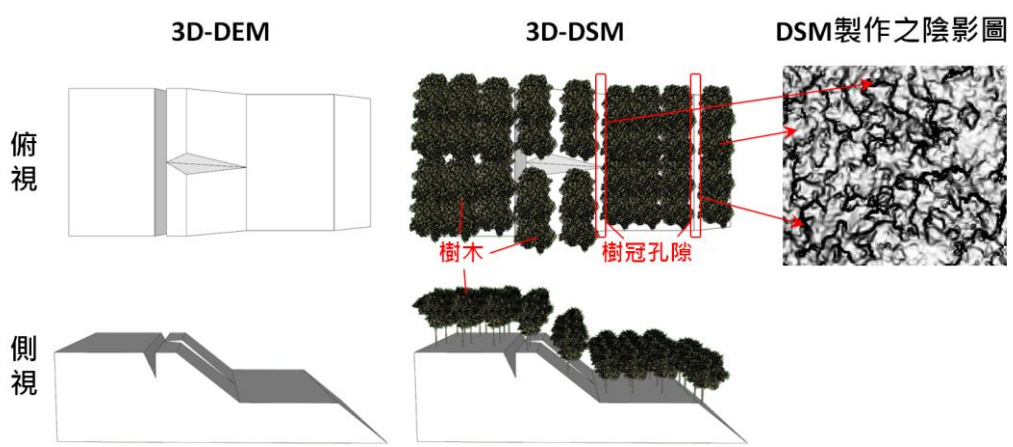
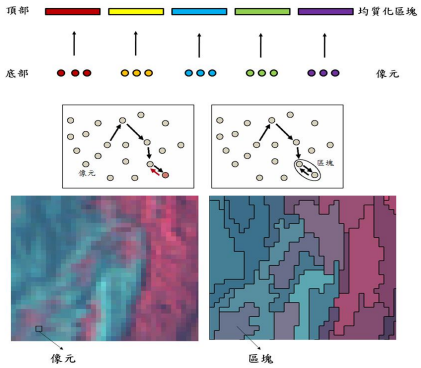
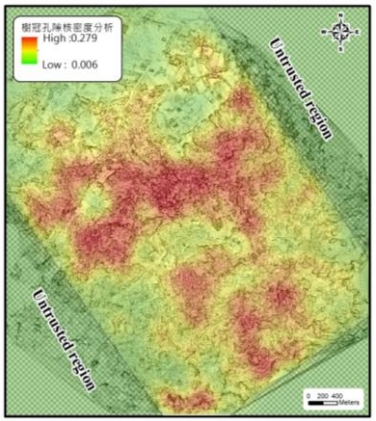
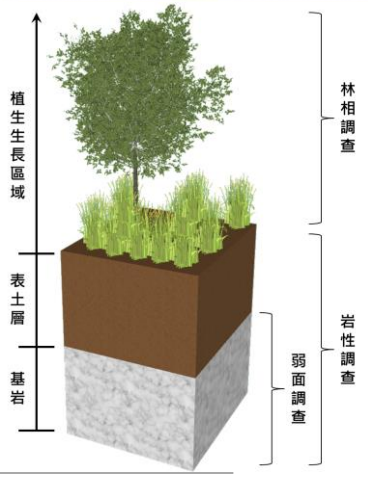








無人載具之高精度數值地表模型應用於樹冠孔隙自動判釋及邊坡土體穩定評估

報告人：財團法人中興工程顧問社 黃韋凱 副研究員

報告時間：2018/10/25

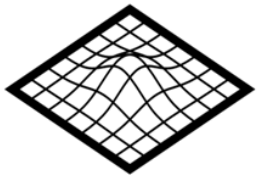
航測資料特性與工程防災應用

航測工具&後製資料

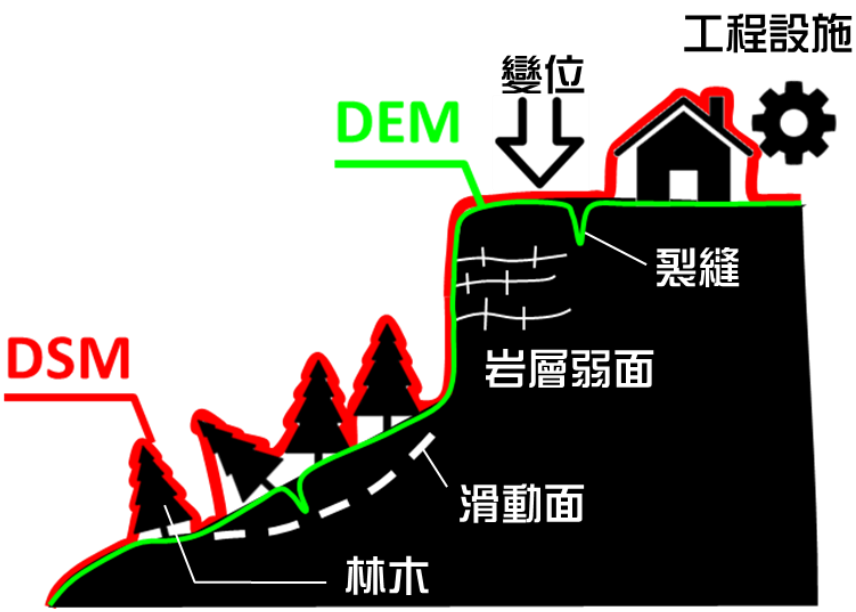
UAV

LiDAR

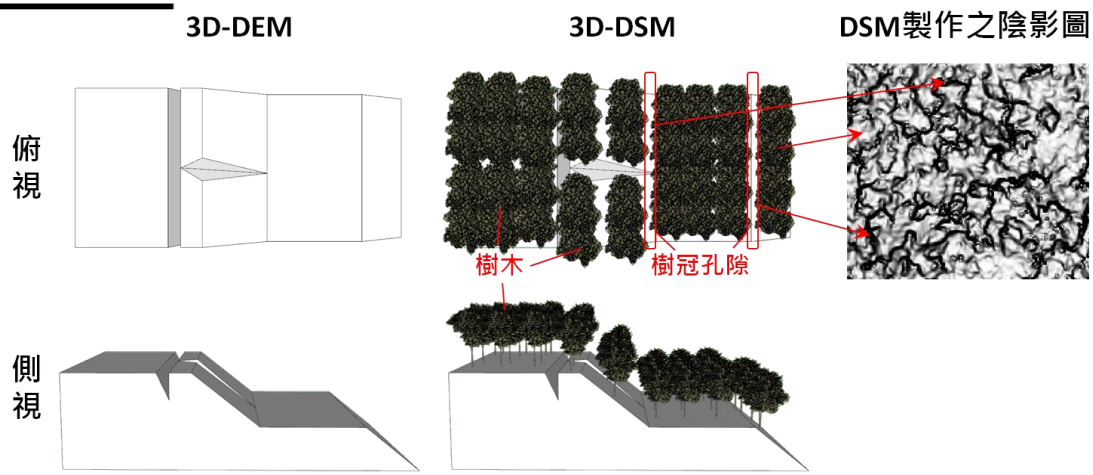
Aerial Photo



Digital Terrain Model



樹冠孔隙與DSM&DEM關聯性



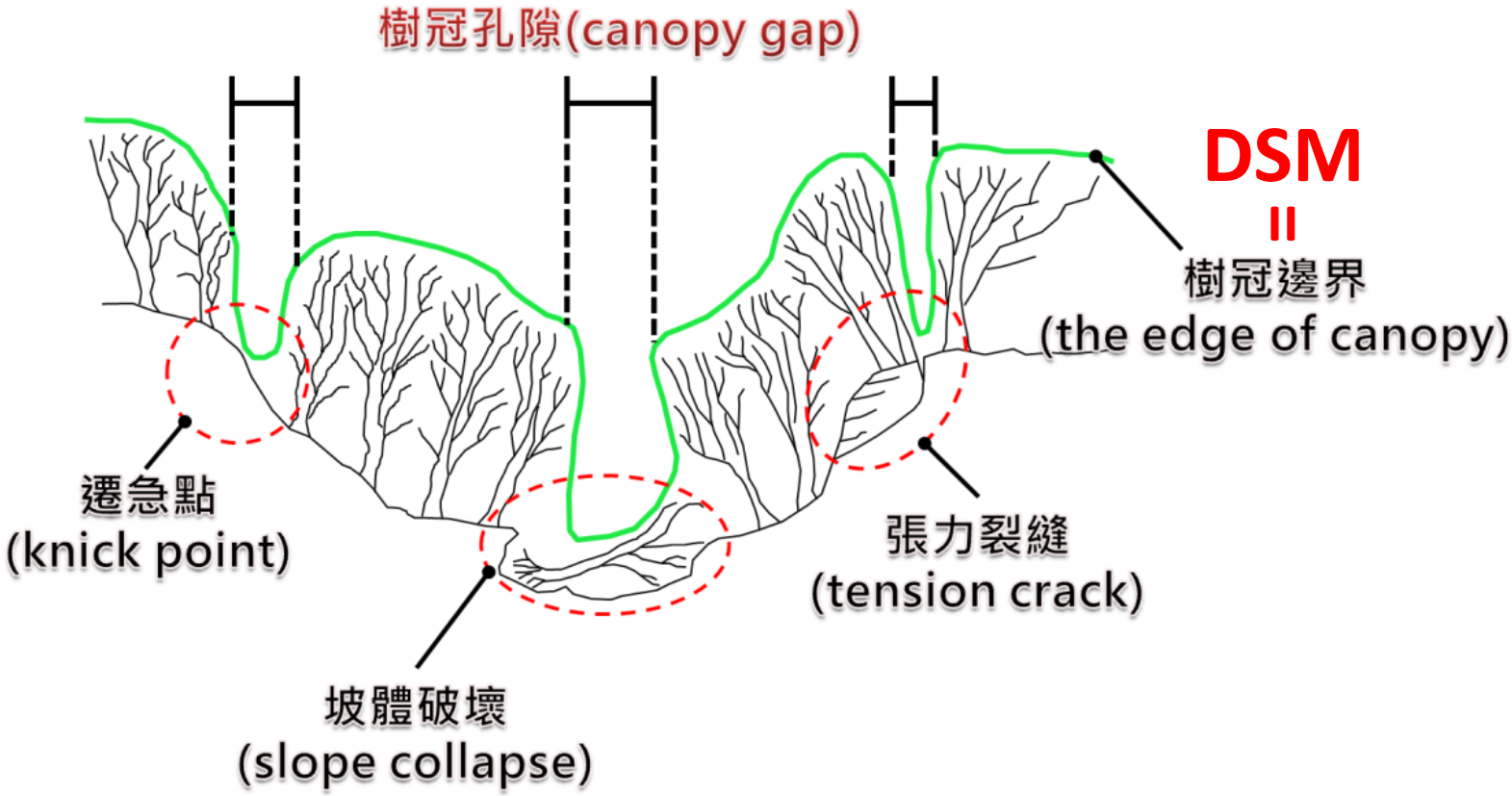
樹冠孔隙與羞避行為

樹冠羞避 (Crown Shyness)

引用自https://www.mindenpictures.com/

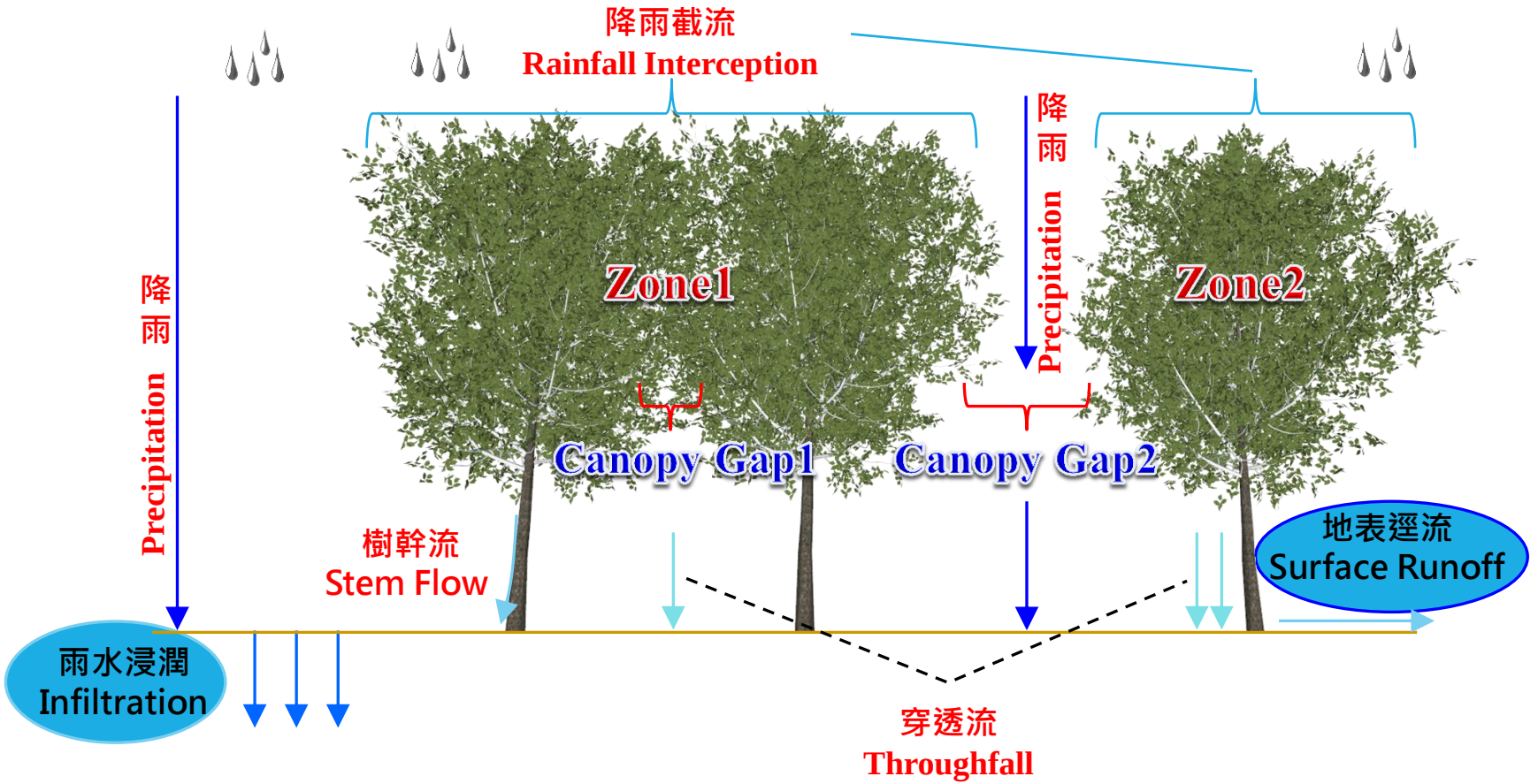
引用自：https://www.thisiscolossal.com/2017/08/the-phenomenon-of-crown-shyness-where-trees-avoid-touching/

樹冠孔隙與坡體形貌關聯性

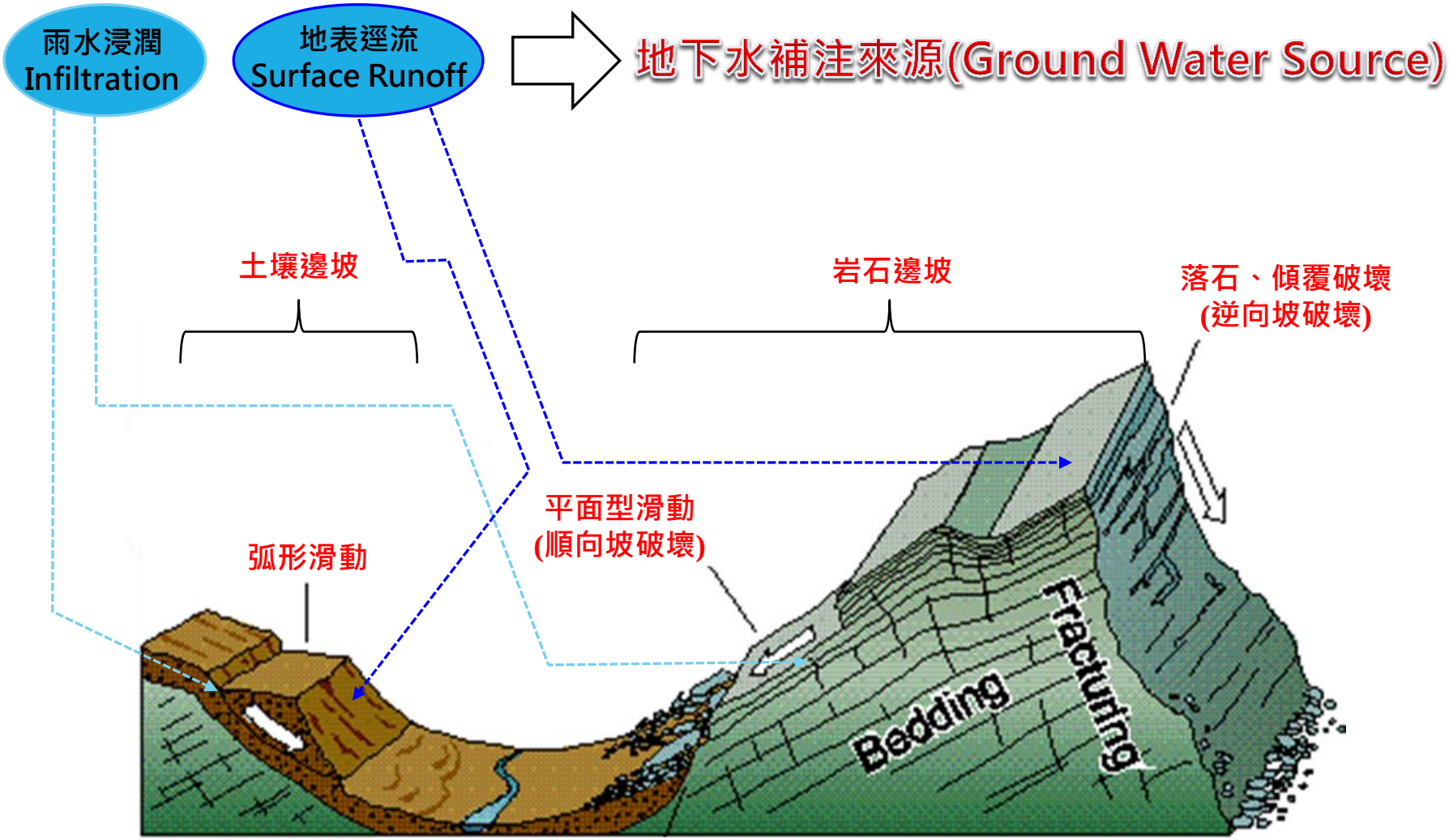


樹冠孔隙與水文學截流關聯性 (1/2)

降雨截流Rainfall Interception(I)=降雨(P) –穿透流(TF) –樹幹流(S)

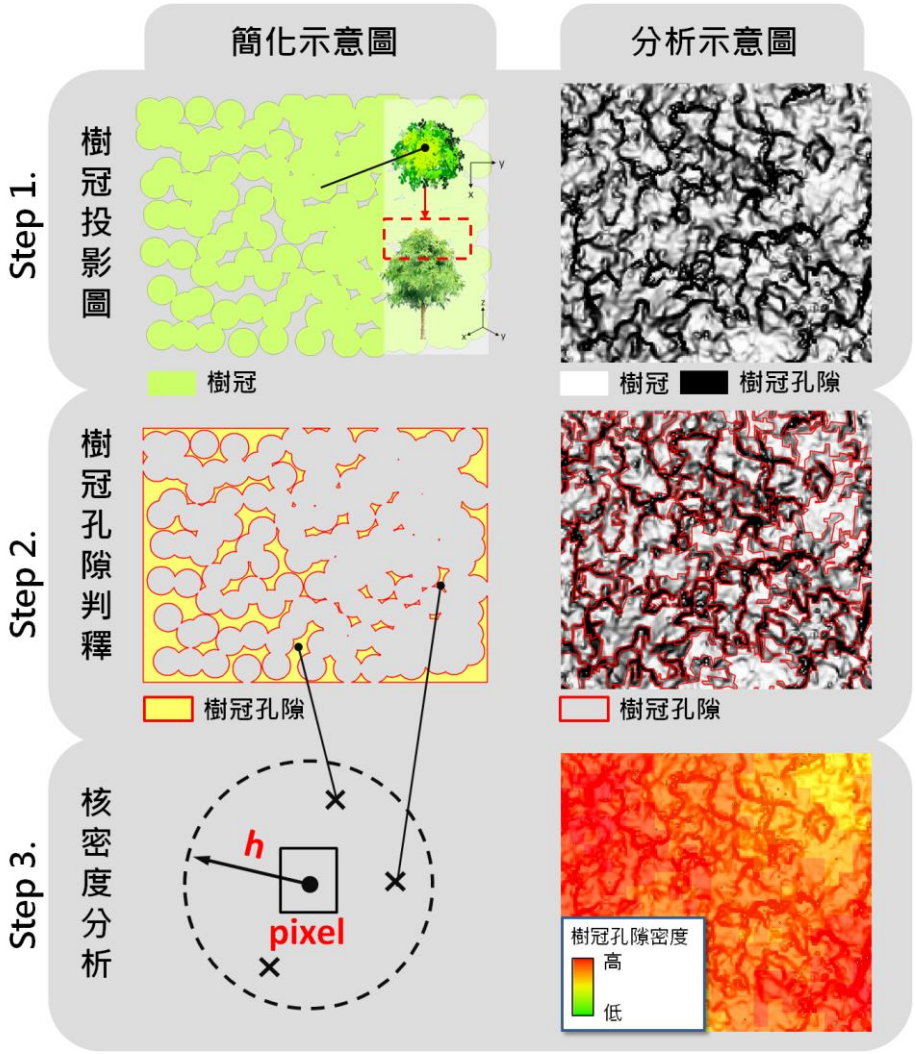


樹冠孔隙與水文學截流關聯性 (2/2)

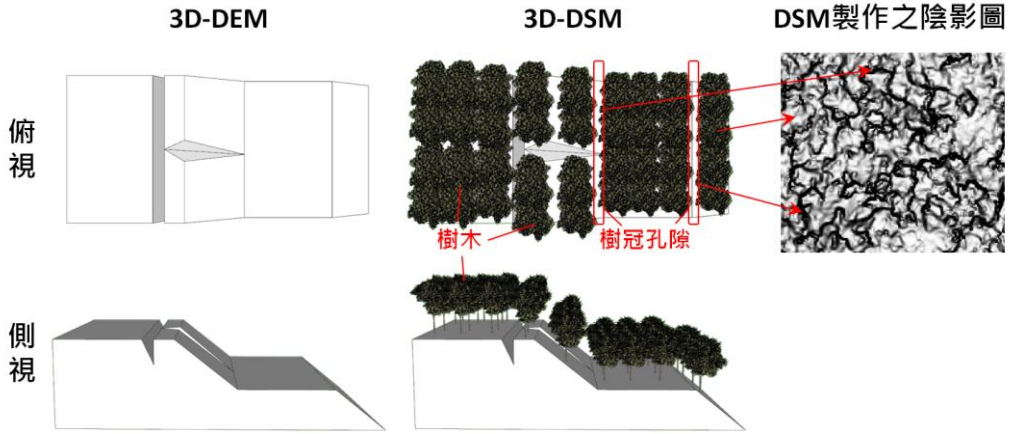


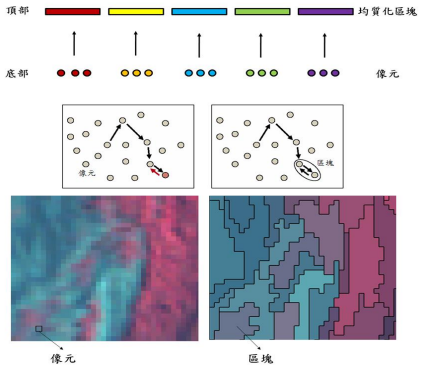
修改自：
http://www.empr.gov.bc.ca/Mining/Geoscience/SurficialGeology/Landslides/Pages/Whatcauseslandslides.aspx

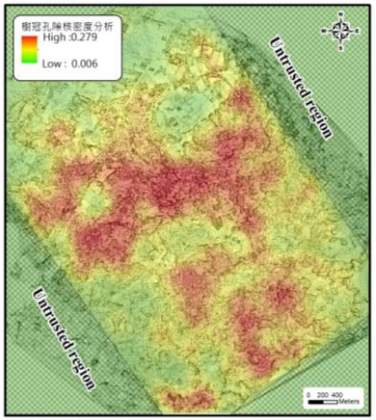
OUTLINE

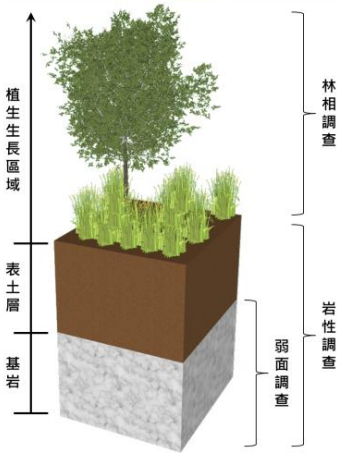


1. 無人載具航拍及地表數值地形建置
2. 影像物件導向分割及分類
3. 現場調查與樹冠孔隙核密度分析之關聯性建立
4. 現地調查與光達地貌特徵判釋驗證
5. 討論與總結



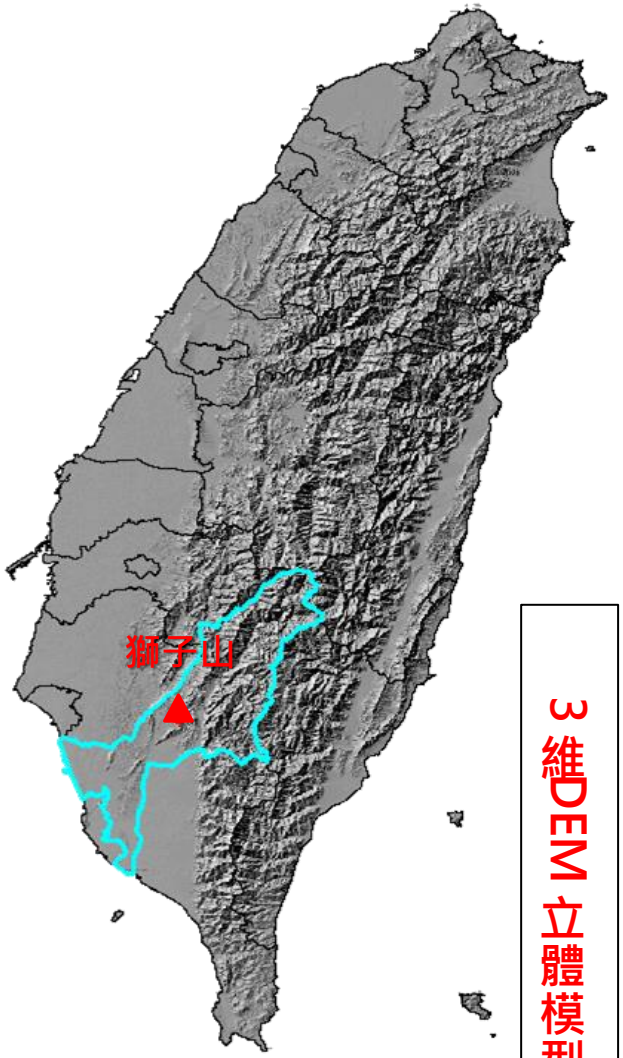




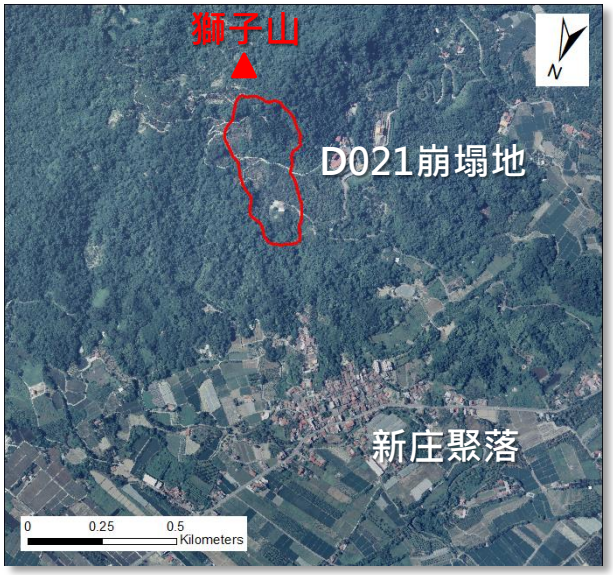


無人載具航拍及地表數值地形建置

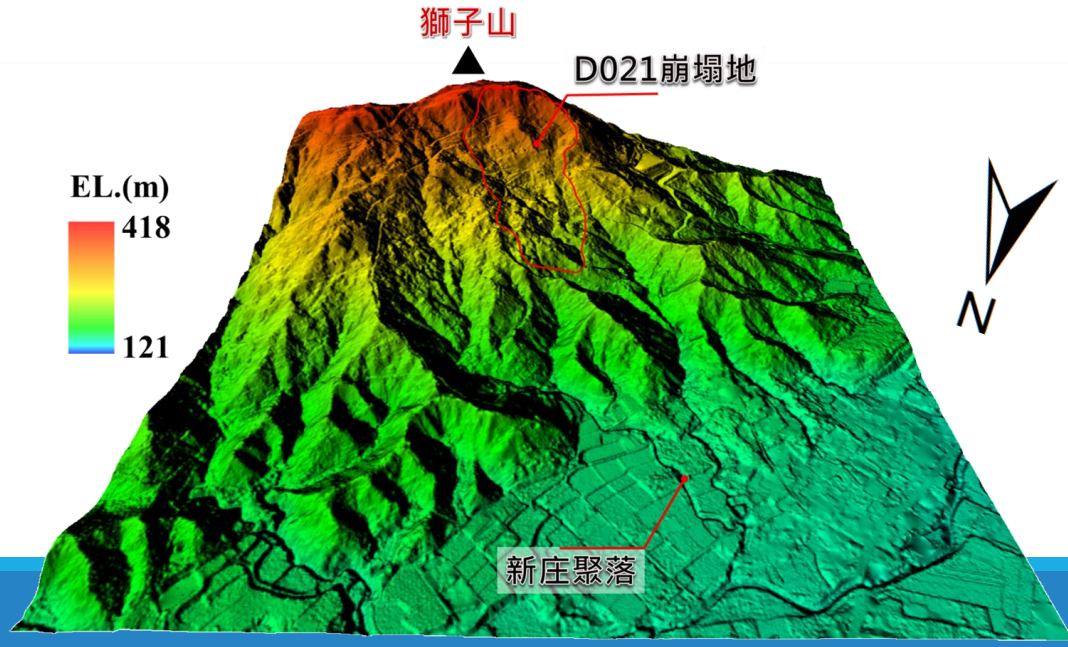
案例探討-以高雄市杉林區獅子山為例



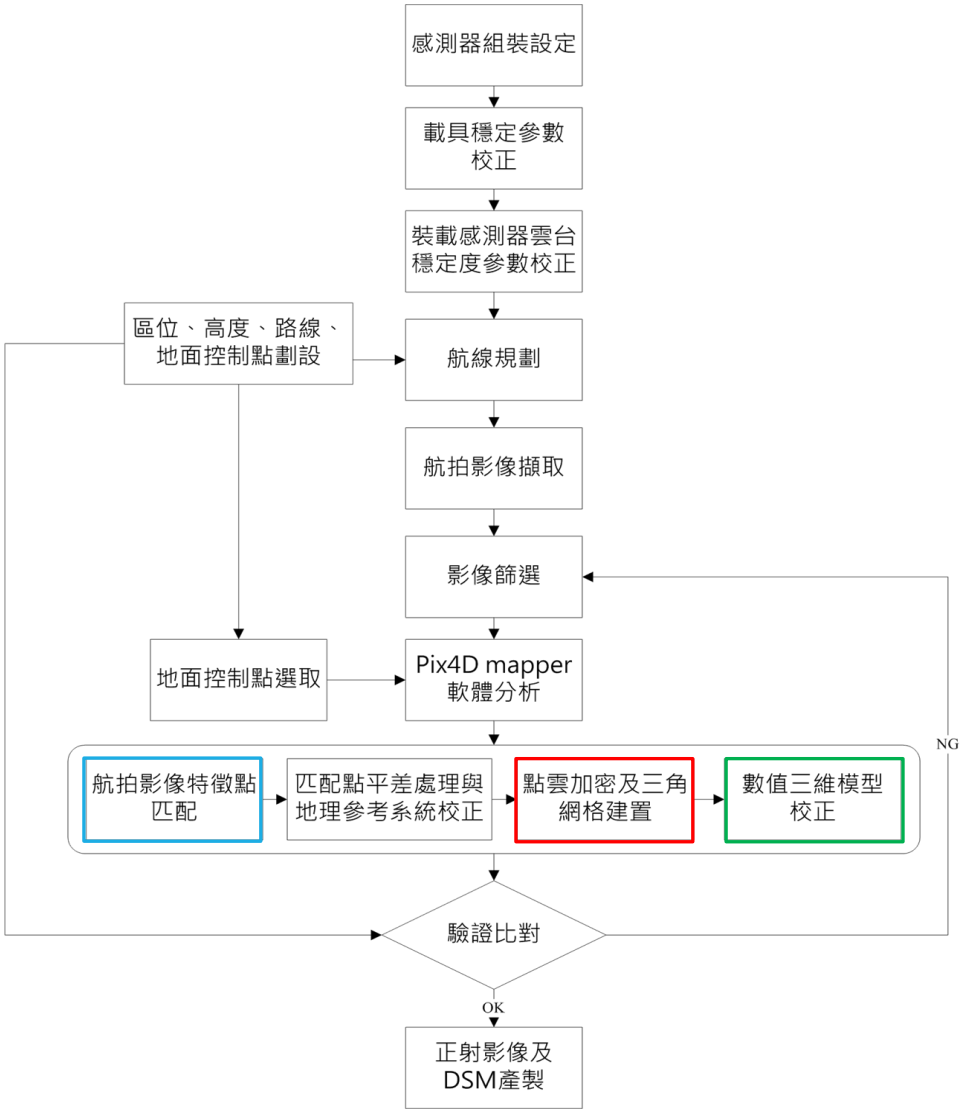
航照圖



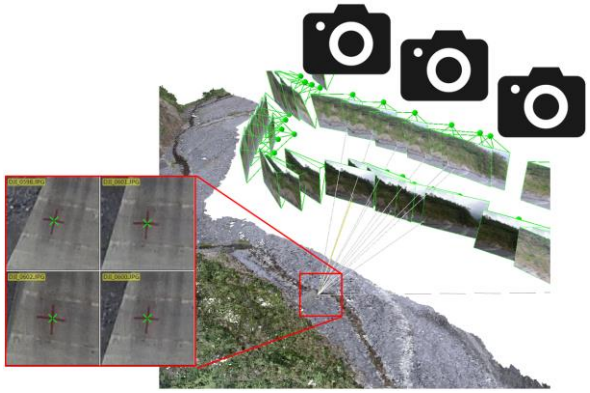
3維DEM立體模型



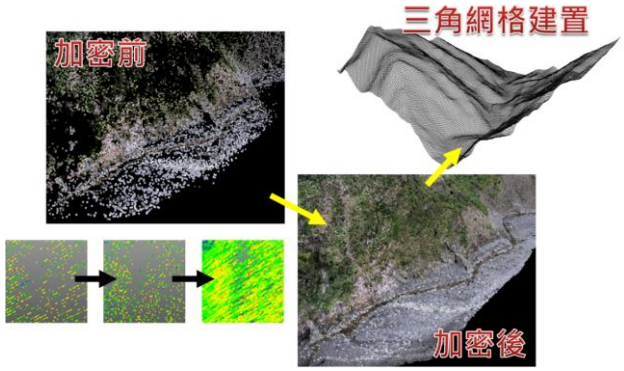
無人載具航拍地表數值地形建置流程與方法



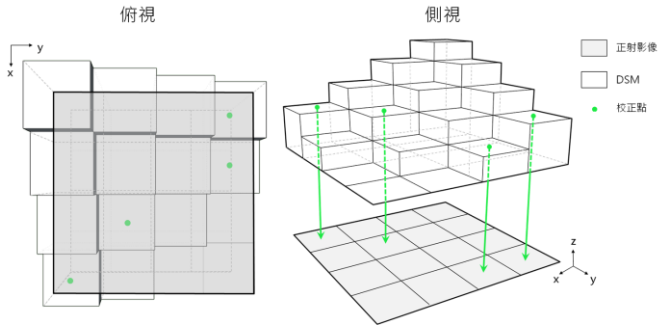
航拍影像特徵點匹配



點雲加密及三角網格建置

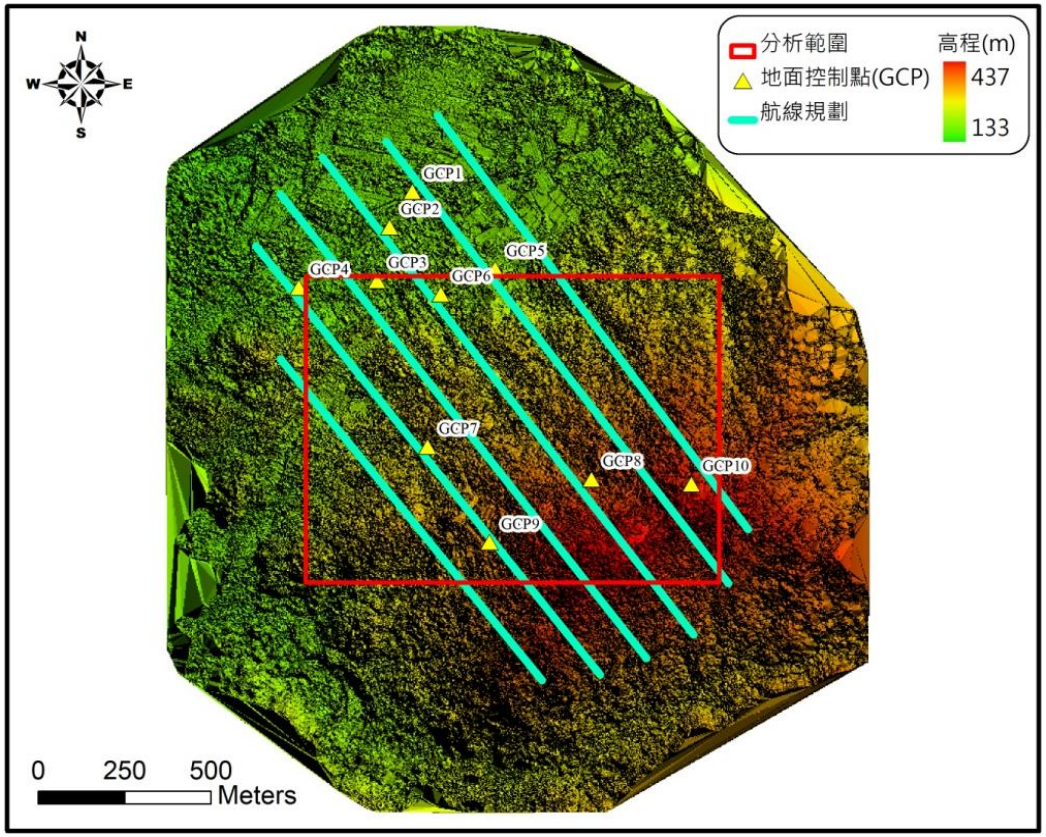


數值三圍模型校正



無人載具航線、控制點分佈與DSM成果示意圖

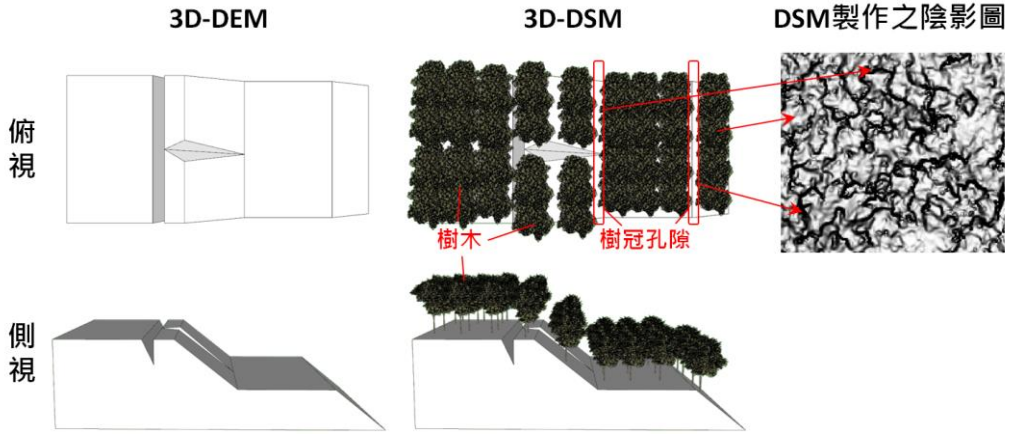
UAV航線、控制點分佈與DSM成果示意圖

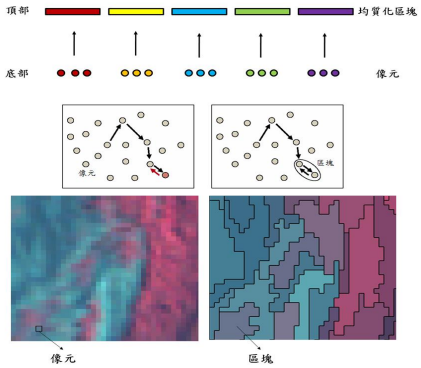


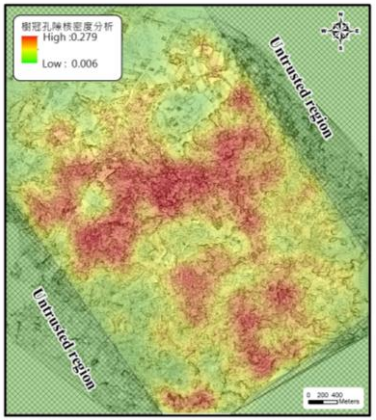
空拍控制點精度檢核

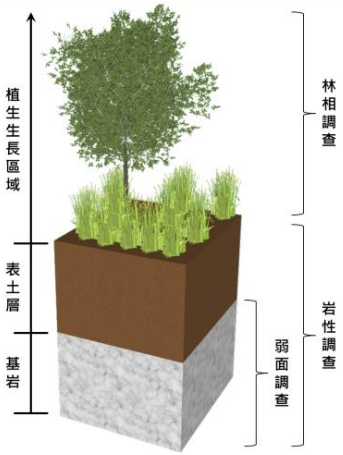
GCP Name	Error X (m)	Error Y (m)	Error Z (m)
GCP1 (3D)	0.039	0.103	-0.079
GCP2 (3D)	0.002	-0.043	-0.032
GCP3 (3D)	0.0375	0.036	0.136
GCP4 (3D)	0.157	0.194	0.346
GCP5 (3D)	0.022	-0.024	-0.059
GCP6 (3D)	0.102	0.0705	-0.084
GCP7 (3D)	-0.045	-0.064	-0.106
GCP8 (3D)	-0.107	-0.034	0.17
GCP9 (3D)	0.016	0.039	0.024
GCP10 (3D)	0.277	0.094	0.292
平均誤差	0.080	0.070	0.133
標準偏差	0.084	0.050	0.108

- 6條航線
- 拍攝面積460公頃





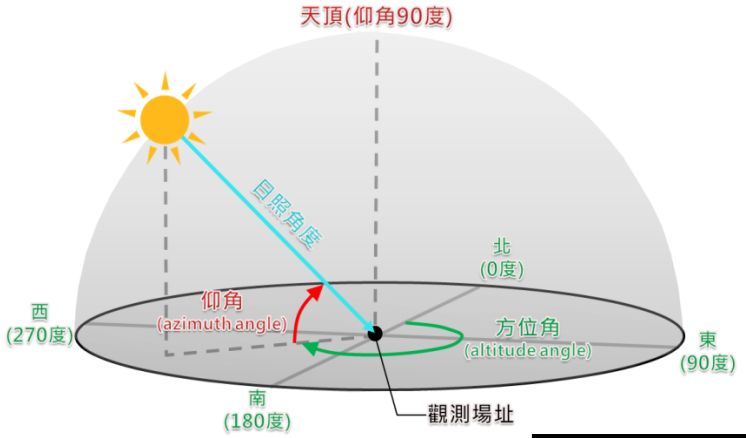




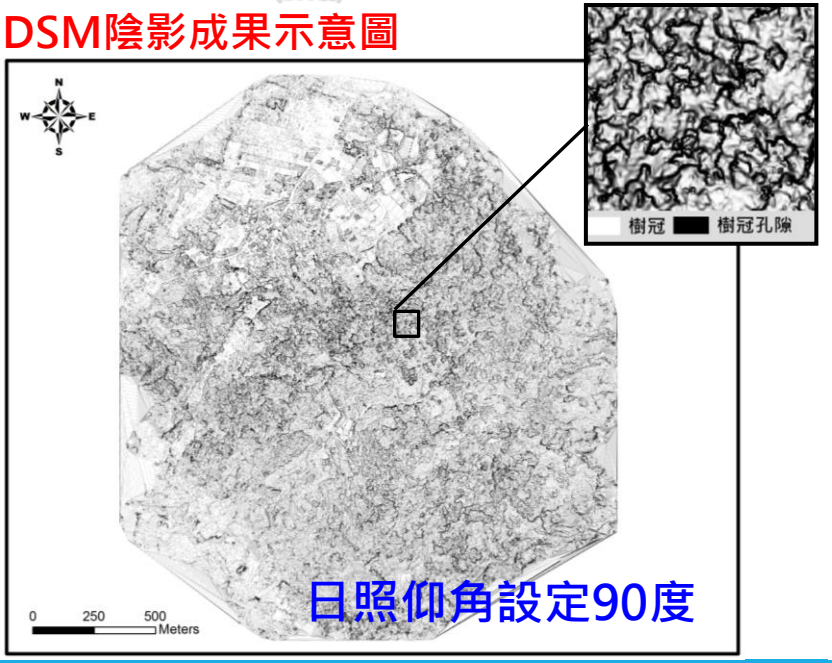
影像物件導向分割及分類

基礎資料陰影圖建立與影像物件導向分割與分類

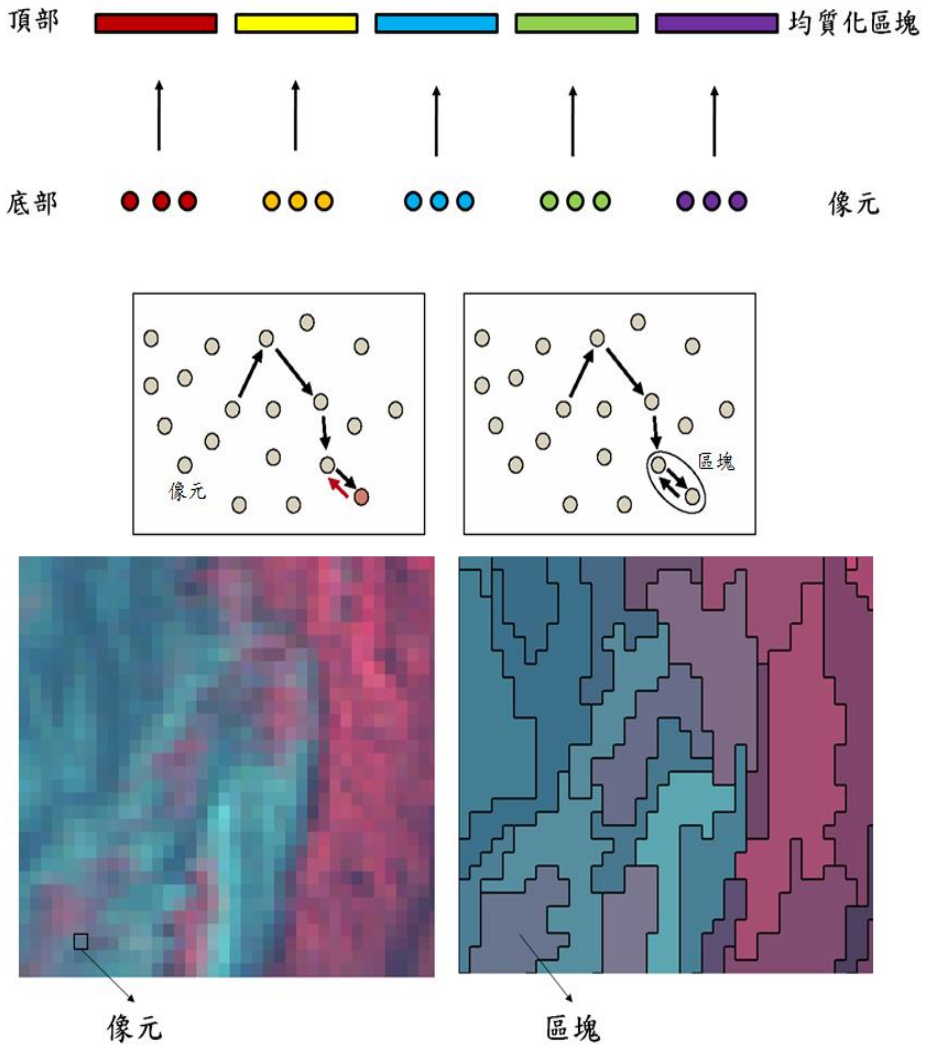
日照陰影圖製作方式



DSM陰影成果示意圖

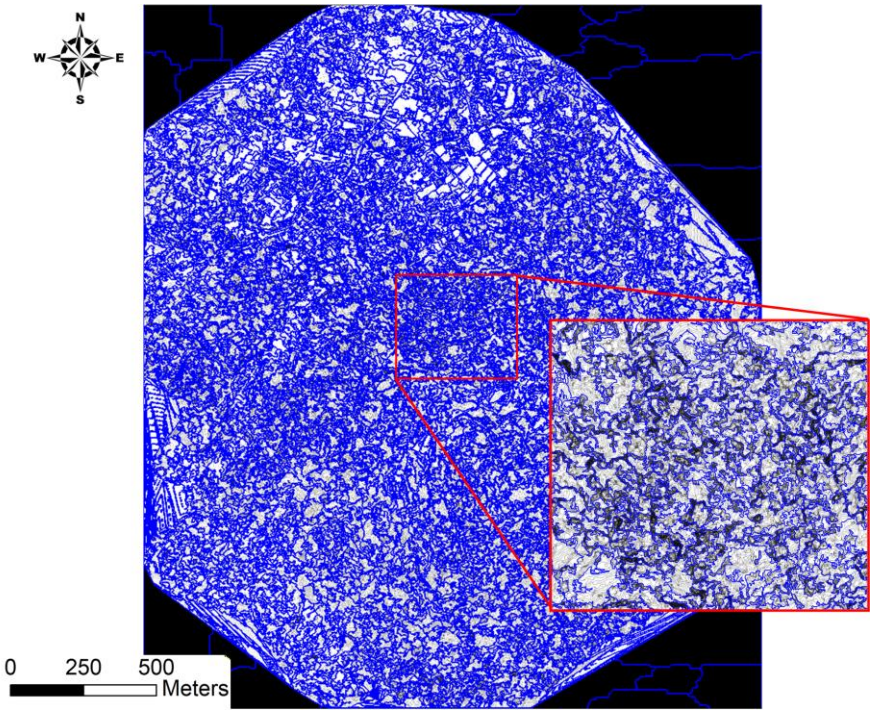


像元合併均質化區塊其原理示意圖

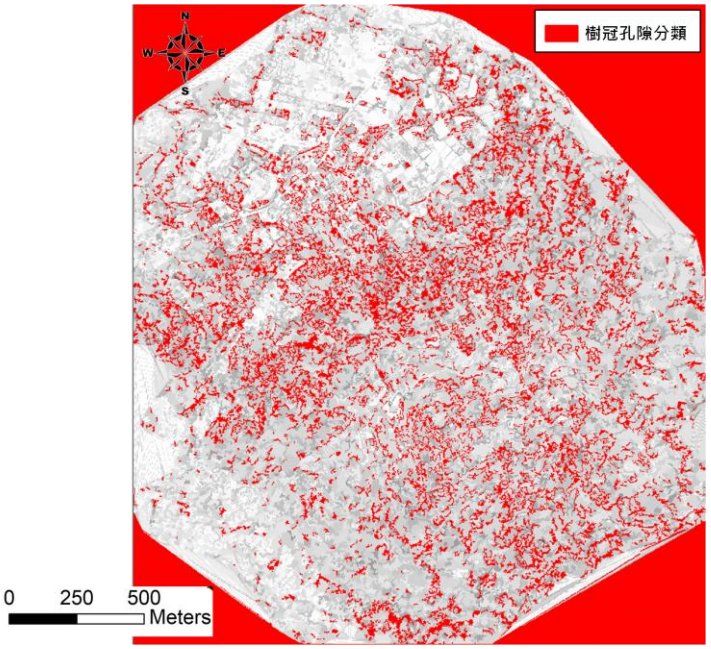


物件導向樹冠孔隙自動判釋

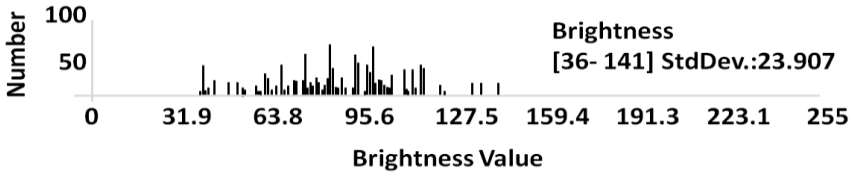
物件導向樹冠孔隙區塊分割



物件導向樹冠孔隙區塊分類

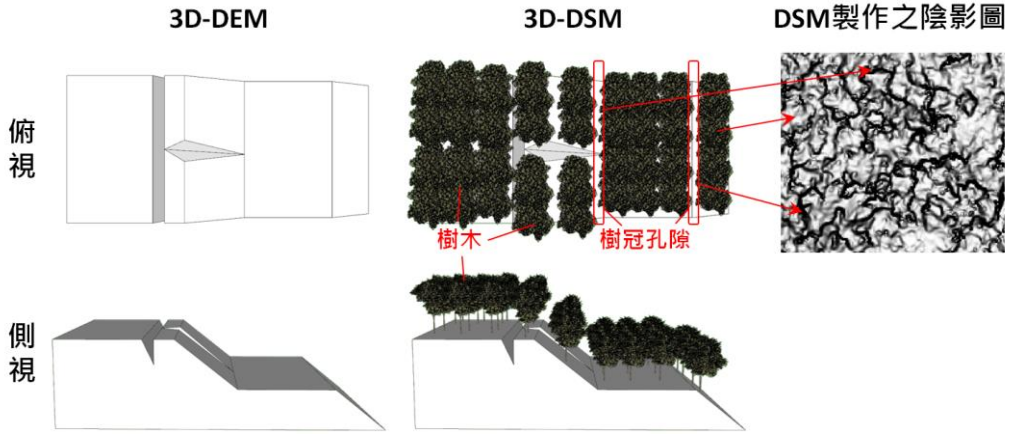


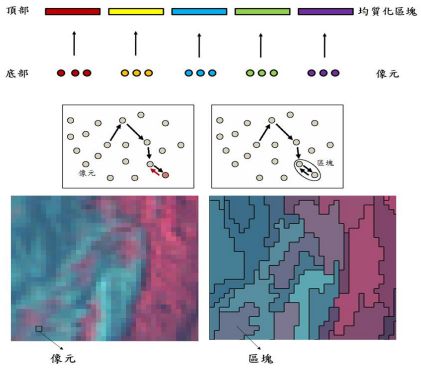
樹冠孔隙分類亮度值域分佈圖

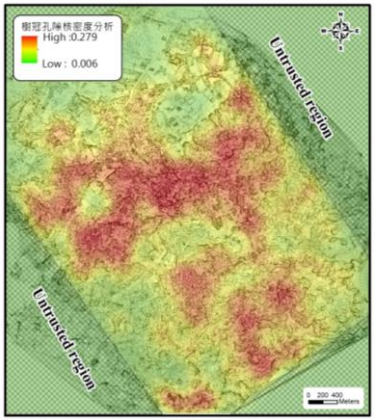


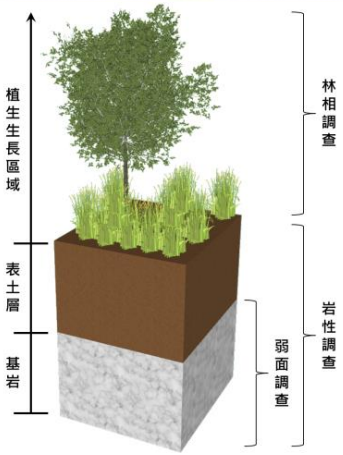
分類成果之正確率

		人工辨識為樹冠孔隙之樣本
自動辨識分類種類	樹冠孔隙	66
	房屋陰影	34
	未分類	1
	Sum	101
Accuracy		
樹冠孔隙分類準確度		0.653





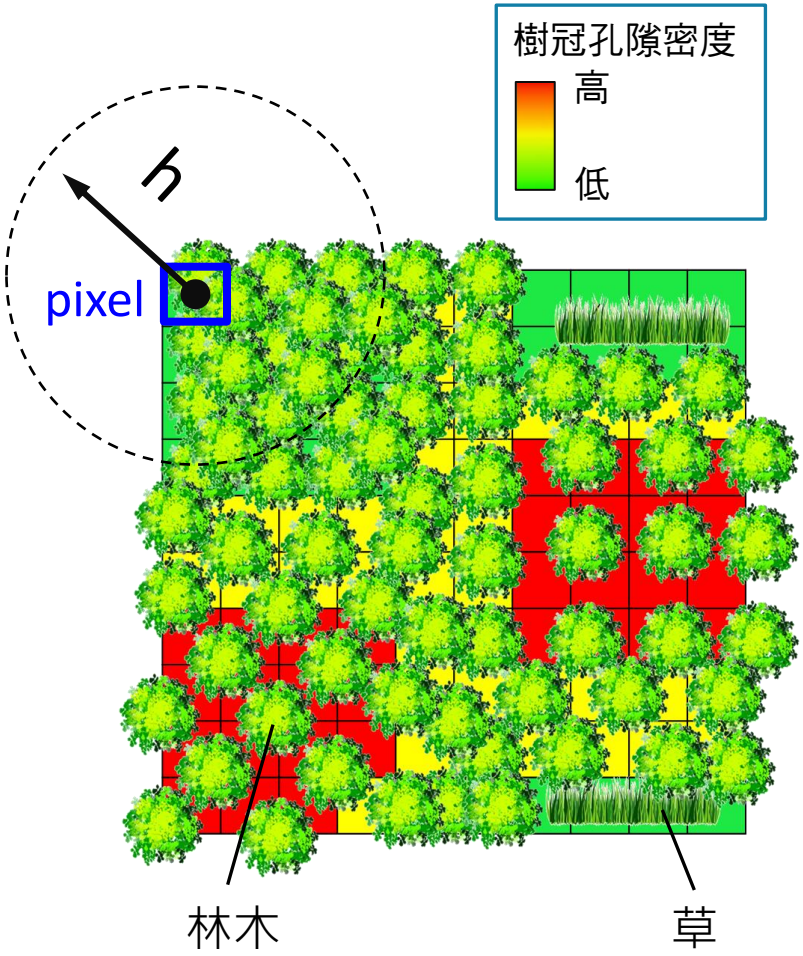




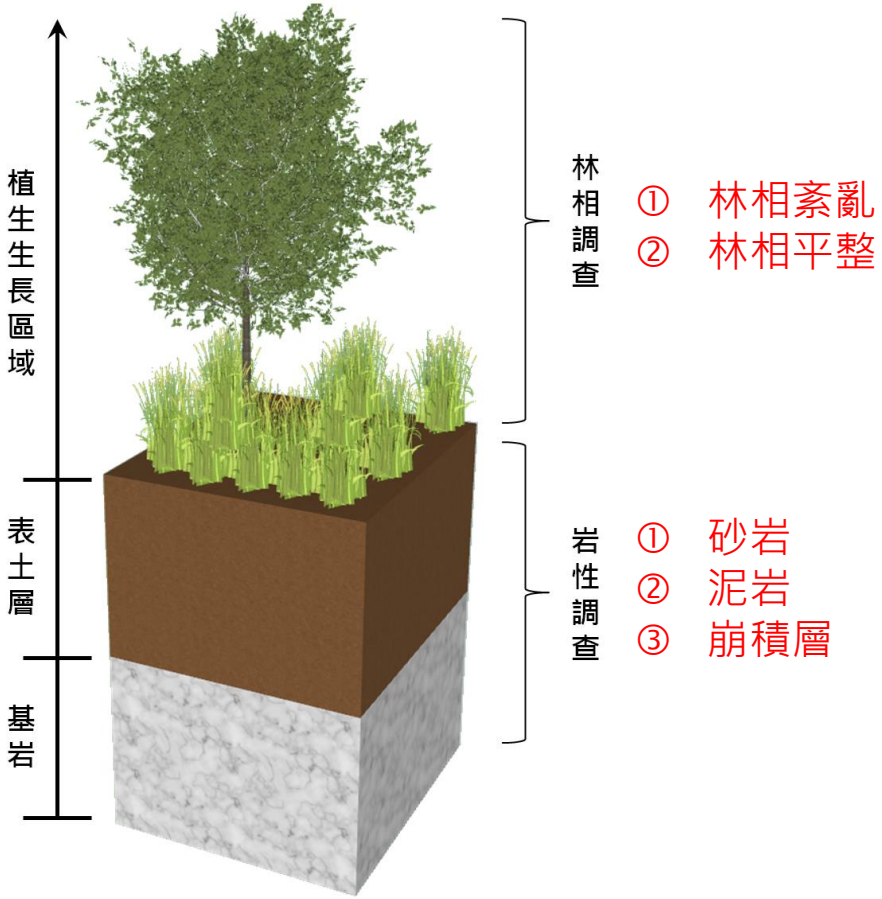
現場調查與樹冠孔隙核密度分析之關聯性建立

樹冠孔隙核密度分析與現地調查

核密度分析

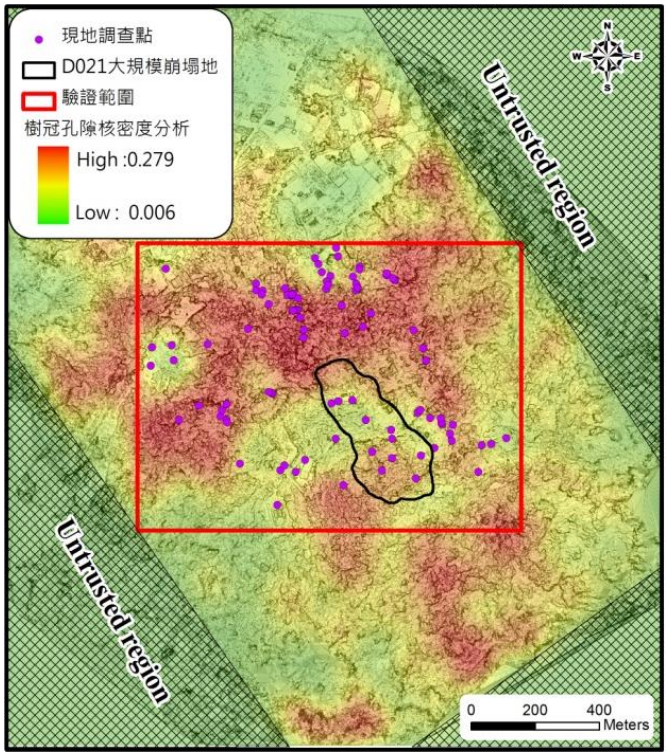


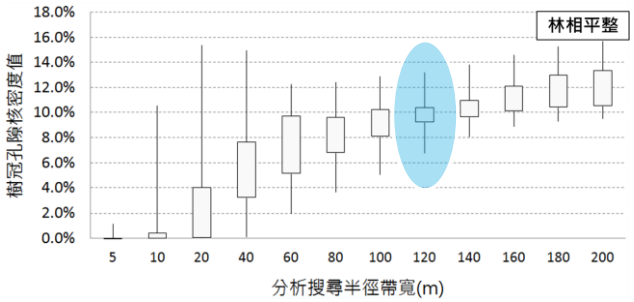
林相、岩性調查區位示意圖

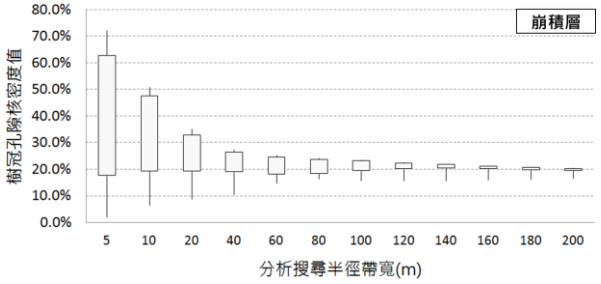


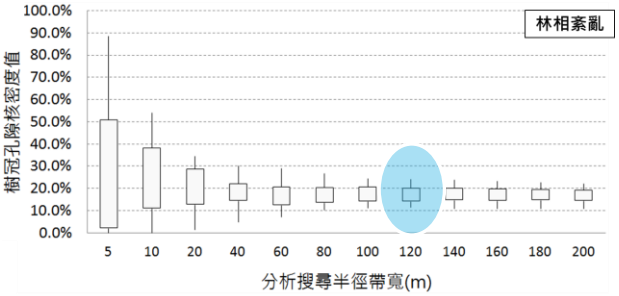
現地調查與核密度搜索半徑設定

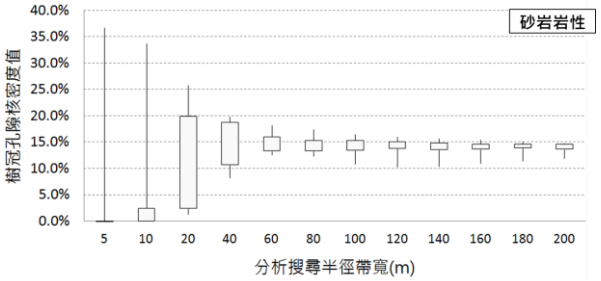
樹冠孔隙核密度評估成果示意與現場調查點分佈





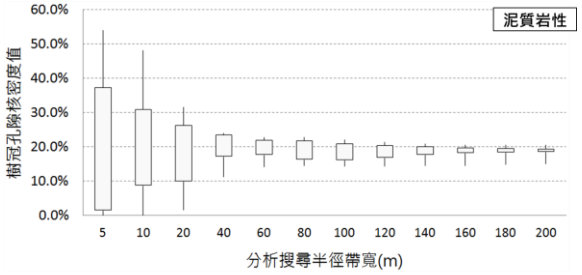




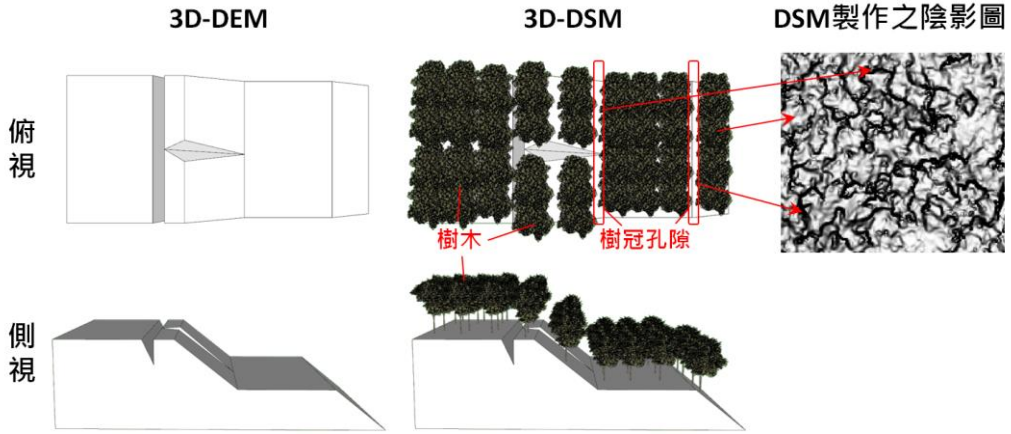


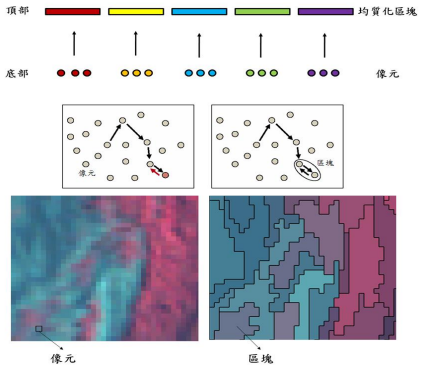
現場調查種類對應之樹冠孔隙核密度統計數值

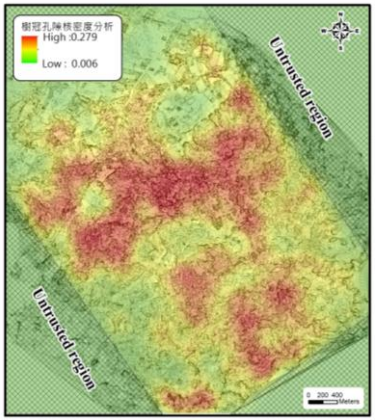
	最低	平均	最高
林相平整	0.068	0.102	0.132
砂岩	0.103	0.141	0.160
林相紊亂	0.114	0.161	0.243
泥岩	0.144	0.201	0.215
崩積層	0.156	0.219	0.226

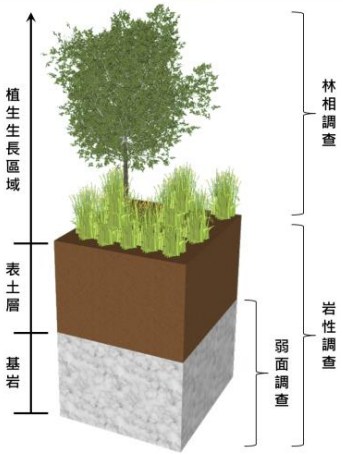


- 配合現場調查成果，進行核密度分析搜索圓域半徑設定，採5~200公尺之範圍進行帶寬測試比對。
- 顯示帶寬掃描半徑設定120公尺時於林相平整、林相紊亂類別時有值域收斂之狀況。





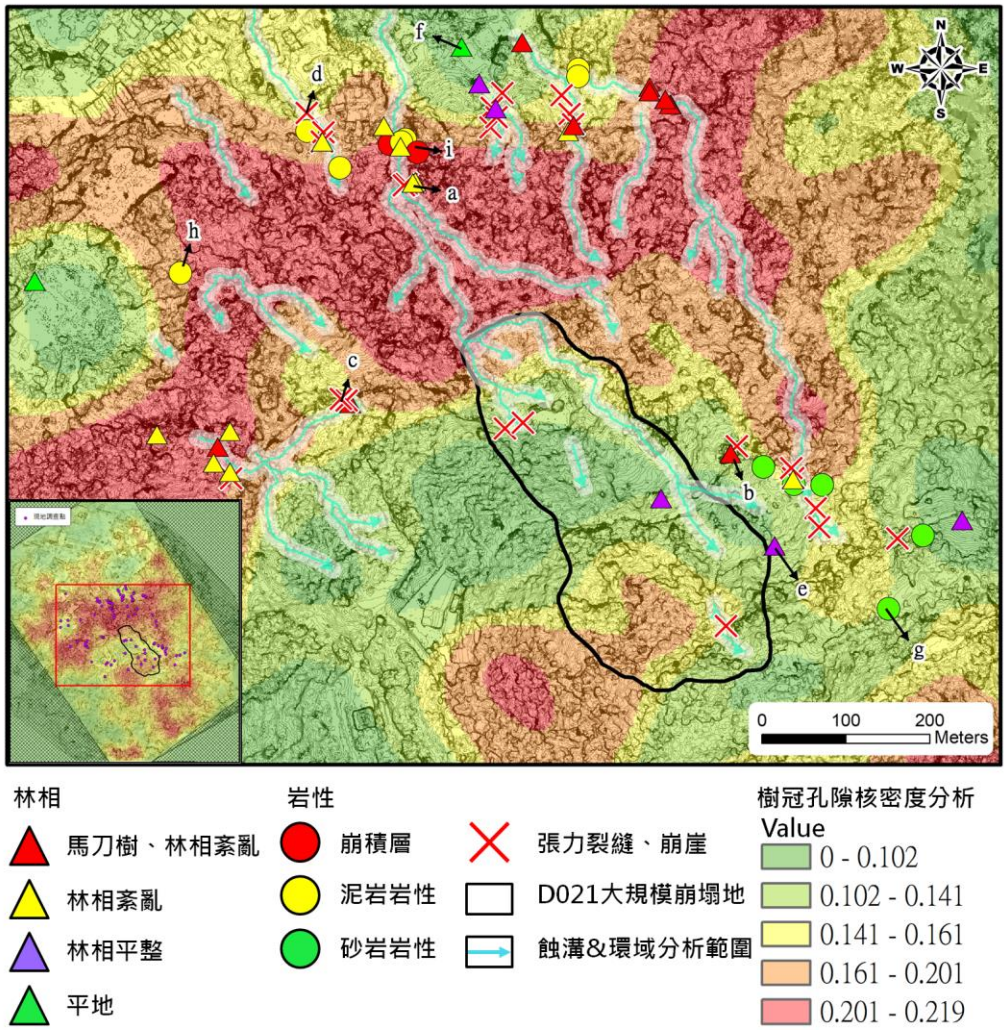




現地調查與光達地貌特徵判釋驗證

樹冠孔隙核密度分析成果驗證

120m之核密度分析搜索半徑與各調查種類核密度平均值設定成果圖



各調查種類現場驗證照片

(a) 植生林相紊亂

(b) 崩崖馬刀樹

(c) 自然邊坡-張力裂縫1

(d) 自然邊坡-張力裂縫2

(e) 植生林相平整

(f) 平地草本植生現況

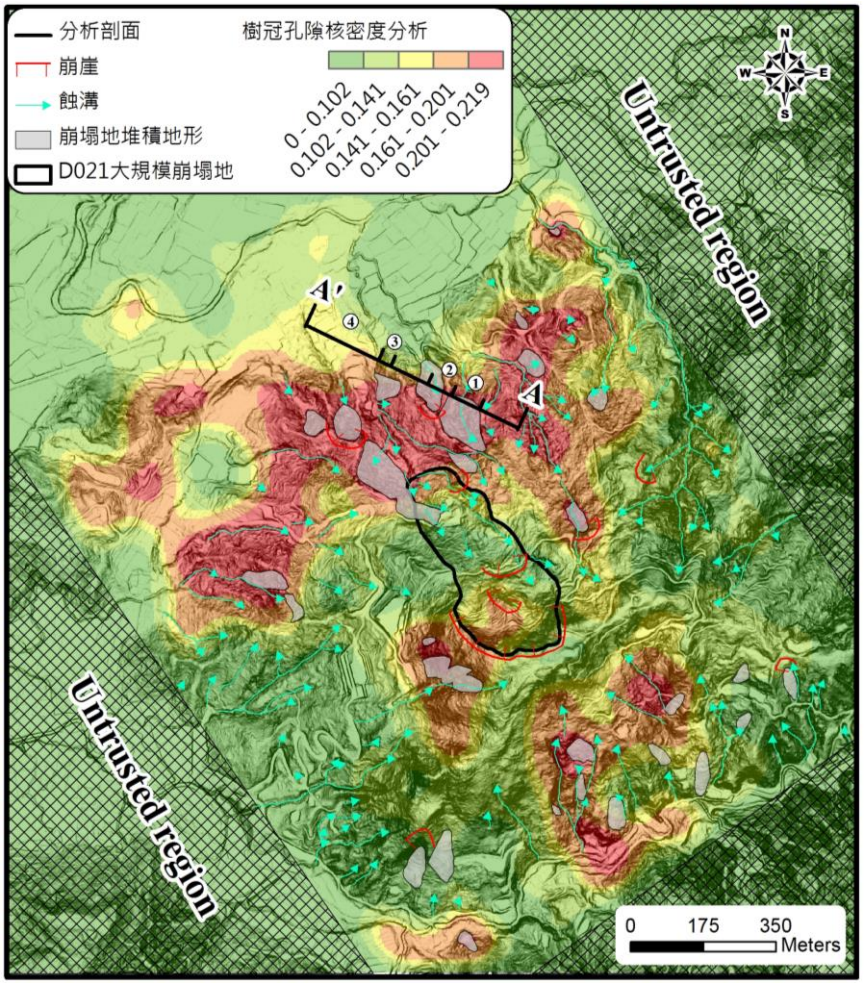
(g) 砂岩

(h) 泥岩

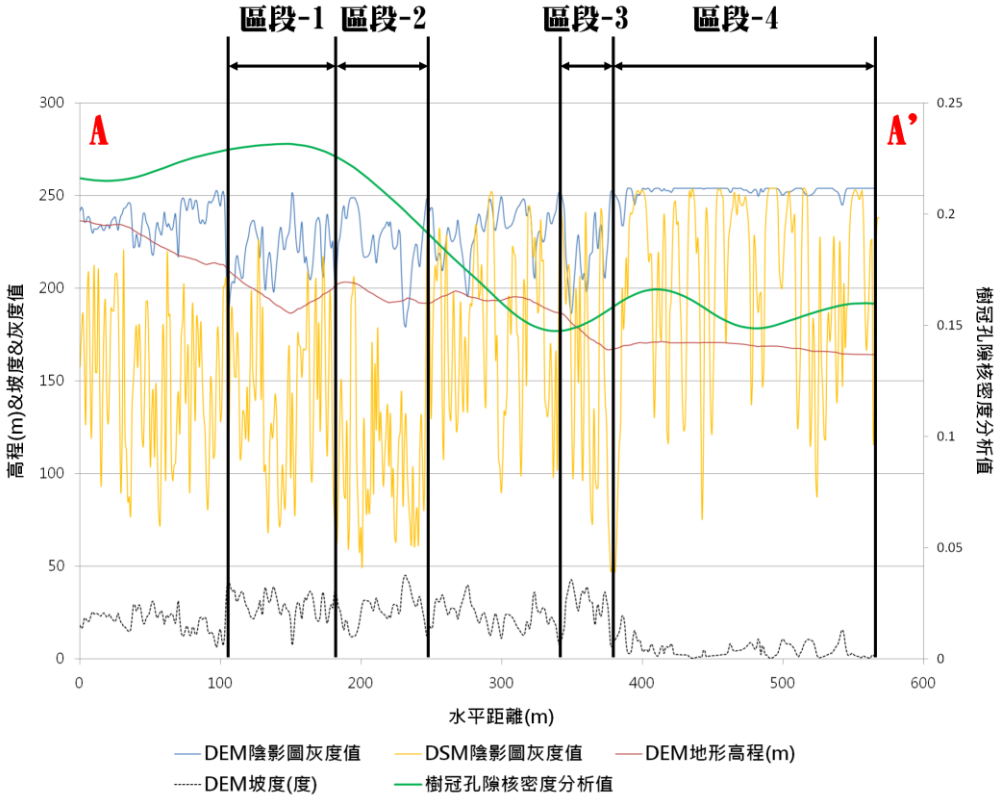
(i) 崩積層

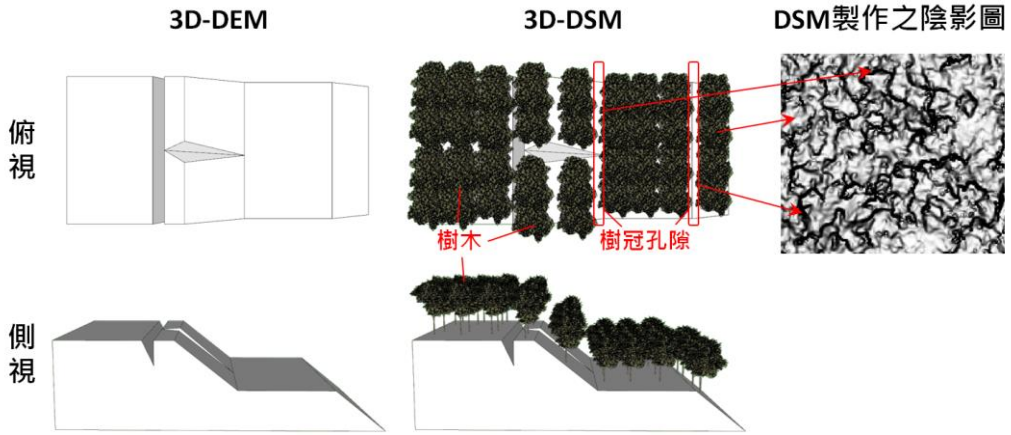
光達微地形判釋與樹冠孔隙核密度關聯性分析

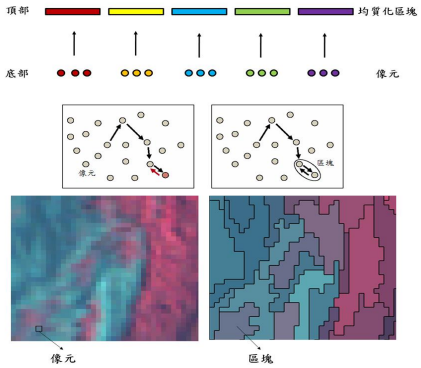
光達微地形判釋與樹冠孔隙核密度成果圖

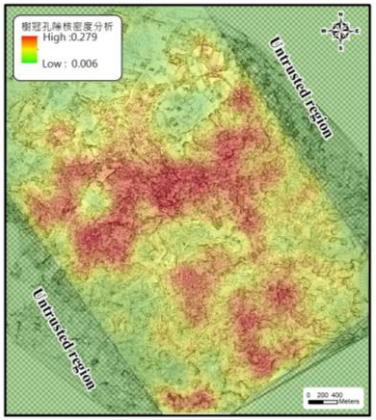


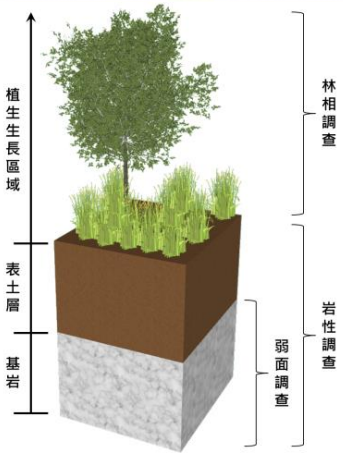
A-A' 剖面地形、陰影圖灰度值以及核密度值比較




3D-DEM
3D-DSM
DSM製作之陰影圖
俯視
側視
樹木
樹冠孔隙


頂部
均質化區塊
底部
像元
像元
區塊
像元
區塊


樹冠孔隙密度分析
High :0.279
Low : 0.006
Untrusted region
Untrusted region


植生生長區域
表土層
基岩
林相調查
岩性調查
弱面調查

結論與建議

討論與總結

- 無人載具攝影測量方法應用於密林環境之邊坡狀況，植生孔隙率密集程度對於初期調查與經費考量，將可提供重點調查位置之選定，可依本研究方法提供有效率之資訊。

- 根據本研究之樹冠孔隙密度分析成果，地形粗糙度越高，則使DEM與DSM之日照仰角90度下陰影圖灰度值變動量上升，DEM與DSM日照陰影圖灰度值則成反比，而與樹冠孔隙核密度分析值成正比。

- 地形起伏變動大之環境，較不利於植生生長。而坡體受地形轉折(緩轉陡)、蝕溝侵蝕、土砂崩落等...狀況下，則因林木倒塌造成林相紊亂之樹冠孔隙核密度值較林相平整之樹冠孔隙核密度值高，整體的樹冠孔隙核密度數值與不利於邊坡穩定之現地狀況(林相紊亂、泥岩及崩積層)成正比。

- 本研究區域樹冠孔隙核密度分析值域範圍為0~0.279，大於值0.161(林相紊亂之核密度平均值)時可捕捉出不利於邊坡穩固之微地形特徵(如：崩塌地堆積地貌、崩崖等)，顯示本研究之樹冠孔隙核密度分析成果與坡體穩定之關聯性評估，已可初步提供重點調查及坡體破壞熱點之參考。

- 岩性與樹冠孔隙關聯性有待進一步研究；本研究目前多半為定性方式進行探討，並已建立樹冠與坡體穩定之關聯性，未來可往降雨沖蝕與樹冠孔隙之關聯性進行定量之評估。

誌謝

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THANKS FOR YOUR ATTENTION

QUESTION