25 | FOREST DEFENDERS:
HAVE FUN WHILE FIGHTING DEFORESTATION

Andres Perez-Uribe[1], Grégoire Aubert[1], Julien Rebetez[1], Alexandre Grillon[1], Hector Satizabal[1], Louis Reymondin[2]
1: University of Applied Sciences Western Switzerland (IICT/HEIG-VD/HES-SO), Yverdon-les-Bains
2: International Centre for Tropical Agriculture (CIAT), Cali, Colombia

Contact: Andres.Perez-Uribe@heig-vd.ch

Land use change is a significant threat to protected areas, biodiversity and the continued provision of important ecosystem services to society. Yet deforestation continues at an alarming rate. Left unchecked, deforestation destroys natural ecosystems, endangers wildlife and wreaks havoc on the freshwater systems on which we depend for clean, safe drinking water [1]. In the face of climate change and the potential impact of forest conversion on human communities, scientists and world leaders are working to curb the continued loss of the world's tropical forest. Decision makers at multiple scales (local, national or regional) are hungry for information on land-cover change, requiring the information to be as accurate and recent as possible in order to prioritize interventions and act upon new land-cover change patterns in a timely manner.

So, since 2012, "Terra-i: An eye on habitat change" (http://www.terra-i.org) has been a monitoring system that uses remote sensing and GIS technologies to provide land cover change data for Latin America and the Caribbean. Since 2016, the tool

> *In the face of climate change and the potential impact of forest conversion on human communities, scientists and world leaders are working to curb the continued loss of the world's tropical forest.*

scope has been extended to encompass the whole tropics, including Asia and Africa into the analysis. It can generate predictive models supported by the use of neural networks and satellite data of vegetation indices (NDVI / MODIS) and precipitation (TRMM and GPM), as well as detect, from 2004 to the current year, the deviation from the normal natural cycle of vegetation over time that can be associated with anthropogenic impacts. The tool-generated data enable the user to determine when, where and how often the region is experiencing change.

Terra-i algorithms work mainly in an unsupervised manner [2]. They exploit historical data to build a set of models of vegetation dynamics, which are used to track major changes in vegetation. To filter noisy data due to clouds in the environment, Terra-i pre-processes time-series of vegetation indices, but the only means to fully assess the detection of a new deforestation site is by validating it through the comparison of high-resolution images of the same region, but from different years, or by fieldwork. The Terra-i team has used both techniques to fine-tune the current system, but they can be annoying or expensive. Inspired by the successful use of games to solve complex problems [3], we conceived a game for Android devices called Forest Defenders (Fig.1) in a way to incite satellite images comparison and crowdsource deforestation detections validation.

Forest Defenders is a classical tower defence game where the goal is to try to stop enemies from crossing a map by building traps to slow them down by placing towers, which shoot at them as they pass. Enemies and towers have varied abilities and costs. When an enemy is defeated, the player earns coins, which are used to buy or upgrade towers. Choosing the tower type and position is the essential

game strategy. In Forest Defenders, the game starts with a first phase, during which the player looks for deforested areas by comparing satellite images from the same area taken at different dates. What the player identifies as deforestation is then stored into a server for further analysis. If they match the detections obtained by the deforestation tracking system, the player gets a power-up that helps her defeat enemies more easily. The second phase is a classical tower defence game.

To ease satellite images comparison, we overlap them in such a way that the player's task consists in identifying a colour change from dark to light green. However, the player has to use some further contextual information to avoid false positives. For instance, isolated pixels in the middle of the forest cannot be deforested, or sometimes the shadow of a cloud makes a region appear dark green, when it is not. The rationale behind our approach is that regions detected as deforested in Terra-i should be tagged as deforested in the game, otherwise, this might indicate false positive detections. Further-more, regions that are tagged several times in the game but that were not detected by Terra-i, might indicate false negatives. The game prototype [4] has not yet been massively diffused, but is available online and has been mainly used during open days in our school and at the King's College of London.

REFERENCES
[1] Barlow, J. et al. *Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation.* Nature 535.7610 (2016): pp. 144–147.

[2] Reymondin, L. et al. *A methodology for near real-time monitoring of habitat change at continental scales using MODIS-NDVI and TRMM.* Submitted Remote Sensing of Environment.

[3] Cooper, S. et al. *Predicting protein structures with a multiplayer online game.* Nature 466.7307 (2010): pp. 756–760.

[4] "ForestDefenders": www.iict-space.heig-vd.ch/ape/forestdefenders