

The Potential of Index Based Flood Insurance in South Asia: A case study on de-risking disasters in Bihar and Bangladesh

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November 25, 2022

Abstract

The poor across the world is very vulnerable to floods and drought disasters and have a detrimental effect on the lives and livelihoods of the poor. Weather based index insurance is one of the ways of dealing with these disasters. Protecting against floods and providing risk cover against losses due to floods has been a major area of concern for any government. Risk transfer through insurance is an important component in managing agricultural risks from extreme flood events. The study developed the first of its kind of designing and implementation of an index-based flood insurance (IBFI) product with the advanced use of satellite data and flood models to estimate crop losses due to floods. IBFI insurance product uses two different data elements, the first one is based on the flood model using HEC-HMS and HEC-RAS that uses inputs from NASA GPM bias-corrected satellite rainfall estimates, observed water level and discharge data, river characteristics, and digital elevation model to generate flood depth and flood duration to develop pre-determined thresholds based on the historical flood events between 1991 to 2015 and the second IBFI product uses only satellite data from NASA MODIS Terra and Aqua satellite data and the Copernicus Sentinel-1 SAR data to generate flood depth and flood duration to develop pre-determined thresholds based on the historical flood events and economic losses. More than 7,000 farming households in Bihar (India) and northern Bangladesh have signed up for a pilot IBFI scheme, which went live in 2017. The participating farmers have received insurance compensation for crop losses of over USD 160,000. In addition to the insurance product implementation, the research evaluated the farming willingness to pay, developing business models for scaling; social equity, and economic benefits of derisk disasters. IBFI initiative promotes a closer linkage between risk transfer and risk reduction that could make this more sustainable and robust financial instruments for flood-affected communities and reducing the burden of post-disaster relief funds for the government. In summary, the index insurance using open-access satellite imagery is a win-win opportunity as it brings down the data development cost, lower insurance premium, quick settlement, and greater transparency among various users.

Reducing vulnerability among smallholder farmers through index-based flood insurance in India: equity matters



WOMEN FARMERS PLANTING RICE IN BIHAR, INDIA. PHOTO: IWMI

Not less than 100 million people were adversely affected by floods in India between 2001-2013¹. Beyond loss of life and property, floods can severely impact health, for example by increasing the incidence of malaria and cholera. They also threaten livelihoods and food security by destroying crops, agricultural land and livestock. Floods particularly affect the rural poor as they often live in the most vulnerable areas. They are also less resilient to shocks as they already struggle to meet basic daily needs. Women are often more affected than men, because of gender norms restricting mobility, limited access to information and risk of gender-based violence.

Agricultural and weather insurance schemes have emerged as a promising tool to protect farmers from the financial losses that result from these flood events, and in helping more generally to reduce the risks of climate variability. Agricultural insurance programs in India are some of the largest in the world, with several running in the country. But many of the poorest in these flood prone regions are unable to successfully benefit from these schemes.

Conventional insurance schemes base payments to farmers on estimates of an individual farmers' loss in yield. In contrast, weather index-based insurance

schemes base payments on a weather index which is developed from rainfall data that is in turn linked to farmer yields. The advantage is the reduced cost and time needed to monitor individual farms and hence lower insurance premiums. Innovative use of technology, such as remote sensing, can improve the accuracy and efficiency of index based insurance schemes by estimating flooded areas and crop losses through digital mapping.

Vulnerability to floods is shaped by social factors, such as poverty levels, gender, land tenure and migration status. In the Eastern Gangetic Plains those most vulnerable to floods are small scale,

KEY RECOMMENDATIONS

In order to reach the most vulnerable, decision makers and those involved in insurance schemes could:

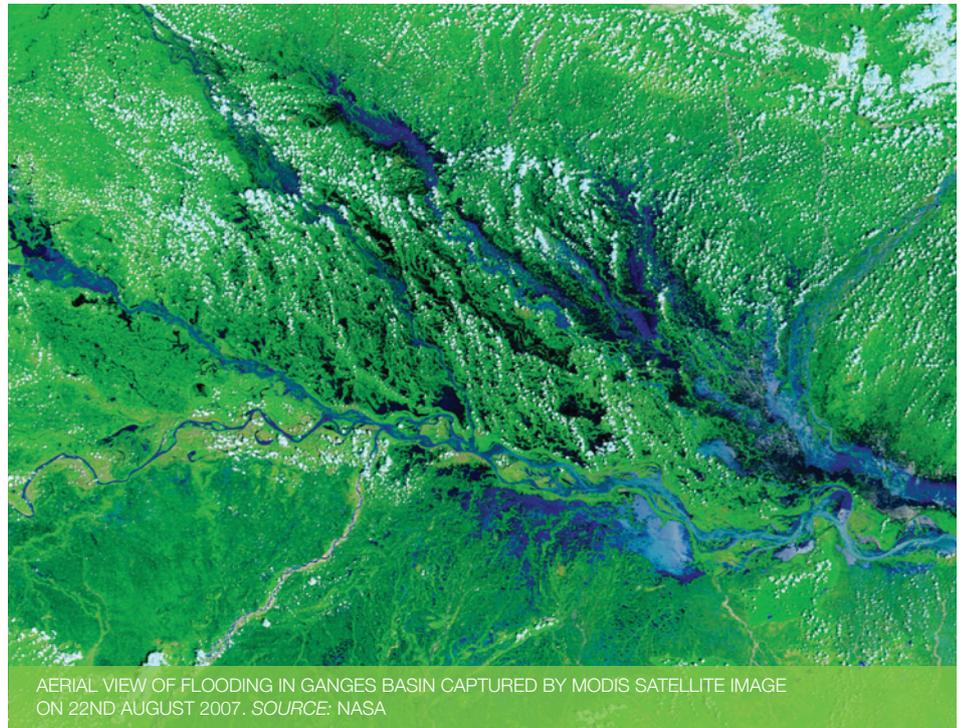
- ensure a thorough understanding of the socio-economic context in which insurance schemes are implemented and identify which social factors create vulnerabilities.
- provide farmers, especially those who are illiterate or particularly vulnerable, with adequate information and training on the most suitable insurance products and how to make best use of them.
- take into account how gender norms restrict women's ability to cope with disasters and to access and benefit from insurance schemes.
- encourage active collaboration between farmer cooperatives, women's groups, state departments and government bodies, extension services, non-governmental organizations and municipal corporations to document land tenancy arrangements.
- foster links between institutional platforms, such as farmers cooperatives and clubs, women's saving groups like Self-Help Groups (SHGs), and relevant insurance schemes to maximize the potential for a diverse range of men and women farmers to benefit from them.

marginal, tenant and women farmers. Yet, the requirement of most public crop insurance schemes to provide land titles, or written tenancy agreements, means they aren't accessible to the most vulnerable farmers. With significant increases in land tenancy and with changing gender roles in agriculture across South Asia, agriculture focused flood insurance schemes need to be more inclusive and offer products that are tailored to the needs of the farmers themselves. Index-based flood insurance may offer a solution.

The Index-based flood insurance approach

The Index-based Flood Insurance (IBFI) project, led by the International Water Management Institute (IWMI), aims to develop remote sensing products for IBFI that can accurately depict yield loss due to adverse weather and other disasters on smallholder farms. The overarching goal is to help smallholder farmers better manage their production risks and thereby help contribute to a more secure future for farmers in India. Once these remote sensing products are developed, tried and tested the team aim to ensure that they are scalable to enable them to be used effectively in large scale insurance schemes.

Index-based flood insurance is an innovative approach to developing rapid, effective payout schemes for low-income, flood-prone communities. This project uses hi-tech modeling and satellite imagery with other data to predetermine flood thresholds and estimate crop losses. This could speed up compensation payouts, enabling farmers to more quickly move on from a destructive flood event. Researchers are working in collaboration with a range of organizations and experts from central and state government bodies, private insurance firms, community-based organizations and nongovernmental organizations. This brief was developed as part of this research project aiming at understanding the equity issues related to access and benefits from the insurance scheme. It was developed based on a



review of literature and fieldwork with local communities in Bihar using qualitative surveys and focus group discussions.

The project is focusing on three sites in the Bihar region of northeastern India; Muzaffarpur, Darbhanga and Katihar and three sites in the Rajshahi region of Bangladesh; Sirajganj, Gaibandha and Pabna.

Gaps between policy and practice: the case of Pradhan Mantri Fasal Bima Yojna

One insurance scheme that aims to reach those more vulnerable to the impacts of flooding (such as sharecroppers and tenant farmers) is the Pradhan Mantri Fasal Bima Yojna (PMFBY). It was launched by the Government of India in 2016. The scheme includes innovative and attractive provisions such as low premiums, rapid payout for replacement seeds if required, and includes payouts covering post-harvest losses. It also explicitly aims at expanding coverage to poor, rain-fed areas and to farmers who are unable to obtain bank loans to cover inputs because they don't have clear land records, as well as sharecroppers and tenant farmers.

However, the PMFBY has a homogeneous or area-based approach, rather than

an individual approach, to assessing vulnerability or when assessing the impacts of a flood event. The pay-out is based on the effects of floods on a large area – if only part of the area is affected, there will be no pay-out. In contrast an individual approach uses farmer's fields as the unit considered. This means that PMFBY faces similar constraints to other insurance schemes on offer such as the National Agricultural Insurance Scheme (which offers area-based crop yield insurance) and the pilot Weather Based Crop Insurance Scheme (which offers area-based rainfall insurance). Studies⁴ note that although PMFBY has reduced the insurance coverage unit from the block (district sub-division) to the village, individual farmers suffering crop losses still cannot benefit from the scheme unless the disaster affects the entire village area. This limits the ability of this scheme to effectively reach the poorest and most marginalized groups who are often the ones living in the most flood prone areas.

Although in principle the commitment of the PMFBY to reach sharecroppers and tenant farmers is progressive, in practice most farmers in these categories are in reality still excluded because they are unable to fulfill key submission requirements, such as

providing an applicable contract or agreement permitted by the relevant state government. Current land sharing arrangements in rural India, such as those in Bihar, are usually based on mutual trust and verbal commitments. Limited documentation and/or a lack of written proof of land tenancy is a barrier that excludes tenant farmers, women and marginal farmers from insurance coverage. Women whose husbands have migrated usually do not possess land titles in their names and therefore are also not eligible for insurance schemes.

Results and conclusions

- **It is essential to first understand the socio-economic context in which insurance schemes are implemented and identify which social factors create vulnerabilities.**

Vulnerabilities to climatic and biophysical events are ultimately rooted in social characteristics. Floods can have dramatically different impacts on lives and livelihoods across different locations depending on pre-existing social, economic and political conditions. Even in one location, floods can affect individuals within the same community very differently. In Bihar, previous studies have indicated that some of the key drivers of vulnerability are linked to gender, age, class and migration. Farmers in Bihar are not only challenged by vulnerability to floods. They also face increasing pressure to develop resilient livelihood strategies to combat low agricultural productivity, the rising cost of inputs, and their already low agriculture-based incomes. At the same time there are limited alternative livelihood options.

Faced with these difficulties, many are choosing to migrate from rural to urban settings. Youth are withdrawing from agriculture and instead pursuing non-farm activities to support themselves and their families. The agrarian structure in Bihar consists of a large number of middle and low caste laborers, tenant farmers and marginal land owners and a small politically powerful class of landlords.

These landlords are able to derive most of the benefits from agricultural activities through rent, credit, loans and insurance. This leads many marginal and tenant farmers to migrate to cities in search of cash-based incomes. However, their households remain largely dependent on agricultural production for food, to repay debts and to invest in agricultural inputs, which makes them particularly vulnerable to the impacts of flood events. Gender roles in agriculture and household production relations are also changing, leading to a transformation in the rural agrarian economy in India. Nearly 25% of the rural population in India now consists of female-headed households due to widowhood, desertion or male out-migration². There has also been a rise in the proportion of small scale farmers with less than 1 ha of land, from 80% in 1990 to 89% in 2000³. There is a need for insurance schemes to design strategies to specifically target and reach women and tenant farmers as they face specific barriers to access information, enroll in and benefit from insurance schemes.

- **Provide farmers, particularly those who are illiterate or especially vulnerable, such as women, with adequate information and training on the most suitable insurance products and how to make best use of them.**

The research shows that poor female and tenant farmers in Bihar are the most vulnerable to floods and droughts. Yet they lack access to relevant information, training or the right connections, to make use of and benefit from crop loss insurance schemes. It is important that insurance schemes develop capacity building and communication strategies that specifically target women, and illiterate and tenant farmers, taking into account their time availability and the mobility restrictions that women might face. This could be done through dialogue and creating awareness among insurance companies and government agencies of the need to develop gender responsive products and services.

- **Encourage active collaboration between farmer cooperatives, women's groups, state departments and government bodies, extension services, non-governmental organizations and municipal corporations to document land tenancy arrangements.**

Adopting an individual approach in insurance schemes faces major challenges in India. Small farm holdings, land fragmentation and a large variety of crops across seasons make it a complex system. Crucially, the adoption of an individual approach is hindered by the lack of records on land ownership and tenancy, and a lack of data on yields and crop damage incurred at the farm level.

"I don't have any documentation for the sharecropping land, so I cannot claim any crop loss compensation for flood from the block [local government] office...The landowner will not agree to give any documentation, neither for three years contract nor seasonal. A legal land sharing document is only provided by the landowners in case the land is on mortgage and not for sharecropping" explained a landless tenant farmer in Barari in Bihar state

- **Foster links between institutional platforms, such as farmers' cooperatives and clubs, women's saving groups such as Self-Help Groups (SHGs) and relevant insurance schemes to maximize the potential for a diverse range of farmers to benefit from them.**

Through focus group discussions with village communities, researchers found that farmers had limited knowledge of crop and index-based weather insurance, whether or not they could afford it or even whom to approach to find out about it. This means that few had taken out crop insurance and so few can have benefited from the support that flood insurance schemes can offer.

Next steps

Effectively designed and implemented index-based flood insurance has the potential to successfully counteract vulnerability to floods. To achieve this however the state-wide and local socio-economic and institutional contexts need to be taken into account when developing and offering these insurance schemes. Flood insurance schemes need to offer demand-driven, flexible products that address the concerns of farmers across different social categories (gender, caste and class) and across regions with different hazard levels (high to low).

This project will conduct further research to better understand these contexts and issues, with a view to implementing an effective index-based flood insurance program that reaches the poorest and most marginalized. As part of this process, further qualitative and quantitative surveys will be conducted with farmers, insurance companies, local NGOs and government implementing agencies. These will be conducted in

order to examine ways to enhance the inclusion of those most vulnerable to floods in the program, such as female headed households, sharecroppers and tenant farmers. In particular, we will explore relevant institutional mechanisms that can connect grassroots organizations with public agencies and insurance companies.

Further information

- About the Index Based Flood Insurance (IBFI) project: <http://ibfi.iwmi.org>
- Video: Index Based Flood Insurance: A more secure future for India's farmers <https://www.youtube.com/watch?v=OcdEsbF3RFY>
- IBFI Farmers enrollment <https://wle.cgiar.org/farmers-successfully-enrolled-flood-insurance-program>

Acknowledgements

This brief is based on research conducted by IWMI authors: Panchali Saikia, Research Consultant; Giriraj Amarnath, IBFI Lead Scientist and Research Group Leader - Water Risks and Disasters

(WRD), and Floriane Clement, Country Representative - Nepal.

The IBFI project is supported by the CGIAR Research Programs on Water, Land and Ecosystems (WLE) and Climate Change, Agriculture and Food Security (CCAFS), and so is supported by CGIAR Fund Donors: <http://www.cgiar.org/about-us/our-funders/>

Notes

- ¹ Amarnath, G.; Alahacoon, N.; Smakhtin, V.; Aggarwal, P. 2017. Mapping multiple climate-related hazards in South Asia. Colombo, Sri Lanka: International Water Management Institute (IWMI). (IWMI Research Report 170). <http://www.iwmi.cgiar.org/publications/iwmi-research-reports/iwmi-research-report-170/>
- ² Sugden, F., Maskey, N., Clement, F., Ramesh, V., Philip, A. & Rai, A. 2014. Agrarian stress and climate change in the Eastern Gangetic Plains: Gendered vulnerability in a stratified social formation. *Global Environmental Change*, 29, pp. 258–269.
- ³ NSSO 2006. Household Ownership Holdings in India, 2003, National Sample Survey Organisation (NSSO), Ministry of Statistics and Programme Implementation, Government of India.
- ⁴ Kainth, G.S., Bawa, R.S. and Kainth, N.S., 2016. Pradhan Mantri Fasal Bima Yojana: Challenges and Way Forward, <http://ageconsearch.tind.io/bitstream/253271/2/eBook-PMFBY.pdf>

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ABOUT WLE

The CGIAR Research Program on Water, Land and Ecosystems (WLE) promotes a new approach to sustainable intensification in which a healthy functioning ecosystem is seen as a prerequisite to agricultural development, resilience of food systems and human well-being. WLE combines the resources of 11 CGIAR centers, the Food and Agriculture Organization of the United Nations (FAO), the RUAF Foundation and numerous national, regional and international partners to provide an integrated approach to natural resource management research. This program is led by the International Water Management Institute (IWMI) and is supported by CGIAR, a global research partnership for a food-secure future.

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IN PARTNERSHIP WITH:



Increasing agricultural resilience and flood-proofing livelihoods in Bihar, India

Remote sensing innovations for index-based flood insurance

Index-based flood insurance (IBFI) is an innovative approach to developing effective payout schemes for low-income, flood-prone communities. This project aims to integrate hi-tech modelling and satellite imagery with other data to predetermine flood thresholds, which could trigger speedy compensation payouts. Effective end-to-end solutions will be developed in collaboration with a range of organizations and experts from central and state government bodies, private insurance firms, community-based organizations (CBOs) and nongovernmental organizations (NGOs). The project will be piloted in selected locations of India and Bangladesh, making it the first attempt to develop IBFI at a large scale.

Why index-based flood insurance (IBFI)?

Growing population, poor management of land and water resources, and increased exposure to extreme climatic events have left a large number of people vulnerable to floods. A report by The United Nations Office for Disaster Risk Reduction (UNISDR) in 2011 estimated that 800 million people live in flood-prone areas, with 70 million experiencing yearly floods. Floods lead to widespread destruction and human tragedy, severely impacting infrastructure, agriculture and ecosystems. Agricultural communities are subjected to severe economic pressure from flood-induced losses.

Traditionally, flood-risk management has focused on engineered responses, such as dams and flood walls, or rebuilding activities and compensation after the event, particularly in the case of agriculture. However, over the last few decades, evidence has emerged that a broader approach through planning, building regulation and early warning systems can significantly reduce flood losses. Index-based flood insurance (IBFI) is one such solution that is both cost-effective and can better target post-disaster relief to compensate agricultural losses.

5 facts about floods in Bihar

1. Bihar is India's **most flood-prone state**.
2. **73%** of the total geographical area is annually flooded.
3. **76%** of the population in North Bihar is at risk of flooding.
4. **Major flood events have occurred in 1987, 1995, 1998, 2002, 2004 and 2007.**
5. Muzaffarpur District, alone, incurred **losses of over USD 3 million** per year from 2001 to 2012 due to floods.

Sources: Flood Management Information System (FMIS) and Disaster Management Department, Bihar.

Pilot locations

Muzaffarpur, Darbhanga, Samastipur or Katihar districts in Bihar, India.

Project

Duration: 2015-2018

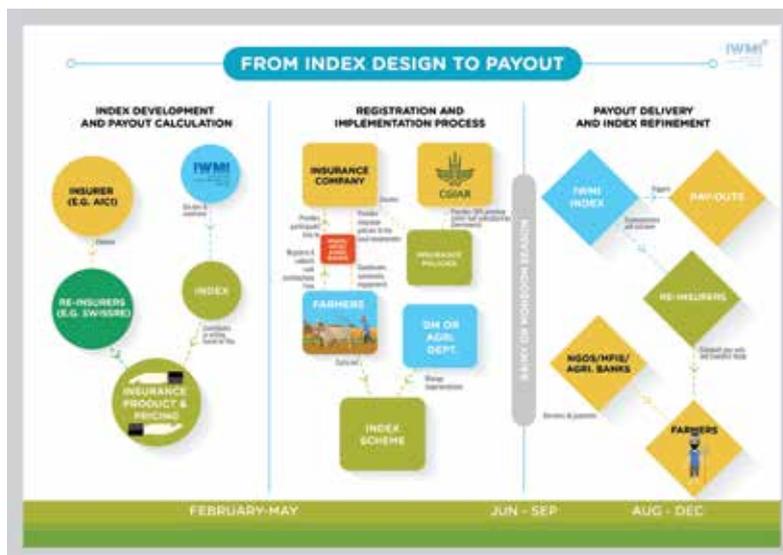
Goal: Contribute to sustainable approaches to index-based flood insurance that can help smallholders better manage their flood risk.

Objective: Develop agricultural flood insurance products using remote sensing data and flood modeling tools that can accurately depict yield loss in smallholder farming due to weather and/or other perils, and be scalable in insurance schemes delivered at micro and meso levels.



In 2017, the IBFI scheme was rolled out to 200 farmers in Muzaffarpur District, Bihar, India (photo: Farah Ahmed/IWMI).

How the project works



Project outputs

- **Proof-of-concept on IBFI** coupled with the flood hazard model and remote sensing (RS) data in selected districts of South Asian countries.
- **Digital flood mapping tool** to monitor and quantify the impact of floods on crops, and its application in insurance schemes.
- **Design and pilot test** a set of farmer-friendly flood insurance contracts for at least three districts with a considerable number of marginalized female farmers/poor people to ensure contracts are not gender biased.
- **Obtaining feedback** from officials/staff of insurance regulatory authorities in countries, operating insurance companies, meteorological agencies, agricultural research institutions, micro-finance institutions or NGOs, and relevant government agencies (e.g., ministries involved with disaster management, water resources, and agriculture).
- **Policy and institutional guidelines**, supporting gender and inclusiveness, for the implementation of flood insurance.
- **Comparative analysis** of the cost-effectiveness of RS-based index insurance compared to traditional methods, and estimating the potential in other parts of the target countries.
- **Rapid response mapping** to support disaster management in Bihar, and development of **post-flood management plan** to enable the utilization of excess soil moisture to cultivate alternative crops to suit the landscape.

If the solutions proposed by the project are scaled up, by 2025, approximately 1 million farmers will have agricultural flood insurance, creating new and different types of jobs supported by strong public-private-partnership business models and delivering INR 10 billion in flood protection.

Project partners



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Increasing agricultural resilience and flood-proofing livelihoods in Bangladesh

Remote sensing innovations for index-based flood insurance

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Traditionally, flood-risk management has focused on engineered responses, such as dams and flood walls, or rebuilding activities and compensation after the event, particularly in the case of agriculture. However, over the last few decades, evidence has emerged that a broader approach through planning, building regulation and early warning systems can significantly reduce flood losses. Index-based flood insurance (IBFI) is one such solution that is both cost-effective and can better target post-disaster relief to compensate agricultural losses.

5 facts about floods in Bangladesh

1. **74 major flood events** were reported between 1980 and 2015.
2. **12,669 people** were killed and **250 million** affected by floods during this period.
3. **8%** of the areas are at very high risk and **19%** are at high risk of flooding with **economic losses of USD 11.38 billion**.
4. Out of the 64 districts, **36 are severely affected** by floods and key districts include Sirajganj, Gaibandha, Pabna, Gopalganj, Kishoreganj, Brahmanbaria and Madaripur.
5. **Major flood events have occurred in 1988, 1998, 2003, 2004, 2007 and 2012.**

Sources: 1, 2 and 5: EM-DAT 2015; 3 and 4: IWMI South Asia flood mapping studies.

Pilot locations

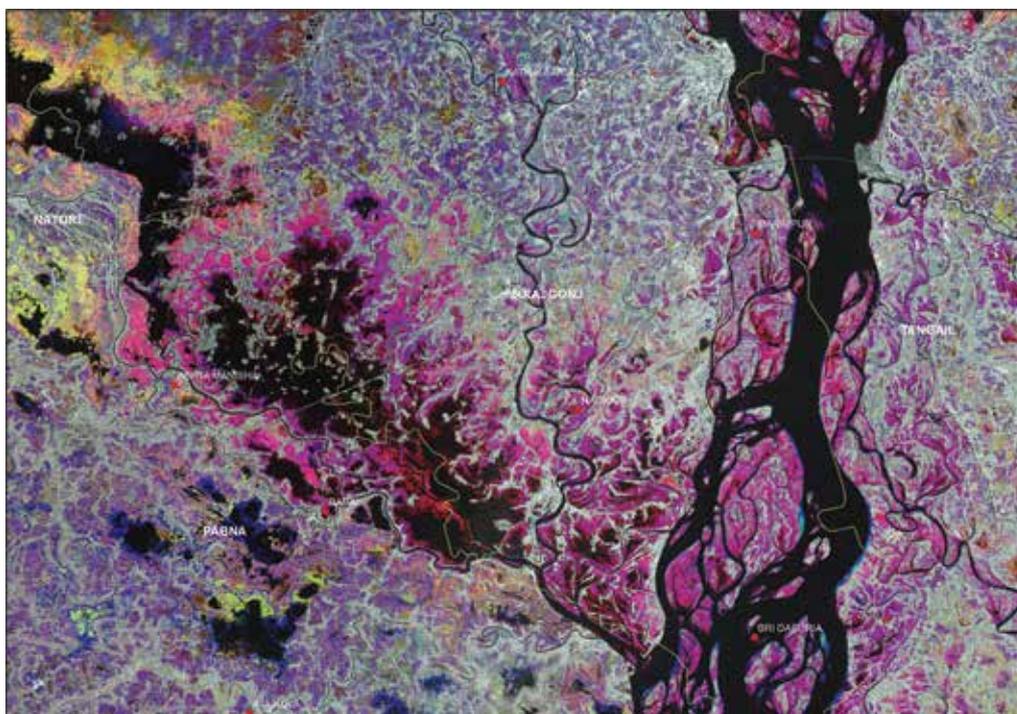
Sirajganj, Gaibandha and Pabna districts in Bangladesh.

Project

Duration: 2015-2018

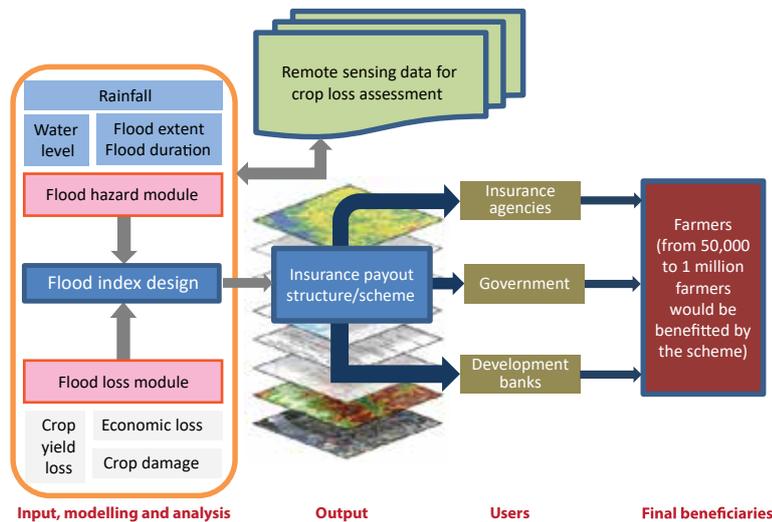
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Flooding in Bangladesh as viewed by a Sentinel-1 Synthetic Aperture Radar (SAR) satellite image (August-October 2015) (Source: European Space Agency [ESA]).

How the project works



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- **Proof-of-concept on IBFI** coupled with the flood hazard model and remote sensing (RS) data in selected districts of South Asian countries.
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- **Comparative analysis** of the cost-effectiveness of RS-based index insurance compared to traditional methods, and estimating the potential in other parts of the target countries.
- **Rapid response mapping** to support disaster management in Bangladesh.

Reference

EM-DAT. 2015. The OFDA/CRED international disaster database. Brussels, Belgium: Centre for Research on the Epidemiology of Disasters (CRED), Université catholique de Louvain. Available at <http://www.emdat.be> (accessed on October 30, 2015).

If the solutions proposed by the project are scaled up, by 2025, approximately 500,000 farmers will have agricultural flood insurance, creating new and different types of jobs supported by strong public-private-partnership business models and delivering BDT 6 billion in flood protection.

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