IBISA entry to the Sinergise script contest

Script description

The goal of the script is to calculate the "anomaly" of an index, avoiding clouds.

In this example, we use the NDVI index, but this can be easily changed.

Anomaly definition

We define here the anomaly of an index as the difference between the average index value during the current month, and the average of the index value, in the same month, over a defined number of years in the past (3 in our script, defined in the "nbPastYears" parameter). It is slightly different from the usual definition.

Example: The NDVI anomaly of 15th January 2019 is : $AverageNDVIofJanuary_{2019} - (\frac{1}{3}\sum_{a=2016}^{2018} AverageNDVIofJanuary_a)$

We have included a constraint on the number of scenes of past years to be used to average each pixel. At least one for the current year, and 3 for the past years. This is the "currentIndexesMinValuesNumber" and "pastIndexesMinValuesNumber" parameters.

Clouds detection

In order to keep only the NDVI value of days without clouds in the scene, we use the Braaten-Cohen-Yang cloud detector. We exclude from the computation the days where cloud is detected by the algorithm (it gives "yes/no" based on a threshold).

This can lead to exclude some snowing part, but this is not an issue: we are not interested in the NDVI of snow, anyhow.

We used for that the cloud-detection script : https://github.com/sentinel-hub/custom-scripts/blob/master/sentinel-2/cby_cloud_detection/script.js

Technical details

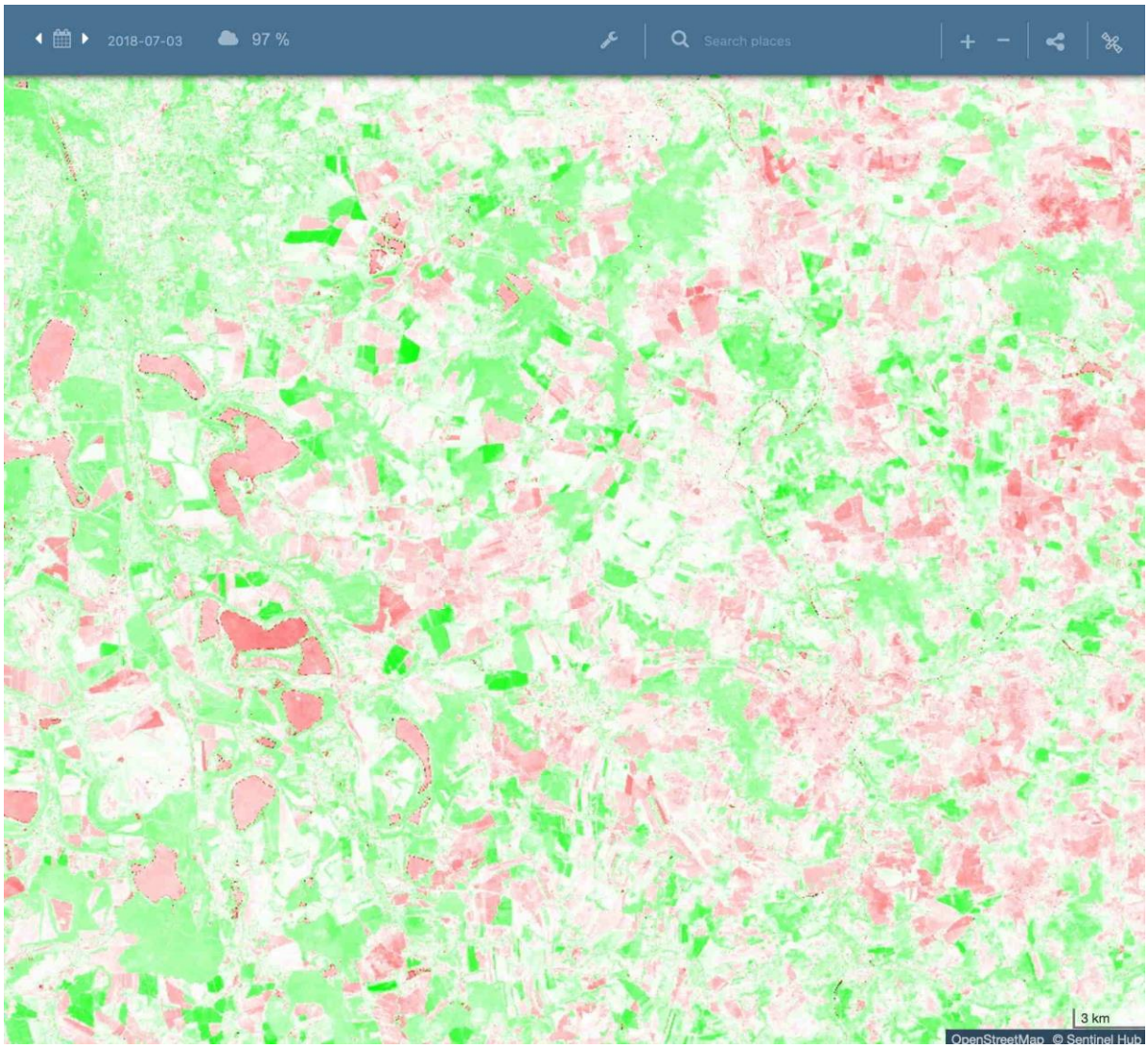
The script is of course multi-temporal.

This script is generated using Babel (https://babeljs.io/). This mean that some parts of the script are only technical. Most of them are materialised with "/******/".

Rendering

We represent the anomaly index in a scale from red for negative values to white and to green for positive values. The pixels with no values (not enough values) are presented in black.

Here is an example of image generated:



Script link

The script submitted by IBISA can be found here: https://github.com/Dessoul/ibisa-eo/blob/master/ndviAnomaly.js

IBISA entry to the Sinergise script contest (long)

Introduction to IBISA

IBISA (Inclusive Blockchain Insurance using Space Assets) is a service of peer-to-peer risk sharing among smallholder farmers against weather hazards (like drought) to their crops.

Smallholder farmers in emerging economies are not covered by existing formal insurances (less than 0.5% worldwide) and remain very vulnerable to crop damage. They don't subscribe because existing insurance policies don't offer enough "value for money" unless heavily subsidised. Protecting them in a meaningful and self-sustainable way is the mission statement of IBISA.

IBISA merges 3 different technologies to provide a service of risk sharing to smallholder farmers at an extremely low cost of operations: blockchain technology (to spread the administrative costs among all participants), Earth Observation (to spread the index tracking costs among the maximum of farmers) and Actuarial Risk Modelling (to keep control of solvency in a decentralized operation).

What is the problem?

The problem is that there are more than 500 million smallholder farmers who don't have access to micro-insurance to protect their crops.

- They don't have access because they only afford an insurance premium of about 10 USD per year per acre;
- This premium ceiling forces insurers to limit premiums to less than 10 USD per year per acre per customer to cover all their costs[1], including the cost of the risk;
- Actually, the administrative cost for the insurance company to manage a policy is not flexible and consume from 30% to 70% of the premium (from 3 to 7 USD are dedicated to pay administrative cost). So there is not enough value for money left to pay the farmer if the risk materialises, and therefore the farmer doesn't buy in.

This is why, despite heavy (but limited in time) government subsidies, less than 0.5% of smallholder farmers worldwide buy micro-insurance and they do so only when it is mandatory to obtain a loan.

Because it is nevertheless important to survive in case of losing crops because of bad weather, smallholder farmers resort to ancestral risk mitigation strategies that are not effective and hinder their growth.

Why is formal insurance not suited?

A lot of research literature have addressed the pains of the insurance business process when applied to crop micro-insurance. The following summarises some of the main reasons.

- Administrative cost and management fees, that are fixed and do not decrease with the premium;
- Assessment costs, because in agriculture loss events are more frequent than in other fields of insurance, and assessment is made by a company expert or based on expensive indicators

[1] Some insurers lower even more the cost by splitting the risk further and offering policy coverage per season (twice a year) and even per crop stage of sowing, growing and harvesting (6 coverage policies per year).

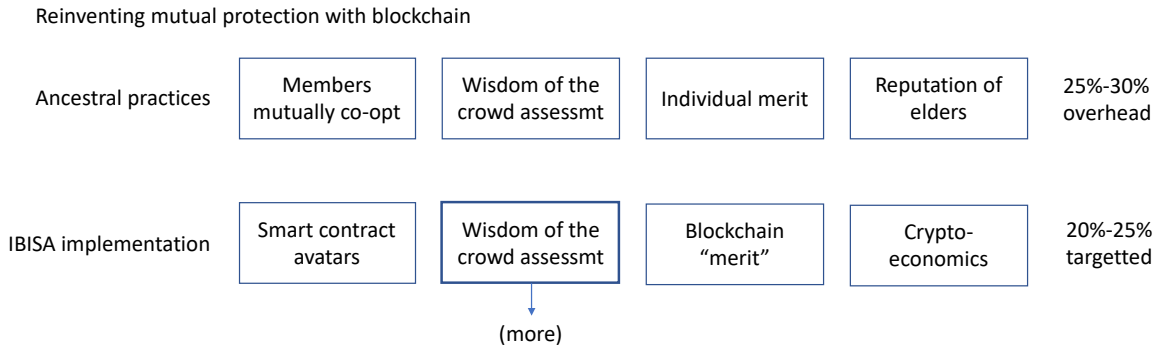
The need of protection exists however, as shown by the popularity of traditional risk sharing associations in agricultural communities worldwide (they are for example called *iddirs* in Ethiopia and have been extensively studied). Such practices enjoy a penetration of 77% nationwide (*Aredo*-2010) as compared to less than 0.5% penetration for formal insurance.

What is the solution?

Long before modern insurance, Chinese, Hanseatic and Florentine merchants — as well as agriculture farmers worldwide — do mutual risk sharing.

Mutual risk sharing is based on trust. There is no payment up-front, but members co-opt mutually. When a member suffers a damage, the lost is assessed by the whole community (the "wisdom of the crowds") and a council of elders takes into account the loss and the "merit" of the person to decide on a compensation. The amount is then collected from every member based on a number of rules.

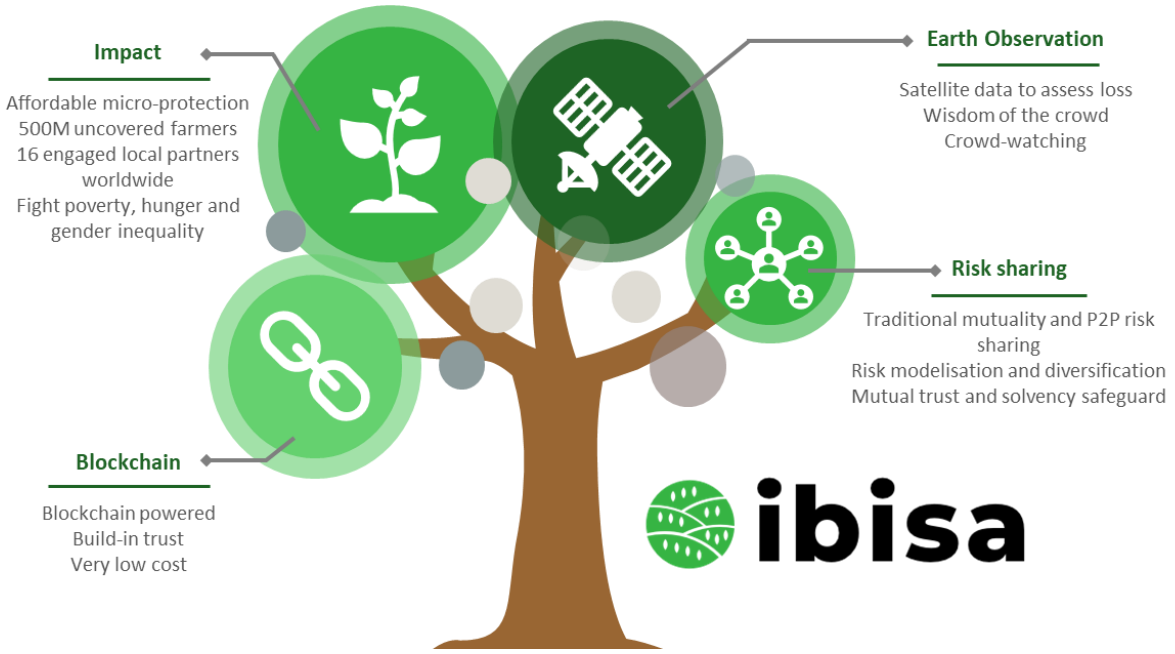
With the blockchain and the technology of the 21st century, IBISA is taking the challenge to transpose ancestral practices to modern technologies and reinvent mutual protection for extra low-revenue farmers with extra low overhead.



With the use of blockchain, IBISA reproduces the process of traditional risk sharing like *iddirs* but at a global scale, thus creating a vast pool of loss compensation resources and minimizing correlated risks and offer an affordable and efficient protection for those populations.

IBISA re-engineers the whole business process to reduce drastically all costs and to succeed by numbers.

To further reduce the costs, IBISA scales up damage assessment by using Earth Observation data and by sharing only crop risks that can be detected remotely without any local field assessment.



The role of Earth Observation

Index-based insurance, blockchain and Earth Observation data

Index-based (parametric) insurance is seen as a way to lower the cost of individual assessment.

Like all index-based insurances, IBISA reduces damage assessment costs by using index-based triggers. For this we use Earth Observation technology (EO) indices instead of rainfall data. Several innovative design decisions in IBISA also contribute to lower the operating costs. Of special interest is how blockchain is used to avoid the need of very accurate EO assessments of traditional insurance.

How is low cost EO assessment achieved?

IBISA implements a unique innovation where we use human “watchers” and merge their assessments using the “wisdom of the crowds” that is itself a transparent and auditable blockchain smart contract. With the help of the large scale of free EO data and many other innovative EO decision choices, this keeps the operating costs low.

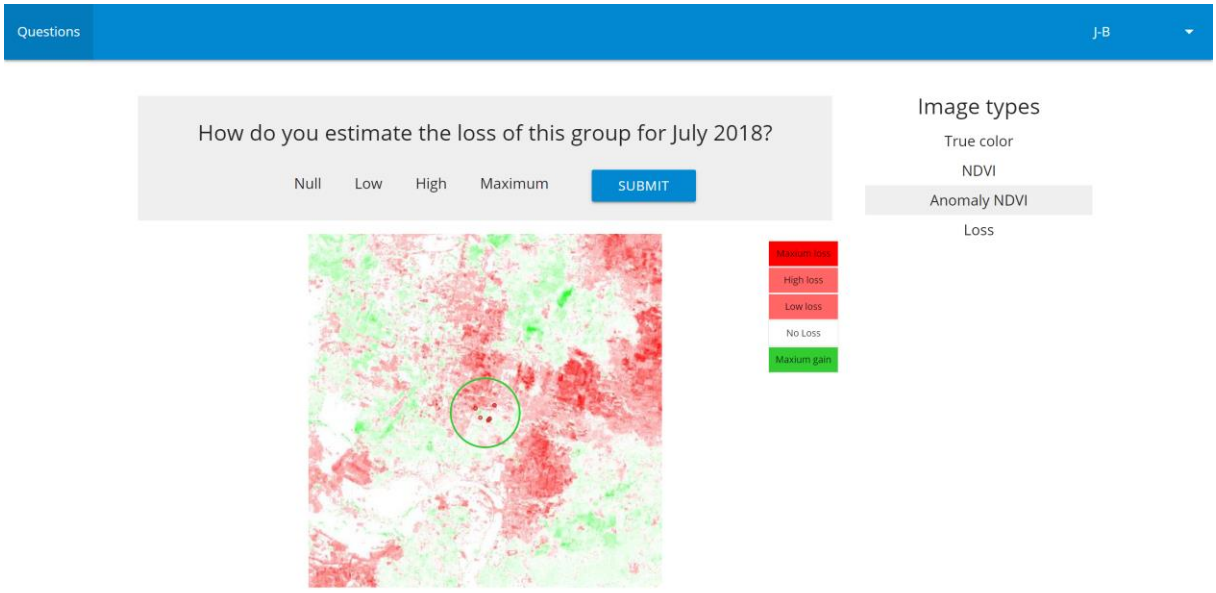
Like crowdfunding, crowdlending, crowdsourcing, crowdfarming, this crowd-watching approach of IBISA takes advantage of the facilities offered by the Internet and by the blockchain. It is very close to the social engineering collaborative applications promoted by ESA, by NASA and by many service providers of which Google Earth Engine and Sentinel Hub.

What is the script participating in the contest?

The Sentinel Hub script that represents IBISA in the contest is part of the watcher’s helper tool. It is also used by IBISA to model the actuarial risk to define how much the farmers members of IBISA are compensated for their loss as well as keep the whole community’s solvency

As explained above, the mission of the watcher is to use ALL possible data freely available on the Internet to assess the loss of all owners of plots of land inside an area of roughly 1 square km. Among the most significant data is the NDVI Anomaly, but a watcher may use also other indexes at will.

Here is an example of how the script is used in the current watcher's helper tool, the interface done to help watcher doing their assessment:



Example of results achieved by the script

The following GIF is the NDVI Anomaly generated by Sentinel Hub using our script. It shows the peak (August) and the end (October) of the drought of summer 2018 in Germany in the region South of Leipzig. It shows what a watcher could see. The scale on bottom right shows 3 km. A typical area to assess would be 1 km wide; the watcher may want to zoom in even closer.

The satellite is Sentinel 2.

Loss visualisation

As IBISA is close to a parametric coverage, it is possible to calculate directly the loss pixel by pixel using the NDVI anomaly: if the NDVI anomaly is positive or null, no benefit is paid, and if the NDVI is negative, then a proportional compensation is payable.

This new script is a direct extension of the current script, and the rendering is the following (black is no compensation, and compensation are in green scale):