RIICE

REMOTE SENSING-BASED INFORMATION AND INSURANCE FOR CROPS IN EMERGING ECONOMIES

IMPROVING FOOD SECURITY THROGH SATELLITE TECHNOLOGY

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IRRI International Rice Research Institute

sarmap your information gateway

www.riice.org

ABOUT RIICE

Remote sensing-based Information and Insurance for Crops in Emerging economies ("RIICE") is a public-private partnership aiming to reduce the vulnerability of rice smallholder farmers in low-income countries in Asia and beyond.

The parties make use of remote sensing technologies to map and observe rice growth in selected regions in Asia (Bangladesh, Cambodia, India, Indonesia, Philippines, Thailand and Vietnam). Such information helps governments to make the necessary provision to meet potential food shortages given that rice is the most important crop for most Asian countries.

Additionally, such information can help stakeholders involved in rice production to better manage the risks involved. A key option at hands for governments is to establish agricultural insurance solutions to protect rice smallholders. In the same way, the risks involved in agricultural lending by banks to rice smallholders can be reduced through insurance that protects the farmers' loans against defaulting due to yield losses and thus trigger more investments in agricultural production.

How does RIICE improve food security?

Food production is said to have to rise by 70% between today and 2050 in order to keep pace with population growth. Several factors jeopardize food security in developing countries and emerging economies, among them most prominently increasing crop losses due to extreme weather events aggravated by climate change, an increasing migration to the urban centres by the rural population and ever more volatile commodity market prices. Food insecurity leads to poverty. This is most obvious in Asia, where over 70% of the world's poor (900 million people) live and where almost 90% of the world's rice is produced and consumed. For the poor in Asia, rice can account for over 50% of their calories and consumption rates can top 100 kg per person per year.

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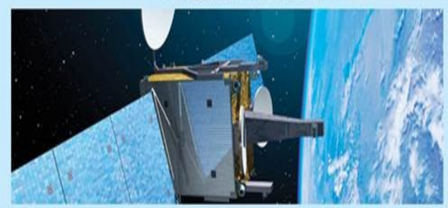
Through regular cloud-free satellite monitoring, RIICE monitors – in near real time – the growth of rice in South and Southeast Asia using satellite data from the European Space Agency and other partners. This information is made available to governments and NGOs to provide accurate and timely information on rice crop area and production for applications in planning and responses to natural catastrophes. Through its insurance partners, RIICE also offers crop insurance to protect smallholder farming populations from natural catastrophes. The project started in 2012 and will run until 2015.

Earth Observation & Date Collection

Several satellites circle the earth on a weekly basis, taking data of the ground with a high resolution of up to 15 meters. Most of the satellites used for RIICE are equipped with a radar-sensor able to observe vegetation growth irrespective of cloud coverage. This is an important feature given that in incidences of flooding, the sky is often cloud-covered.



Through satellites by the European Space Agency (ESA) and other providers, RIICE is scanning the earth surface in Southeast Asia using radar-based remote sensing technology. This technology has the ability to detect and interpret change on the earth's surface without direct observation. Depending on the satellites and the sensors used, the remote sensing data can have a spatial resolution of only several meters (20 by 5 meters for the ESA's Sentinel programme) and a temporal resolution of several days (i.e. the satellite can take data from the same spot every few days as it circles the earth).

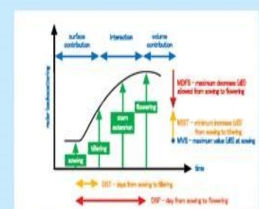
What is radar-based remote sensing?

Radar-based remote sensing, also called Synthetic Aperture Radar (SAR), collects information on the earth's surface by emitting energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target. Radar-based remote sensing technology measures the time delay between emission and return, establishing the location, height, speed and direction of an object.

The microwave sensors of radar-based, space-borne earth observation offer hence an effective alternative to optical observation which has a major disadvantage of clouds often obstructing the earth observation.

By analysing time series, radar-based remote sensing technology can determine the extent of rice cropping, monitor the rice growth, estimate (to some extent) biomass and identify crop damages and losses caused by droughts and floods.

Remote sensing also replaces costly and slow data collection on the ground which was often found to be inaccurate or even manipulated.

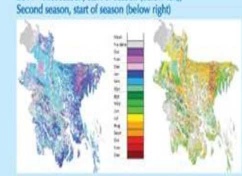


How can remote sensing observe crop growth over time?

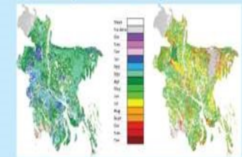
The basic idea behind the generation of rice acreage using SAR techniques is the analysis of changes in the acquired data over time. Measurement of temporal changes in reflectivity of the plants relates to the phenological status of the rice: an increase in the radar backscatter corresponds to a growth in the rice plants. In fact, the radar response to rice fields at different growing stages during the crop cycle can be distinguished in three main growing stages, namely sowing-transplanting (surface scattering), growing (surface-volume scattering) and flowering (volume scattering).

Actual rice-growing seasons observed in Bangladesh:

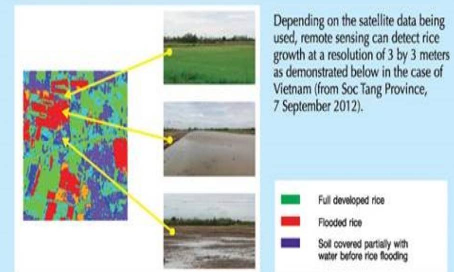
2011 - First season, start of season (below left); Second season, start of season (below right)



2011 - First season, peak of season (below left); Second season, peak of season (below right)



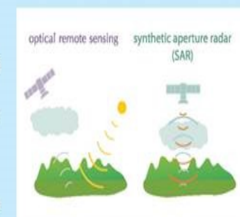
How precise can remote sensing map rice areas?



Depending on the satellite data being used, remote sensing can detect rice growth at a resolution of 3 by 3 meters as demonstrated below in the case of Vietnam (from Soc Tang Province, 7 September 2012).

Is radar-based remote sensing better than optical remote sensing?

Synthetic Aperture Radar (SAR) is an active remote sensing system. An antenna, mounted on a platform, transmits a radar signal in a side-looking direction towards the Earth's surface. The reflected signal is backscattered from the surface and received a fraction of a second later at the same antenna. Spaceborne SAR sensors offer hence an effective alternative to optical observation which has a major disadvantage of clouds often obstructing the mapping and monitoring.

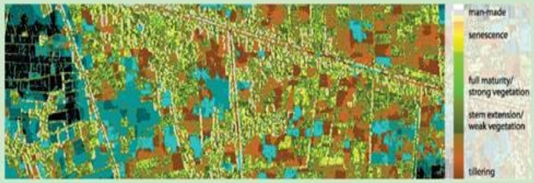


Is remote sensing a new technology?

While earth observation from space is a recent matter, pigeon photography as an aerial photography technique was invented in 1907 by the German apothecary, Julius Neubronner, who also used pigeons to deliver medications. A homing pigeon was fitted with an aluminum breast harness to which a lightweight time-delayed miniature camera could be attached. Later, this technique was not only used in the art context but also by the military.

Mapping & Forecasting

The satellite data is being processed by sarmap, a Lugano-based satellite technology start-up, decoded into a readable format and uploaded to a WebGIS portal accessible for the partners of RIICE in the respective countries. Simultaneously, RIICE partners are monitoring the rice crop on the ground at selected sites in each region to obtain field level information on rice crop growth and rice yield. IRRI takes these ground observations and correlates them with the SAR imagery to generate maps of planting dates and crop growth rates.



The data-sets captured by the satellites are processed through a dedicated software that decodes the remote sensing data and makes them readable as maps. The key mapping and forecasting products that RIICE will deliver until 2014 based on remote sensing recognition are

- Rice area maps in Southeast Asia
- Continuous observation of rice growth across Southeast Asia
- Actual rice yield information at harvest time
- Rice yield forecasts before the season is complete

These products will be available for the stakeholders of the participating countries through a WebGIS portal.

How are rice areas being mapped?

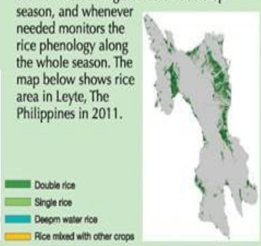
The basic idea behind the generation of rice acreage using radar data is the analysis of changes in the acquired data over time. Measurement of temporal changes of SAR response due to the rice plants phenological status lead to the identification of the areas subject to transplanting / emergence moment and the rice growth. The rice acreage statistics are stored in map format showing the rice extent and, in form of numerical tables, quantifying the dimension of the area at the smallest administrative level - typically village unit - cultivated by rice. These products are linked to district, region, province and country, so that statistics on any of these administrative units can be produced. The figure shows a typical output.
Rice yield prediction is performed by combining remote sensing, in situ, climatic data and an Agro Meteorological Model. Production (t), finally, is simply calculated by combining yield estimation (t/ha) and the acreage (ha) derived from the radar data.

Which rice maps are RIICE delivering, and what do they show?

In a first instance, RIICE will generate two maps: a.) a rice extent map and b.) the actual rice as observed in 2011.

a Rice Extent Map
The Rice Extent Map is generated by considering multi-year archive medium resolution (100m) ENVISAT ASAR data. It provides at national level the rice extent, and whenever needed, to identify the different rice crop seasons/ cultivations. Below are examples showing the Philippines and Bangladesh.

b Actual Rice Area Map
The Actual Rice Area is generated by considering high resolution (15m) ENVISAT ASAR and ALOS PALSAR data. It provides from local to national level the rice area during a selected rice crop season, and whenever needed monitors the rice phenology along the whole season. The map below shows rice area in Leyte, The Philippines in 2011.



How will yield forecasts be modelled?

Rice yield information will be based on a crop growth simulation model that estimates rice yields based on: SAR imagery for planting dates and crop growth rate information; current and historical information on daily weather conditions and soil, and crop management and variety information. These yield maps will be used by RIICE partners to model a yield index which can later be made the triggering basis for an insurance product.

Who will model rice yields?

The rice crop growth model will be based on Oryza2000, a model that simulates rice growth under different environmental conditions. The input data for Oryza2000 are generated by sarmap, IRRI and RIICE national partners and the results are validated by RIICE national partners by means of crop cut experiments across the target regions. Oryza2000 is used to estimate yields after harvest and also to forecast the expected yield before the season is complete. Forecasting yields require a blend of current season information on crop growth rate and weather and "forecasted" weather – derived from historical averages from weather stations. This forecasting component is critical for crop loss estimates in the event of a flood or drought.

What can yield information be used for?

Gaining better information on rice crop growth can address several problems, in particular:
it can help governments and other stakeholders to adapt their economic policies, such as making decisions on importing more rice if a food crisis could be imminent or exporting more if it is felt that rice yields will be sufficient;
it can enable relief organizations to better anticipate and coordinate relief efforts in the wake of a natural catastrophe;
it can provide the technical backbone of an insurance solution where risks of yield losses from the rice smallholders are transferred to the insurance market.

Reducing Farmers' Vulnerability

The yield observation data as well as the yield forecasts can be used to better target food security programmes in those areas that are most likely to be affected by damaged crops. It also forms the basis for insurance companies to be able to monitor crop losses in a transparent and reliable manner, providing the basis to make crop insurance for rice smallholders viable.

What are the advantages of using insurance as a means for disaster risk financing?

The current donor-appeal-based approach is both lengthy and lacks transparency. The distribution of financial aid to affected communities after a disaster can be arbitrary and the payout-process is often little transparent. RIICE can help governments to institute an insurance mechanism that reduces the vulnerability of rice smallholders from natural catastrophes as the adjacent graph explains. Through an insurance mechanism, governments transfer their farmers' risks to the insurance sector and are hence unblocking funds which can be put to more productive use rather than holding them as a contingency in government accounts.

Will climate change exacerbate crop risks?

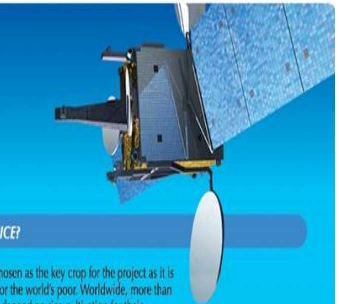
A major cause for food insecurity is climate change which is being seen as having adverse effects on rice growers in Asia that are henceforth exposed to higher infrequency and higher severity of natural catastrophes. Their need for protection against these perils has risen in order to ensure that they can continue to exercise their profession and can overcome the financial losses of a natural catastrophe leading to yield losses which in turn endangers their credit worthiness. Crop insurance is henceforth an important income stabilisation programme.

Can crop insurance solution help for disaster relief ?

Crop Insurance helps to decrease the vulnerability of smallholder farmers and save lives and livelihoods through more cost-effective and timely disaster response. Crop insurance solution also helps prevent people from falling into poverty traps by protecting investments.

How will insurance reach smallholders?

Rural banks and cooperatives are acting as an aggregator for crop insurance services and reach out to farmers on behalf of primary insurance companies that offer a crop insurance cover.



Why rice in RIICE?

Rice has been chosen as the key crop for the project as it is the staple food for the world's poor. Worldwide, more than 1 billion people depend on rice cultivation for their livelihoods. Rice is cultivated on some 158 million hectares annually and has an annual yield value of 122 billion USD (based on FAO value of yield data) of which 110 billion USD is produced in lower income countries.

In which countries is RIICE currently active?

Who will be the primary beneficiary of RIICE?

Rice smallholders are the key target group – but RIICE invites other interested parties to put forward their interest in the project and describe how they would plan to use the information provided.

What is the legal structure of RIICE?

RIICE is a project which is carried by the five parties, described in the Project Partner section. The parties of RIICE are bound by an agreement and each party brings in its own funding to the project, though most costs are borne by SDC.

PROJECT PARTNERS

Allianz Re
Development of insurance solutions based on the data provided by sarmap and IRRI.
www.allianzre.com

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (German International Cooperation)
Convenes aggregator networks and trains them to pass on the solutions as microinsurance products (jointly with Allianz Re).
www.giz.de

Swiss Agency for Development and Cooperation (SDC)
Key donor of the programme that also organises the knowledge management of the programme.
www.sdc.admin.ch

International Rice Research Institute (IRRI)
Calibration and validation of Oryza2000 rice crop growth model. WebGIS platform for information sharing. Coordination of scientific regional partners.
www.irri.org

sarmap
Provision of innovative customized earth observation based products and services.
www.sarmap.ch