# Measuring the Value of Earth Observations

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Over the last few years, the use of satellite technologies has been of great relevance for the improvement of daily life and the development of communities thanks to its revolution in telecommunications and navigation, but fortunately, the scientific community that promotes this technology, it also made incalculable efforts to improve and reduce the impact of natural disasters and protect the most vulnerable species from the cruel greed and ambition of the human being.



Fig. 1. Deforestation of the Peruvian Amazon.

The use of these technologies has been useful to improve and optimize the efforts of the responsible entities, such as the RECOVER project, which specializes in analyzing data from topography satellites, biodiversity maps, and others, to make plans and assessments for the rehabilitation of forest fires, even long before this disaster can be controlled; in a similar way to this success story, many preventions, protection, and rescue strategies have already been applied around the world in which the information provided by satellites together with an adequate analysis and data processing generates a huge increase in efficiency and benefit of the available resources to use.

For the Peruvian Amazon and all of Latin America, within all the wide range of environmental problems present, the destruction and contamination of forests and jungles are probably one of the problems with the greatest negative consequences for the future; This problem does not only affect the populations or countries to which the affected regions
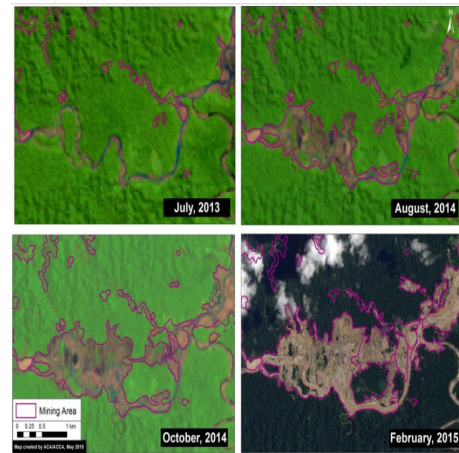


Fig. 2. Increase in Amazonian deforestation.

belong, otherwise all the countries of the world, Amazon store between 90 and 104 million tons of carbon, which drastically contributes to stabilizing the global climate, it is the main sources of oxygen in the world and it is also one of the main sources of biodiversity in flora and fauna in the world.

Unfortunately, the Amazon rainforest of Peru, due to poor management and little scope of government regulation standards, is an area with the highest levels of illegal deforestation; as mentioned previously, it is not only harmful to the Peruvian population, it is a problem for the entire world.

Efforts and attempts to use satellite technology to prevent deforestation in the Amazon has more than 30 years, and the main organizer of these efforts was the Brazilian government in conjunction with the National Aeronautics and Space Administration (NASA), and from that, two pioneering systems were born for the collection and processing of satellite images, which are PRODES and DETER. These systems use information from the Landsat 5 and 7, and Aqua and Terra satellites respectively, these tools with an orderly and diligent government system, was able to reduce over the years up to 80% of the massive deforestation in the jungles of Brazil; Unfortunately, these policies were not applied in Peru, and despite having public information on these missions, the lack of interest and little presence of the authorities in the Amazonian communities limited progress in reducing deforestation. Progress in preventing deforestation

in the Colombian, Venezuelan, and Bolivian Amazon was not significant either. With this context of abandonment by the authorities towards the Amazonian communities, some alternative solutions emerged, they support the indigenous habitants to defend their land.

One of these initiatives arose thanks to the collaboration of the Rainforest Foundation US, ORPIO, and Global Forest Watch, which developed a high-speed satellite monitoring system and was also in charge of generating a friendly app to empower native indigenous peoples themselves in their role of protection to the jungle.



Fig. 3. Forest rangers monitoring predatory activity Increase in Amazonian deforestation



Fig. 4. Forest rangers monitoring predatory activity Increase in Amazonian deforestation.

The system implemented in this proposal is simple and practical, this consists of having a team of forest rangers, who are the inhabitants of the native indigenous communities themselves, to do this, they proceeded to search for volunteers and these were called community monitors, these leaders of indigenous peoples will be the first line of defense of nature.

The creation of this community monitoring group is not only to reduce costs; it tries to engage the population to empathize with the damage that these illegal actions cause to their community, to their culture and the entire world, and in this way, generates greater awareness within Amazonian communities.

In general, the operating process of the monitors consists of periodically reviewing the alerts generated by the application developed by Global Forest Watch in which are the coordinates of the suspected areas of illegal logging, therefore these monitors have the function of going to the identified areas to verify the alerts, and in case of confirming the felling of the trees, they have to inform the leaders of their community and they will have the freedom to make their decision, and these can range from notifying the corresponding police and legal authorities or even intervening on their own the illegal actions carried out. In summary, these monitoring programs are made up of three properties, the first being the selection and appointment of monitors, the second; training in incentive for patrolling, and the third remote sensing deforestation alerts.

To test the effectiveness of this project, they search communities near Napo and Amazon rivers in the department of Loreto, because there are the most affected by deforestation. In total, the project was implemented in 75 native communities.

Although this project is simple and the decision against deforestation rests only with the natives (and not in governments to make public policies as it should be); in the end, they got good results and the benefits went beyond the recovery of the forest, and these are:

- Communities that implement monitoring reduced deforestation in their territory by 52% in the first year, and by 21% in the second year, compared to communities that did not change their protection practices.
- The deterioration of the habitations surrounding deforestation areas was reduced, since many of the animals and plants suffer damages due to indirect factors such as the sound of machinery, design residues, and even new smells, in addition to the vegetation itself which was destroyed.
- The empowerment of native indigenous communities and their insertion into a culture of sustainable and organized growth, allowing them to quickly and effectively protect the majesty of their lands.
- Help the preservation and protection of indigenous populations, preserving their traditions and culture.
- Motivate the commitment of government institutions for the development of new alliances and the development of public policies that allow improving the efficiency in time and quality of the response.

Although this project is a great step in the long effort to protect our tree reserves in the Amazon, it is also true that this initiative is still very small and it is necessary to make substantial improvements with better techniques, new technologies, and a development paradigm that guarantees the commitment of the authorities. In this way, better use and better results of satellite technology could only be generated.

In the first place, it is necessary to be able to determine the main deficiencies of this system, and they are two, the

satellites used use MODIS technology, which allows having a large data flow but at the cost of a low resolution, this produces that for the processing systems and identification of deforested areas, it is almost impossible to determine areas smaller than 1 hectare of deforestation, which is an advantage for new loggers to seek more subtle and distributed methods to go unnoticed. Fortunately, Peru has its observation satellite in space Peru SAT1, and it is equipped with the best technology in the region and is capable of taking photographs with a resolution of 0.7m per pixel, this enormous precision compared to MODIS technology will allow the identification of any illegal activity in real-time. The second disadvantage of this method is the natural limitations of any imaging system, and they are environmental factors, in rainy seasons, dense cloud formations deteriorate the quality of the images that can be obtained, as in low light conditions such as at night, the solution to this natural disadvantage of optical sensors is the use and implementation of a Synthetic Aperture Radar (SAR), the advantage of this technology is that by relying on electromagnetic pulses and not waves of light, then this technology is immune to noise from environmental conditions or light conditions, therefore the monitoring it allows is infallible.

In addition to the necessary improvements, it is necessary to take certain specific considerations for Peru, which normally go unnoticed, and the first is that in the Peruvian jungle, obtaining wood is not the only motivation for cutting down trees, there are other factors such as drug trafficking and cocaine cultivation that requires the logging of thousands of hectares for agriculture, according to official data, throughout the Peruvian jungle there are more than 72 thousand illegal hectares of coca leaf plantations, which means a production of more of 704 tons of cocaine



Fig. 5. Illegal coca harvesting.

The problem of the identification problem of this type of plantation is that based on the traditional methods of color segmentation, these plantations can go unnoticed, therefore it is necessary to implement Artificial Intelligence and Machine Learning techniques to perform spectral analysis and determinate not only the lack of vegetation, otherwise differentiate the type of products that are replacing the natural flora. Similar situations occur due to illegal mining, which in



Fig. 6. Illegal cocaine processing.

addition to destroying all the flora and fauna that surround it, pollutes the land and water of the rivers, making it impossible for that area to ever have vegetation again.

Thanks to the changes proposed in the system, and considering the new analysis and processing approach, the benefits that we can expect from this model for native communities and the environment are broader, but they can basically be classified into two large groups, social and environmental benefits, and due to their qualitative and quantitative nature respectively, it will be necessary to define different models to measure their benefit and development.

First, to measure the environmental benefit, it will be necessary to make use of all the satellite information that you have on the deterioration of the Amazon before starting with these prevention models, therefore, with this information, a neural network will be trained that will be able to generate future projections of the deterioration of the forests and these values can be compared with the real values after implementing this prevention system. This method of crossing information can also be complemented with maps of biodiversity, air quality, and water quality to be able to quantify how the rescue of these areas is also collaborating with the development and recovery of the native flora of the region. Similarly, it is possible to revolutionize the decision-making of the corresponding authorities in the process of defending nature, using our neural network to project the benefits of the actions to be carried out, that is, we will provide leaders with a tool that allows them to determine the Results of action even before executing it, this is possible because historical data is available of the protection attempts of previous projects such as those of Global Forest Watch.

These cutting-edge technologies allow responsible entities to improve their logistics processes and properly distribute their resources to guarantee the success of any rescue or rehabilitation operation in our Amazon.

This entire process is automated and included in our free web application, this service is open source and free access that allows generating all these parameters and results from the processing of satellite information, with advanced image processing algorithms, systems predictive tools with artificial intelligence, and overall with a friendly interface for any novice user, it is the tool that will allow us to revolutionize the protection of our biodiversity. This platform makes it possible to identify all the threats in the selected area, including illegal logging, deforestation due to coca leaf cultivation, informal mining, and even the identification of damage to biodiversity caused by natural phenomena such as floods or fires; in addition to abstracting all this information along with the corresponding statistical analysis, this generates a summarized set of data, including suggestions and recommendations of the measures that leaders could take to face the identified problem, including projections of the behavior expected in the future due to the development of these decisions.



Fig. 7. Risk Estimation with our application "SONQUGREEN". .

This technological tool will also make it possible to determine by indirect methods the social benefit, thanks to the monitoring the number of volunteer members of the communities committed to protecting the forest, the reports sent by the monitors, and patrols, it is possible to estimate the commitment and empowerment of native communities. When supporting indirectly against drug trafficking, thanks to the collaborations of other entities specialized in these issues, it is possible to see the incorporation of new citizens into their communities of origin, since many residents are kidnapped and taken against their will for the production of Coca leaf.
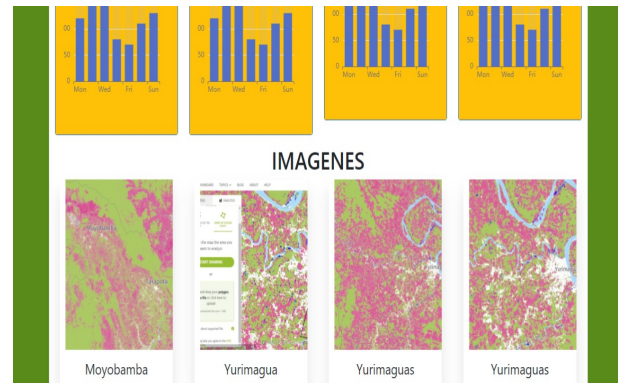


Fig. 8. Visualization of detected events with our application "SONQUGREEN".

This web application designed by our team is finally the tool that was needed to save our Amazon.

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