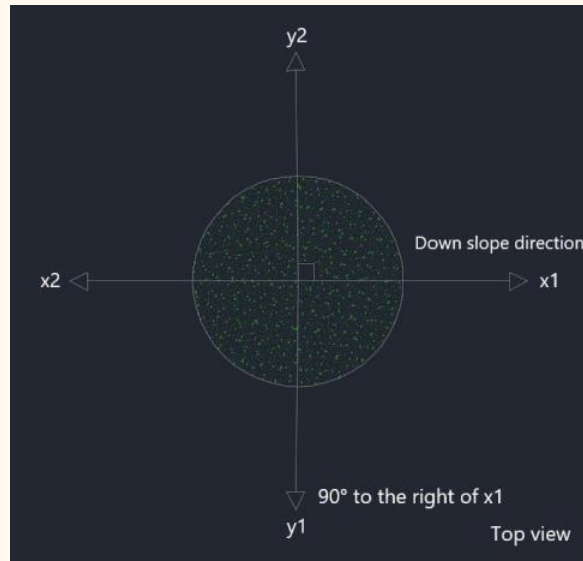
Weak positive linear relationship
 $r=0.191$, $p=0.001$

Crown parameters

No significant difference between x_1 and x_2 (Independent t-test, $p=0.439$)

No significant difference between y_1 and y_2 (Independent t-test, $p=0.366$)

No significant difference between x and y (Independent t-test, $p=0.944$)



Inclinations of *Acacia confusa*

Significant stem inclination

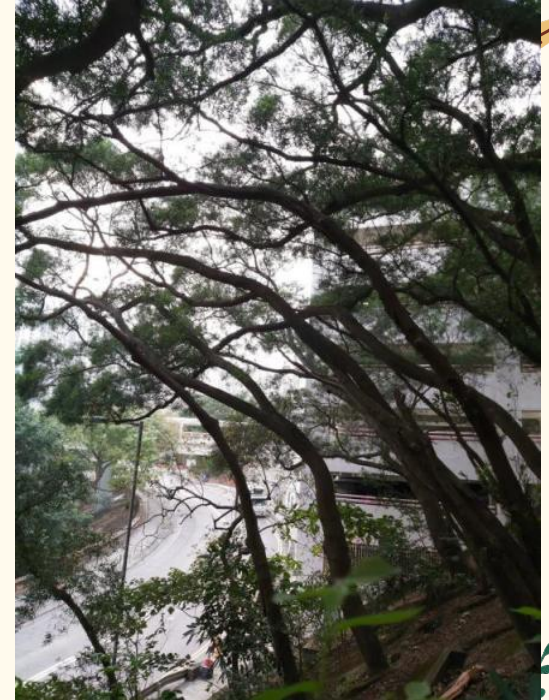
(One-sample t-test, mean=22.444, hypothesized mean=15, $p=0.000$)

Significant crown inclination

(One-sample t-test, mean=32.953, hypothesized mean=15, $p=0.000$)

Crown inclination is **significantly greater** than stem inclination, mean average=10°
(Independent t-test, $p=0.000$)

→ Bending from stem to crown



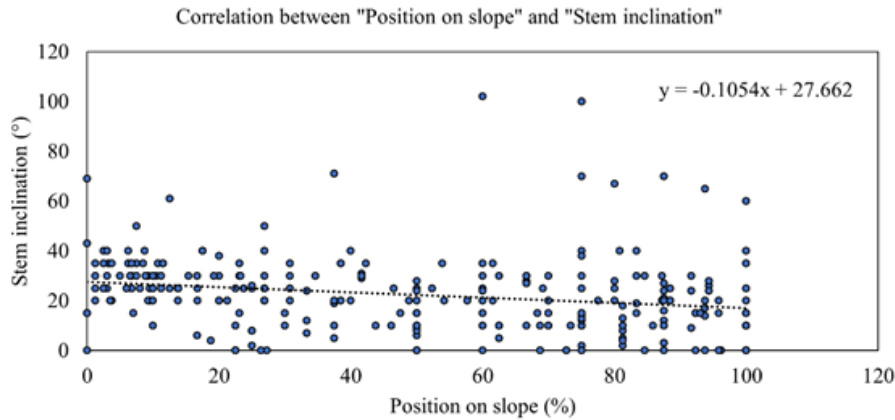
11SE-B-CR554

Inclinations of *Acacia confusa*

No significant difference between slope orientation and *Acacia confusa*'s inclination orientation
(Independent t-test, $p=0.716$)

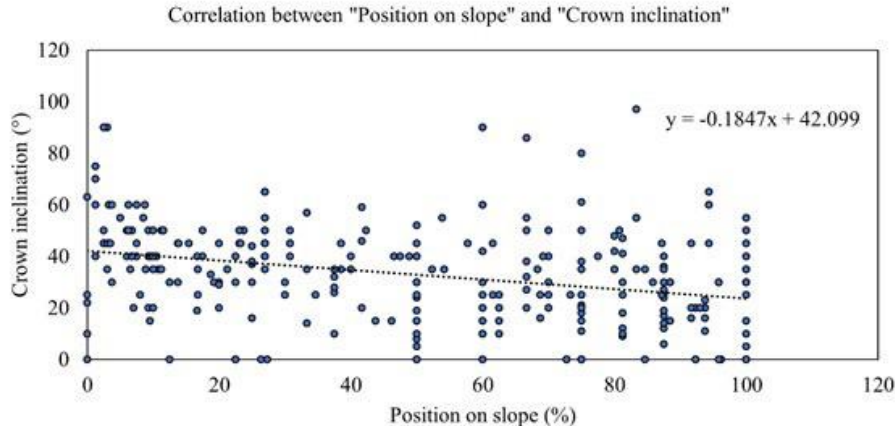


Correlation between Position on slope & Inclinations



Weak negative linear relationship
 $r = -0.212$, $p = 0.000$

→ higher position of a slope, its stem inclination would decrease



Weak negative linear relationship
 $r = -0.318$, $p = 0.000$


→ higher position of a slope, its crown inclination would decrease



Effect of orientations of slopes on inclinations

No significant difference among stem inclinations on various slope orientations
(One way ANOVA, $F(6,268)=0.933$, $p=0.471$)

Significant difference among crown inclinations on various slope orientations
(One way ANOVA, $F(6,268)=2.361$, $p=0.031$)



Crown inclination degree on **East facing slopes** is **significantly less** than those on **Southeast** ($p=0.010$), **Southwest**($p=0.013$) and **West**($p=0.048$) facing slopes




Effect of types of slopes on inclinations



Significant difference among stem inclinations on various slope types
(One way ANOVA, $F(3,271)=2.847$, $p=0.038$)

Stem inclination degree on **cut slopes** is **significantly greater** than those on **fill slopes**
($p=0.032$)



Significant difference among crown inclinations on various slope types
(One way ANOVA, $F(3,271)= 9.783$, $p= 0.000$)

Crown inclination degree on **cut slopes** is **significantly greater** than those on **fill slopes**
($p=0.001$) and **fill slopes with retaining wall** ($p=0.005$)



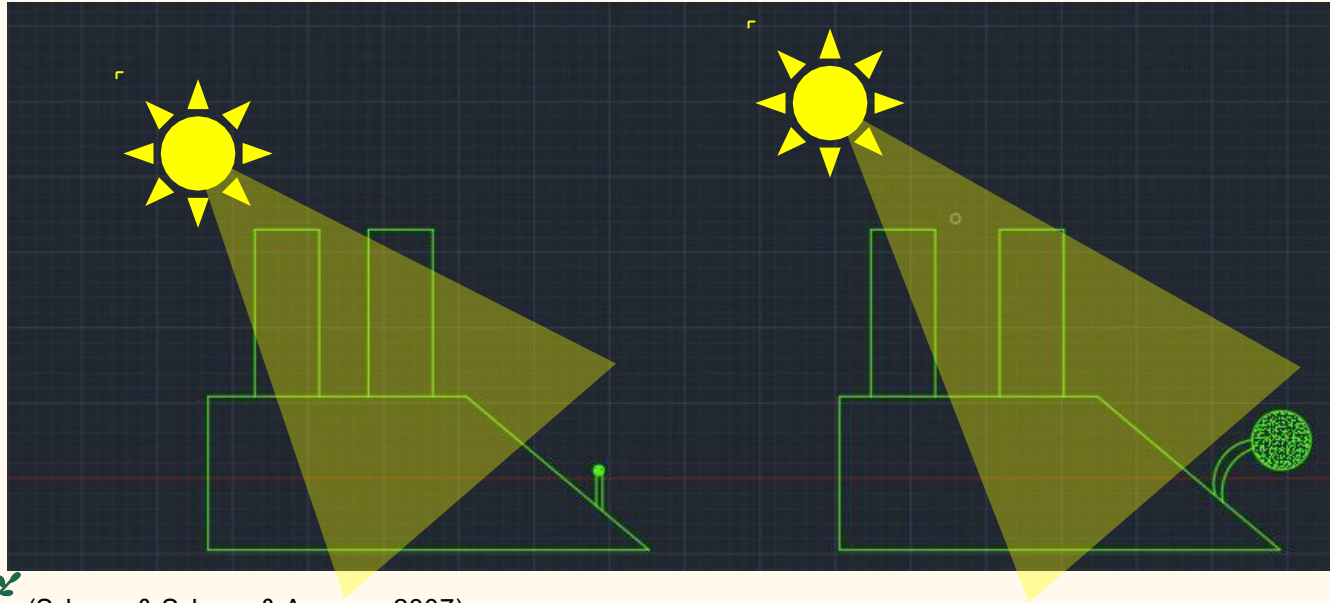
05

Discussions

- Implications of phototropism
- Enhancement methods

Implications of phototropism

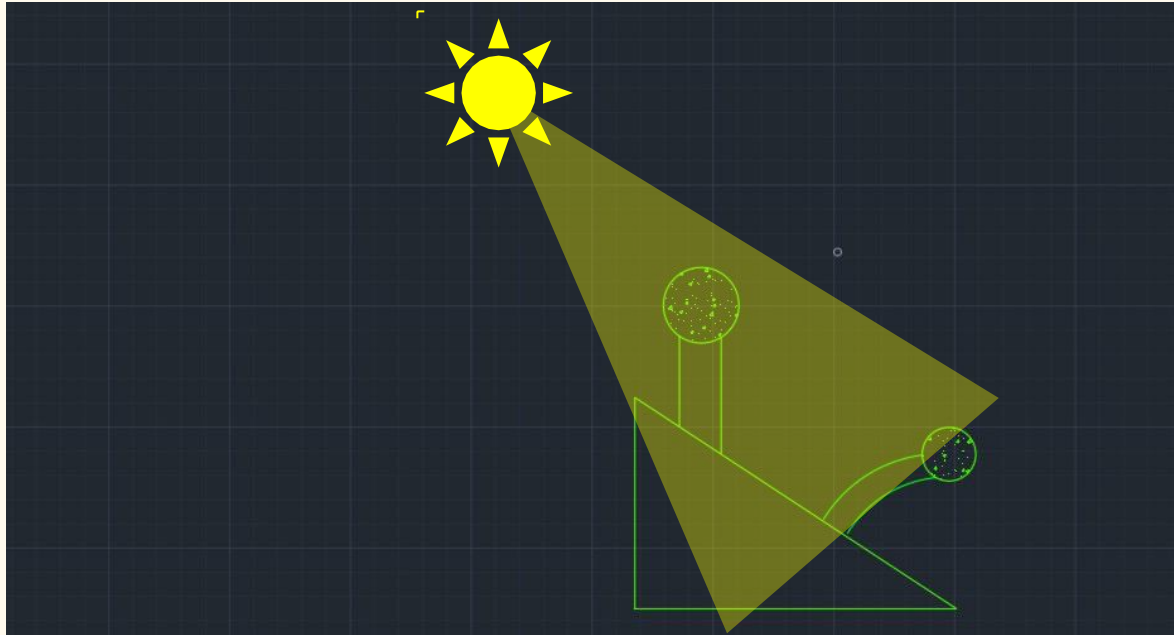
Why down-slope direction?



(Schamp & Schurer & Aarssen, 2007)

Implications of phototropism

Higher position → less inclination



(Getzin & Wiegand, 2007)

Implications of phototropism

11SE-B-FR44



Situation on lower position

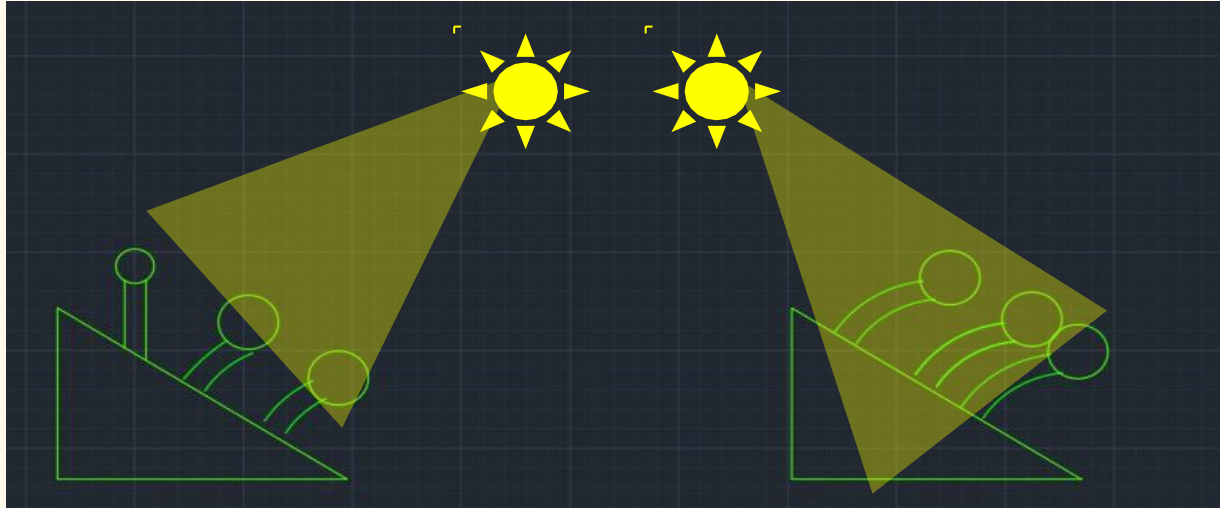
11SE-B-FR44



Situation on higher position

Implications of phototropism

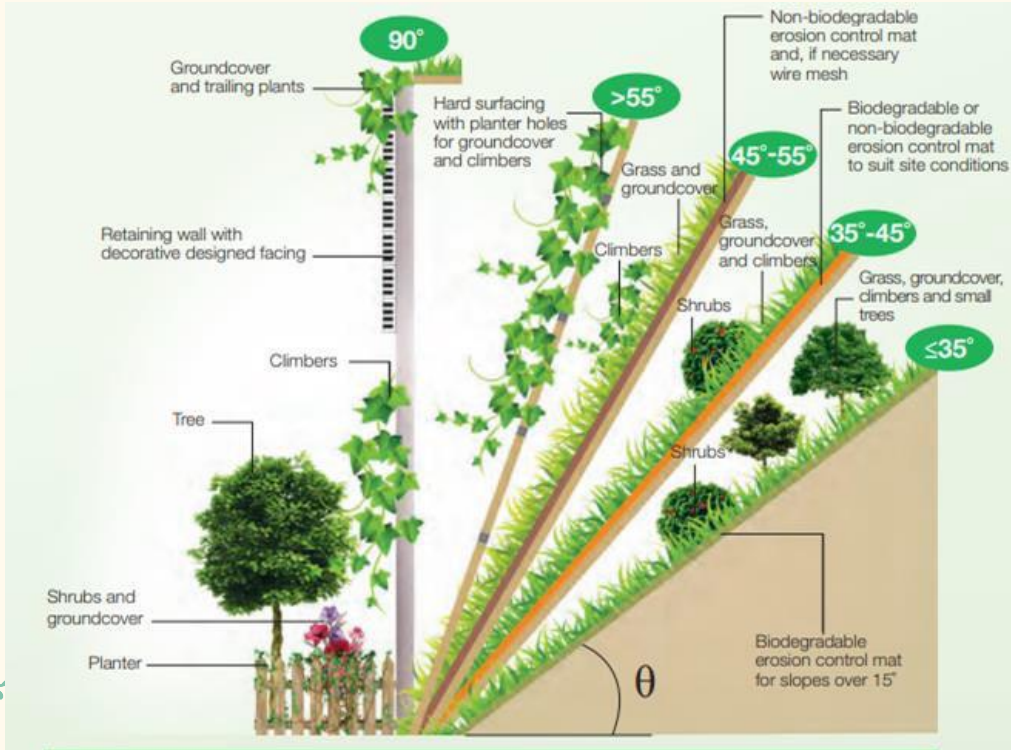
East facing slope: less inclination than Southeast, Southwest and West slopes



East facing slope

Southeast, Southwest, West facing slope

Enhancement method (Planting selection)



Native trees

Schefflera heptaphylla (鴨腳木)

Reevesia thyrsoides (梭羅樹)

Sterculia lanceolata (假蘋婆)

Liquidambar formosana (楓香)

✓✓✓ Biodiversity

(Highway Department, 2019; Civil Engineering and Development Department, 2012)

Planting opportunities on slopes
(Civil Engineering and Development
Department, 2012)

Enhancement method (Slope maintenance)



Maintenance

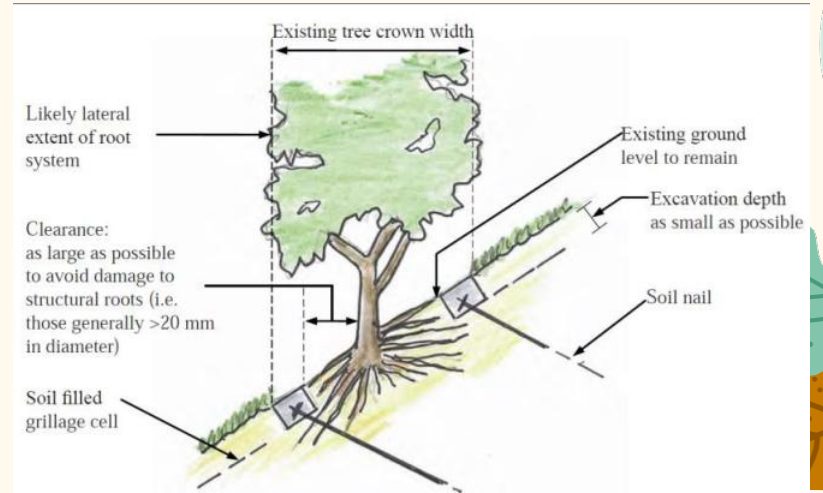
Fill the cracked surface with similar filling material

Filling the cracked slope surface (CEDD, 2018)

Install soil nail

↑↑↑Stability

Soil Nail Grillage in Vicinity of Existing Tree Roots (CEDD, 2011)





06

Conclusions

- Summary
- Limitations
- Further study

Summary

Respond growth on slopes: Inclination

Causes: Nearby environmental conditions





Limitations

Sample size↑↑↑

Only 5 and 4 data on Northeast and Northwest directions respectively

No data on North facing slope

1000 data✓✓✓ → ↑↑↑Data representation & accurate result






Further study

Native species e.g. *Sterculia lanceolata* &
Liquidambar formosana

→ Database of slope trees to understand their
responses to slopes



The slide features decorative floral and leaf motifs in the corners. The top-left corner has a branch with small brown leaves and a green leaf with two red dots. The top-right corner has a light blue wavy shape, a brown leaf, and a green leaf with two red dots. The bottom-left corner has a brown branch, a green leaf, and a light blue wavy shape. The bottom-right corner has a green leaf, a brown leaf, and a light blue wavy shape.

Thank you!

References

- Agriculture, Fisheries and Conservation Department (AFCD). (2006). *Measurement of Diameter at Breast Height (DBH)*. Retrieved from https://www.afcd.gov.hk/english/conservation/con_tech/files/common/NCPN_No.02_measurement_of_DBH_ver.2006.pdf
- Buildings Department. (2020). *Slope safety*. Retrieved from <https://www.bd.gov.hk/en/safety-inspection/slope-safety/index.html>
- Chan, N. L., Cheung, T. F., Leung, M. W., Tam, K. C., Yip, H. Y. (2014). *Tree management and the greening of the environment in Hong Kong: a study of collaborative governance* (Master's capstone project, The University of Hong Kong, Hong Kong). Retrieved from <http://hdl.handle.net/10722/211007>
- Civil Engineering and Development Department. (2011). *Technical guidelines on landscape treatment for slopes*. Retrieved from https://www.cedd.gov.hk/filemanager/eng/content_151/ep1_2011.pdf
- Civil Engineering and Development Department (CEDD). (2012). *Layman's guide to landscape treatment of slopes*. Retrieved from https://www.cedd.gov.hk/filemanager/eng/content_440/elg_landscape.pdf
- Civil Engineering and Development Department (CEDD). (2018). *Guide to slope maintenance*. Retrieved from https://www.cedd.gov.hk/filemanager/eng/content_113/eg5_20181120.pdf
- Corlett, R. T. (1999). Environmental forestry in Hong Kong: 1871–1997. *Forest Ecology and Management*, 116(1), 93-105. [https://doi.org/10.1016/S0378-1127\(98\)00443-5](https://doi.org/10.1016/S0378-1127(98)00443-5)
- Development Bureau. (2018). *Registration and updating of the catalogue of slopes*. Retrieved from <https://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/358/1/C-2018-02-01.pdf>
- Fasona, M., Adeonipekun, P. A., Agboola, O., Akintuyi, A., Bello, A., Ogundipe, O., ... & Omojola, A. (2019). Incentives for collaborative governance of natural resources: A case study of forest management in southwest Nigeria. *Environmental Development*, 30, 76-88.
- Getzin, S., & Wiegand, K. (2007). Asymmetric tree growth at the stand level: Random crown patterns and the response to slope. *Forest Ecology and Management*, 242(2), 165-174. <https://doi.org/10.1016/j.foreco.2007.01.009>
- Highway Department. (2019). *Succeed sustain slopescape*. Retrieved from https://www.hyd.gov.hk/en/district_and_maintenance/landscape/enhancement/doc/booklet_e.pdf
- Hohm, T., Preuten, T., & Fankhauser, C. (2013). Phototropism: translating light into directional growth. *American journal of botany*, 100(1), 47-59.
- Ishii, R., & Higashi, M. (1997). Tree coexistence on a slope: an adaptive significance of trunk inclination. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 264(1378), 133-139.
- Lam, Z., & King, S. A. (2005, November). Simulating tree growth based on internal and environmental factors. In *Proceedings of the 3rd international conference on Computer graphics and interactive techniques in Australasia and South East Asia* (pp. 99-107).
- Lang, A. C., Härdtle, W., Bruelheide, H., Geißler, C., Nadrowski, K., Schuldt, A., Yu, M., & von Oheimb, G. (2010). Tree morphology responds to neighbourhood competition and slope in species-rich forests of subtropical china. *Forest Ecology and Management*, 260(10), 1708-1715. <https://doi.org/10.1016/j.foreco.2010.08.015>



References

- Leung, F., Yan, W., Hau, B., & Tham, L. (2018). Mechanical pull-out capacity and root reinforcement of four native tree and shrub species on ecological rehabilitation of roadside slopes in Hong Kong. *Journal of Tropical Forest Science*, 30(1), 25-38. <https://doi.org/10.26525/jtfs2018.30.1.2538>
- Liu, J., Yunhong, T., & Slik, J. W. F. (2014). Topography related habitat associations of tree species traits, composition and diversity in a chinese tropical forest. *Forest Ecology and Management*, 330, 75-81. <https://doi.org/10.1016/j.foreco.2014.06.045>
- Liscum, E., Askinosie, S. K., Leuchtman, D. L., Morrow, J., Willenburg, K. T., & Coats, D. R. (2014). Phototropism: growing towards an understanding of plant movement. *The Plant Cell*, 26(1), 38-55.
- Malon, A. W. (1997). Risk management and slope safety in Hong Kong. *HKIE Transactions*, 4(2-3), 12-21. Retrieved from https://www.researchgate.net/profile/Andrew-Malone-3/publication/262884744_Risk_Management_and_Slope_Safety_in_Hong_Kong/links/00b7d539181826c315000000/Risk-Management-and-Slope-Safety-in-Hong-Kong.pdf
- Matsuzaki, J., Masumori, M., & Tange, T. (2006). Stem phototropism of trees: A possible significant factor in determining stem inclination on forest slopes. *Annals of Botany*, 98(3), 573-581. <https://doi.org/10.1093/aob/mcl127>
- Schamp, B., Schurer, M., & Aarssen, L. (2007). Testing hypotheses for stem bending in tree saplings. *International Journal of Plant Sciences*, 168(5), 547-553. <https://doi.org/10.1086/513480>
- Smiley, E. T., & Kane, B. (2006). The effects of pruning type on wind loading of *Acer rubrum*. *Journal of Arboriculture*, 32(1), 33.
- 東方日報 (2020年6月6日)。〈斜坡塌5米樹擊傷3途人〉。取自 https://orientaldaily.on.cc/cnt/news/20200606/00176_066.html
- 明報 (2016年6月12日)。〈兩樹倒塌壓兩車 東頭村道一度封路〉。取自 <https://news.mingpao.com/ins/%E6%B8%AF%E8%81%9E/article/20160612/s00001/1465716746366/%E5%85%A9%E6%A8%B9%E5%80>