Monitoring of nature reserves via social media and deep learning

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A Abiotic (Transport)

Top 10 AI-generated tags (decreasing order)				
1 vehicle	3 outdoor	5 car	7 road	9 auto part
2 land vehicle	4 wheel	6 sky	8 tree	10 tire

Manually Identified Objects		
Driving	Train	Train station
Flying	Hot air balloon	Car

B Abiotic (Sports)

Top 10 AI-generated tags (decreasing order)				
1 outdoor	3 nature	5 mountain	7 landscape	9 plant
2 sky	4 tree	6 water	8 cloud	10 grass

Manually Identified Objects		
Mountain Climbing	Watersports	Cycling
Hiking	Skiing	Cave
Scuba Diving		

C Abiotic (Watching)

Top 10 AI-generated tags (decreasing order)				
1 astronomy	3 moon	5 star	7 outdoor	9 sun hat
2 sky	4 night	6 hat	8 fashion accessory	10 clothing

Manually Identified Objects	
Stargazing	Lake
Walking Outdoors	Mountain Fog

D Biotic (Watching)

Top 10 AI-generated tags (decreasing order)				
1 animal	3 bird	5 branch	7 wildlife	9 perched
2 outdoor	4 tree	6 water	8 plant	10 aquatic bird

Manually Identified Object				
Bird	Butterfly	Reptile	Palm Tree	Mushroom
Gardening	Monkey	Wildlife	Fruit Tree	Animal

E Humans (Heritage)

Top 10 AI-generated tags (decreasing order)				
1 building	3 sky	5 window	7 cloud	9 old
2 outdoor	4 house	6 tree	8 stone	10 church

Manually Identified Object		
Old Building	Old Bridge	Urban Exploration
Old Statue	Walking Urban	Old Ruins
Old Church	Art	Museum

F Humans (Socializing)

Top 10 AI-generated tags (decreasing order)				
1 indoor	3 drawing	5 table	7 chair	9 text
2 food	4 painting	6 art	8 floor	10 furniture

Manually Identified Object				
House	Cooking	Beach	Market	Dining
Art	Beer Drinking	Camping	Belly Dancing	Birthday Celebration

The figures above (A to F) show the six main categories of human activities that were identified within the nature reserves. The labels represent the top 10 tags automatically detected by the deep learning algorithm, while the objects were manually identified by the researchers from these tags. The three main categories are Abiotic, Biotic and Humans, each with sub-categories as indicated

in brackets. The images shown serve as examples of the types of potential images that could be found in the dataset. Credit: National University of Singapore

Environmental biology researchers at the National University of Singapore (NUS) have developed an efficient method for rapidly identifying and classifying human activities within nature reserves at the global level, using social media and deep learning techniques.

Many people visit nature reserves for various reasons, such as hiking to keep fit. Despite these benefits, it is clear that having too many visitors could lead to overcrowding and negatively impact conservation efforts.

Consequently, to implement more effective land use management strategies for crowd control, governments need to gain insights into how these green spaces are used. However, as most of these nature reserves cover large land areas, using conventional field surveys to monitor human activities within them can be costly and time-consuming.

The research team, led by Associate Professor L Roman Carrasco from the Department of Biological Sciences at NUS along with his Ph.D. student, Mr. Timothy Bing Lun Yee, has developed a technique to process social media images taken within protected areas (PAs) as a proxy for identifying human activities within them.

By parsing these images through a deep learning image tagging model, the human activities depicted within them are automatically detected. These tagged images are then subsequently grouped into distinct categories of human activities. They analyzed a total of 87,090 photos from 2,813 PAs in 207 countries for this study.

These findings have been published in *Scientific Reports*.

The researchers made some interesting observations. Most notably, distinct clusters of activity types across PAs aligned closely with expectations. For instance, there were many photographs of animals and plants in Southeast Asian PAs, while European PAs had numerous photographs of historic castles. Also, PAs within the same country showed similar activities, even if they had different physical environments.

Mr. Yee said, "While there have been similar studies, this is possibly the first study that tries to investigate human activities within PAs on a global scale. It demonstrates the utility of social media and deep learning in empowering researchers to investigate pressing environmental issues at a much larger scale."

Prof Carrasco added, "The team hopes that this technique can be adopted by nature organizations to monitor land use patterns in nature reserves efficiently and cost-effectively, enabling more targeted conservation efforts to protect ecosystems despite increasing visitor numbers."

More information: Timothy Bing Lun Yee et al, Applying deep learning on social media to investigate cultural ecosystem services in protected areas worldwide, *Scientific Reports* (2024). DOI: 10.1038/s41598-024-64115-3

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