ICDF's GIS/EO technologies and AI applications:
Marine Debris Detection, Agriculture Monitoring, and Forest Pest Management

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Outline

ICDF's project utilizing GIS/EO technologies

Honduras Forest Pest Management Project

GIS/EO technologies and AI applications in TW

Marine Debris Detection in TW
Agriculture Monitoring in TW

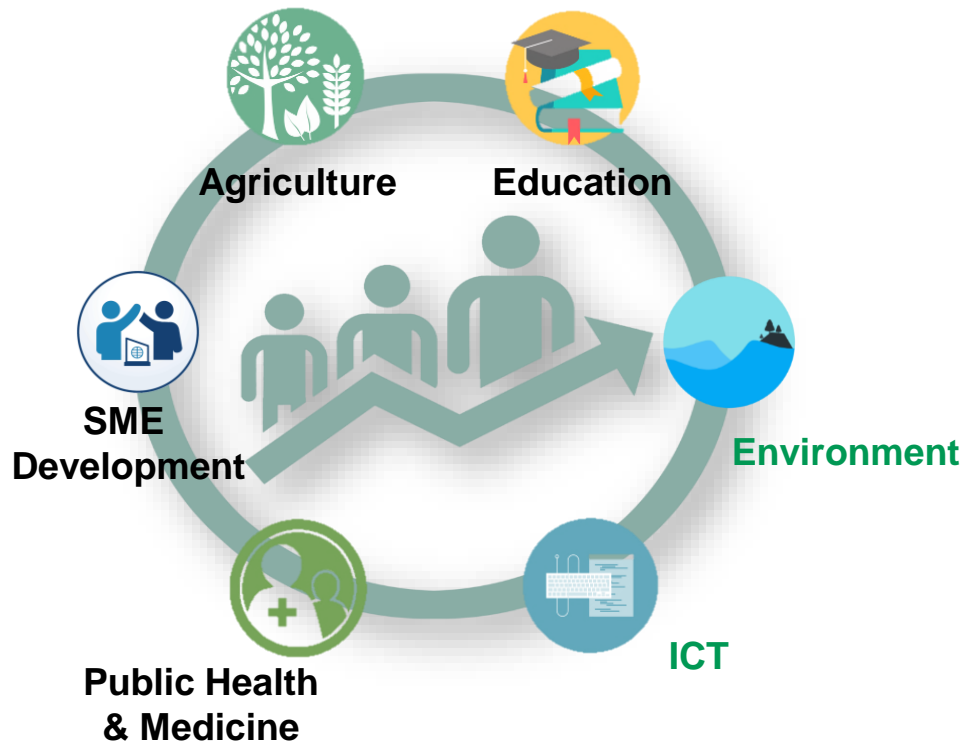**GIS/EO technologies and AI applications in Honduras**

Forest Pest Management in Honduras

Honduras Forest Pest Management Project

ICDF Priority Project Themes

- Agriculture
- Education
- SME Development
- Public Health & Medicine
- ICT
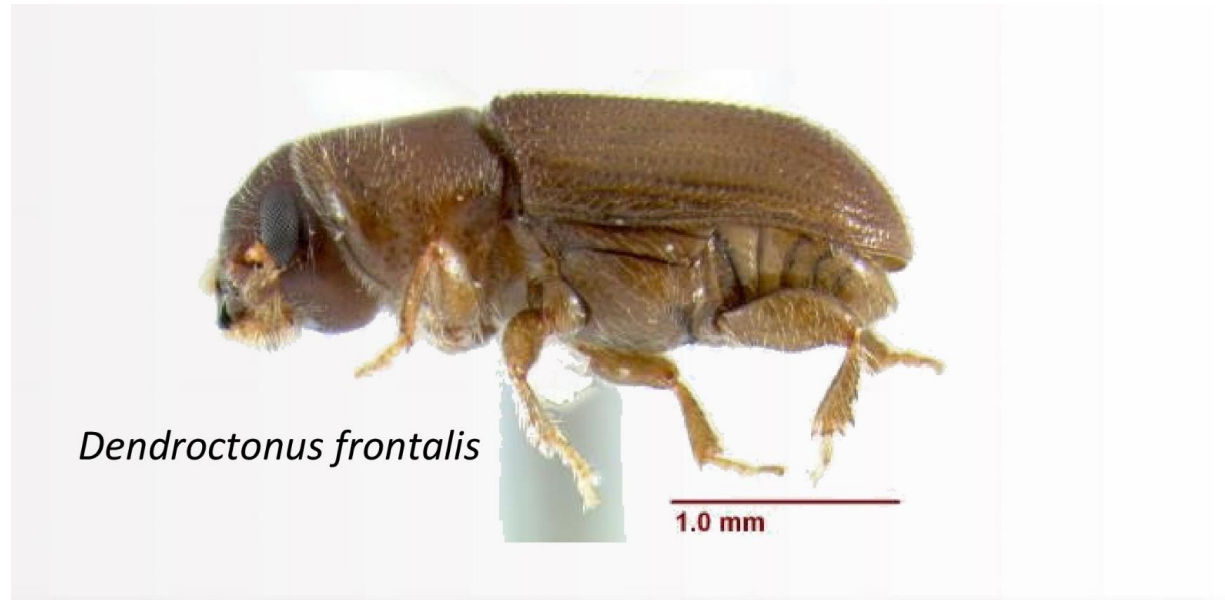- Environment

Project Summary

- Period:
  June 2018 – Dec 2021
- Objective:
  To establish a decision support platform
- Outcome:
  Reduce the early warning time of pest outbreak from 2 months to 1 week

What happened here in Honduras?

Photo provided by World Vision

What happened here in Honduras?

Dendroctonus frontalis

1.0 mm

South Pine Beetle

What happened here in Honduras?

14 Days

14 Days

22 de julio 2016. Nótese que el follaje de los arboles aún estaba verde

Segunda Aplicación 05-08-2016, el cambio de color empieza a resultar evidente

Tercera Aplicación la mortalidad de los arboles es evidente

Photo provided by World Vision

What happened here in Honduras?

National area
112,000 km^2

KR 100,210 km^2

Forest area
66,000 km^2
59% of national area

TW 60%, JP 67%

Pine forest area
20,000 km^2
30% of forest area

Area damaged by
insect plague in 2015:
5,054 km^2
25% of pine forest area

What can we do?

What can we do?

What can we do?

Cut and Leave Method

Use satellite image to detect the pest outbreak faster?
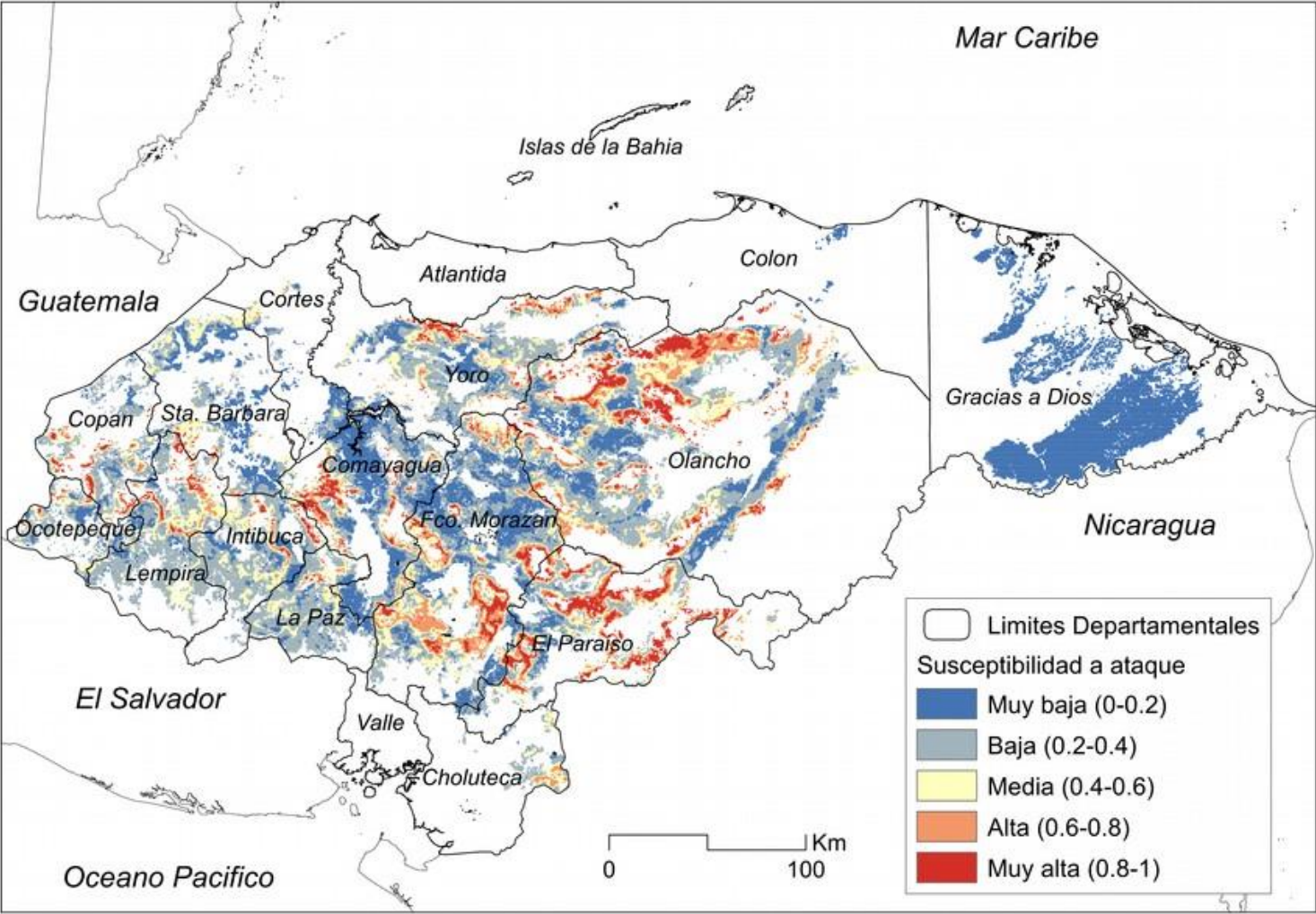

14 Days

So...

- Satellite image is necessary but NOT fast enough

- Faster tool

- Not only Detect but **Predict**

Risk map

Decision Support Platform

ICDF's GIS/EO technologies and AI applications

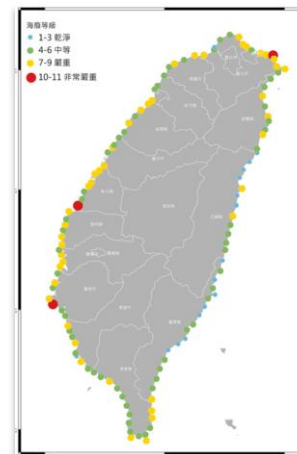# Marine Debris Detection in TW

Dr. Chi-Farn Chen | Professor, NCU

Introduction

- **Marine Debris pollution that impacts the marine environment is a global problem, particularly in coastal areas.**

- **Rapid assessment on TW's beaches.**

- **56% of marine debris accumulates in 10% of the coastline on the Northern, Southwestern coast.**

Information and pictures from GREENPEACE, SOW

Information and pictures from UN News

Drone Video

Traditional Beach Debris Sorting and Identification

- Usually done with manual involvement
- Time-consuming
- Labor intensive
- Small area

Drone Image Acquisition

What did we do?

- **Acquire drone images at beach areas from the marine debris hot spots.**

- **Generate orthophotos of resolution better than 5 cm.**

Video

Video

Artificial Intelligence(AI) Technology for Marine Debris Identification

- **Collect the marine debris images by drone.**

- **Establish a marine debris imagery database for AI training.**

- **Develop AI models to automatically identify different types, distributions, and quantities of marine debris.**

Collect marine debris image	→	Generate training dataset	→	Develop AI model	→	Identify debris category and amount

Major Marine Debris Category

The three major categories of marine debris on the beach in TW are:

- **Plastic bottle**
- **Fishing buoy**
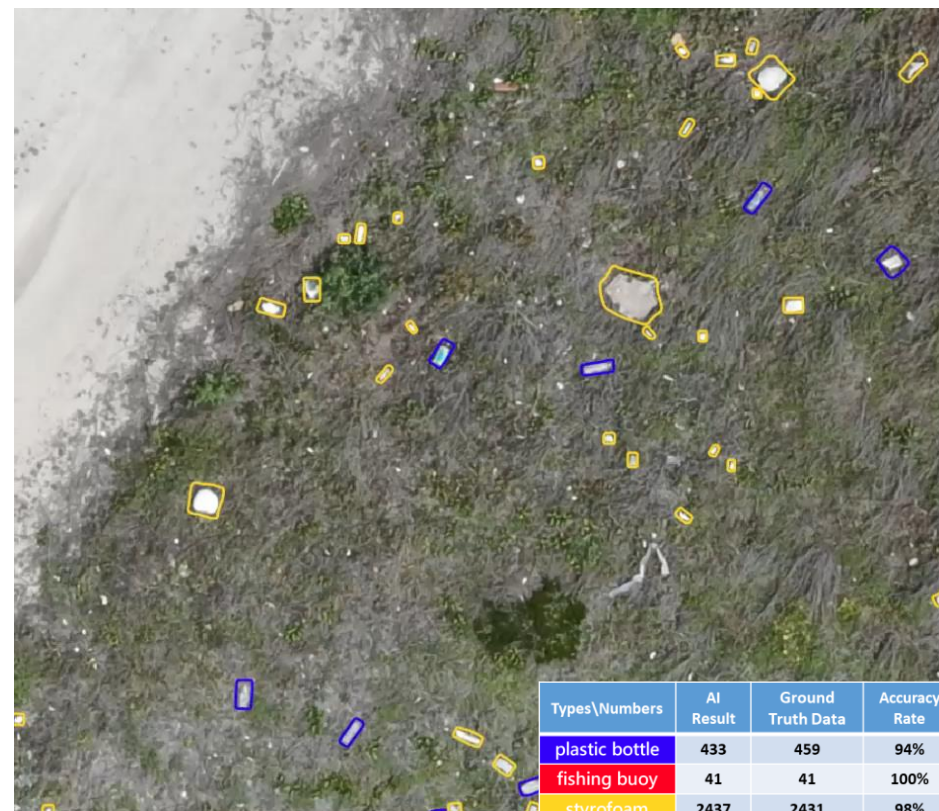- **Styrofoam**

Plastic Bottle

Fishing Bouy

Styrofoam

Drone acquisition on April 17, 2020 at Citou Beach, Penghu County

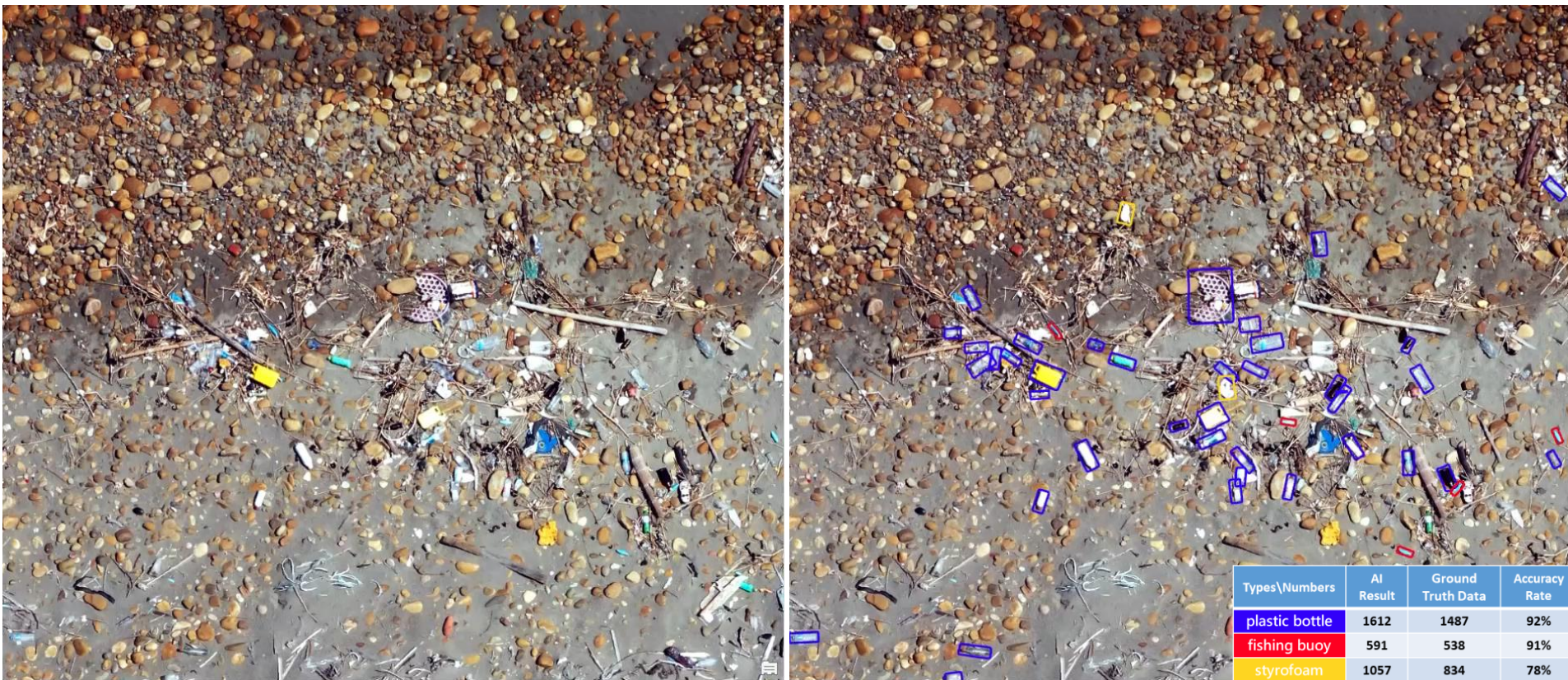# Marine Debris Category Identification Using AI and Drone Image: Case 1

Types\Numbers	AI Result	Ground Truth Data	Accuracy Rate
plastic bottle	433	459	94%
fishing buoy	41	41	100%
styrofoam	2437	2431	98%

Case 1 – Drone image   **Case 1 – AI for Debris Category Identification**

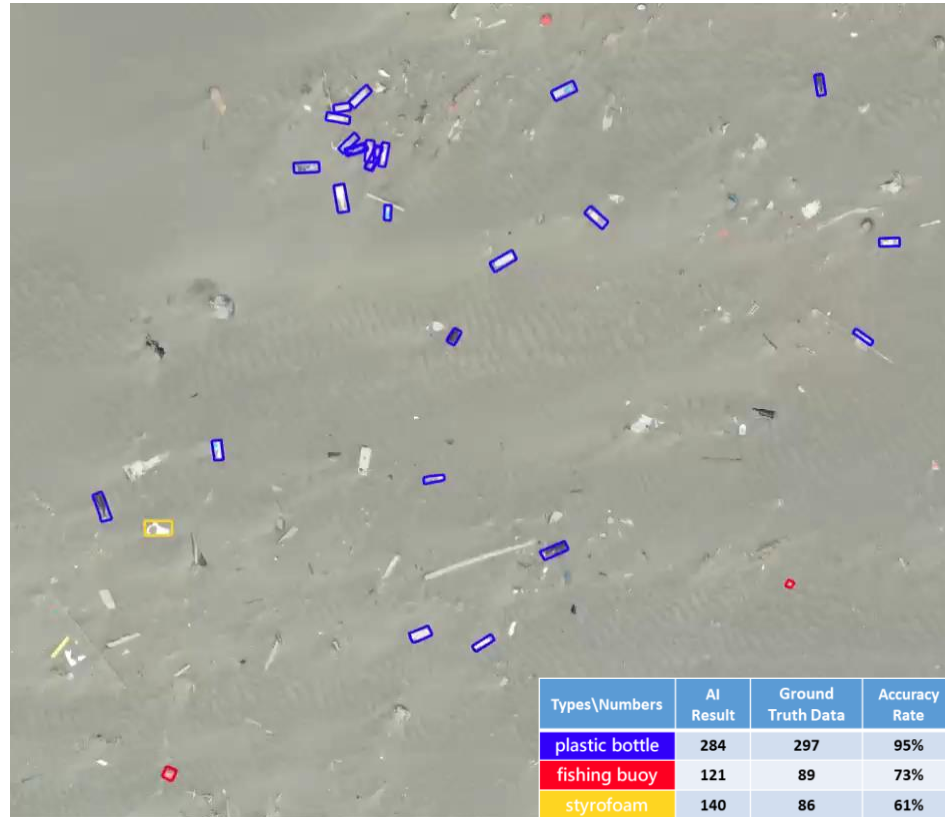# Marine Debris Category Identification Using AI and Drone Image: Case 2

Types\Numbers	AI Result	Ground Truth Data	Accuracy Rate
plastic bottle	1612	1487	92%
fishing buoy	591	538	91%
styrofoam	1057	834	78%

Case 2 – Drone image   **Case 2 – AI for Debris Category Identification**

Marine Debris Category Identification Using AI and Drone Image: Case 3

Types\Numbers	AI Result	Ground Truth Data	Accuracy Rate
plastic bottle	284	297	95%
fishing buoy	121	89	73%
styrofoam	140	86	61%

Case 3 – Drone image　　**Case 3 – AI for Debris Category Identification**

Marine Debris Category Identification Using AI and Mobile Phone Image

We are currently developing an AI model using mobile phone images to automatically detect debris categories on the beach.

ICDF's GIS/EO technologies and AI applications

Agriculture Monitoring in TW
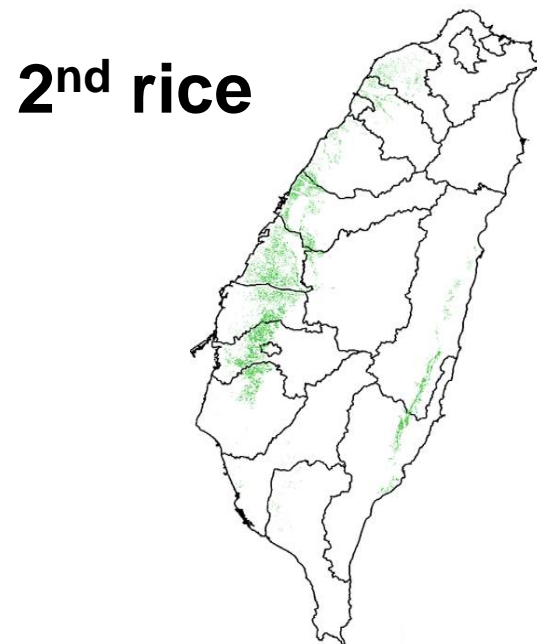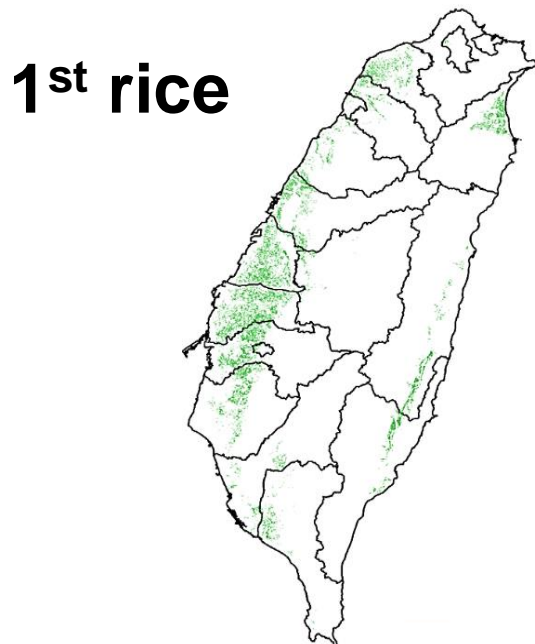
Dr. Chi-Farn Chen | Professor, NCU

Introduction

- **Rice is the most important food crop in TW.**

- **GIS/EO technologies with artificial intelligence (AI) are used for rice area and yield prediction.**

1st rice

2nd rice

Radar Data for Rice Area Prediction
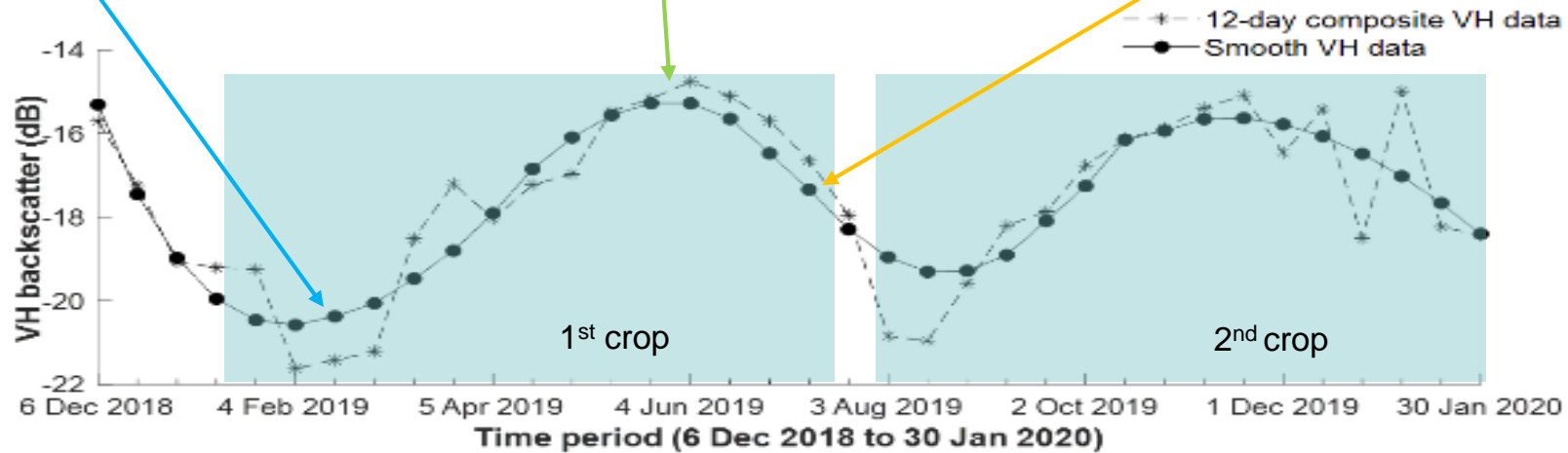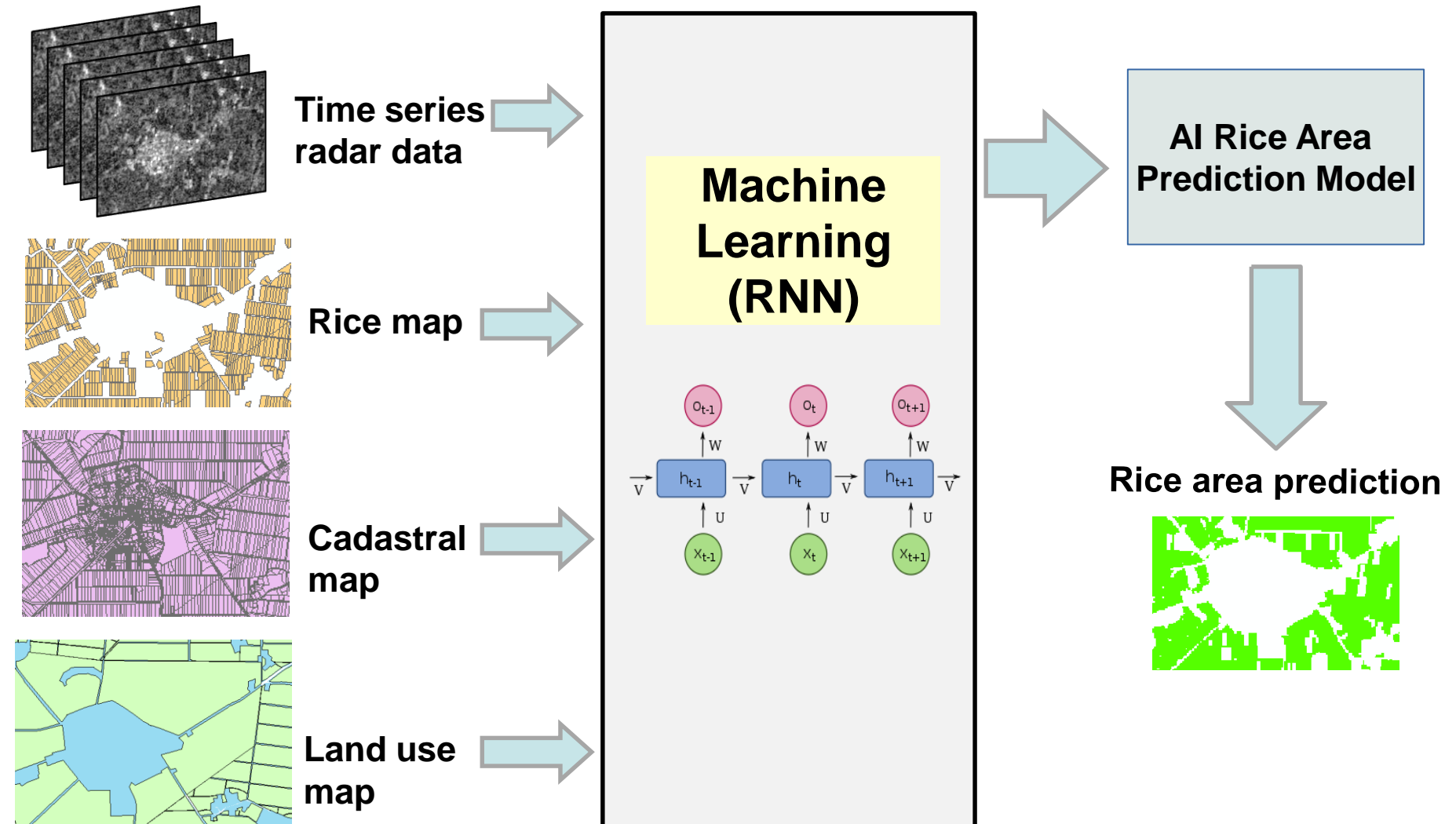

Planting   **Heading**   **Harvesting**

Time-series radar signal profile

AI Model Development for Rice Area Prediction

Time series radar data

Rice map

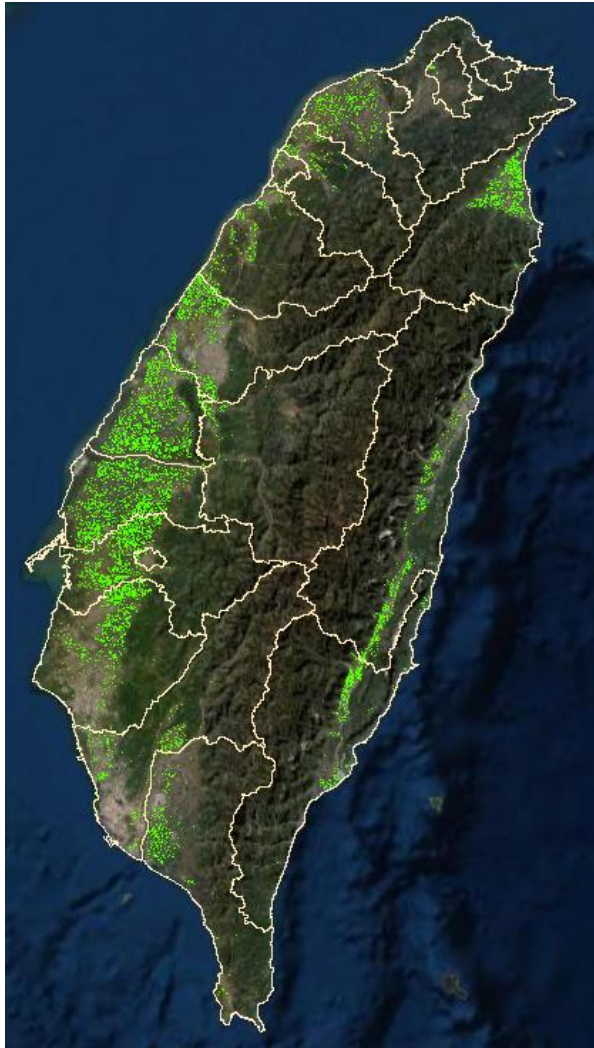Cadastral map

Land use map

Machine Learning (RNN)

AI Rice Area Prediction Model
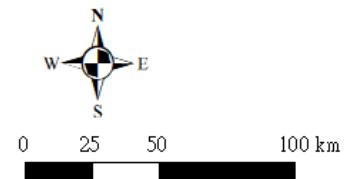
Rice area prediction

AI Rice Area Prediction Result

**Rice area prediction
(first crop)**

**Rice area prediction
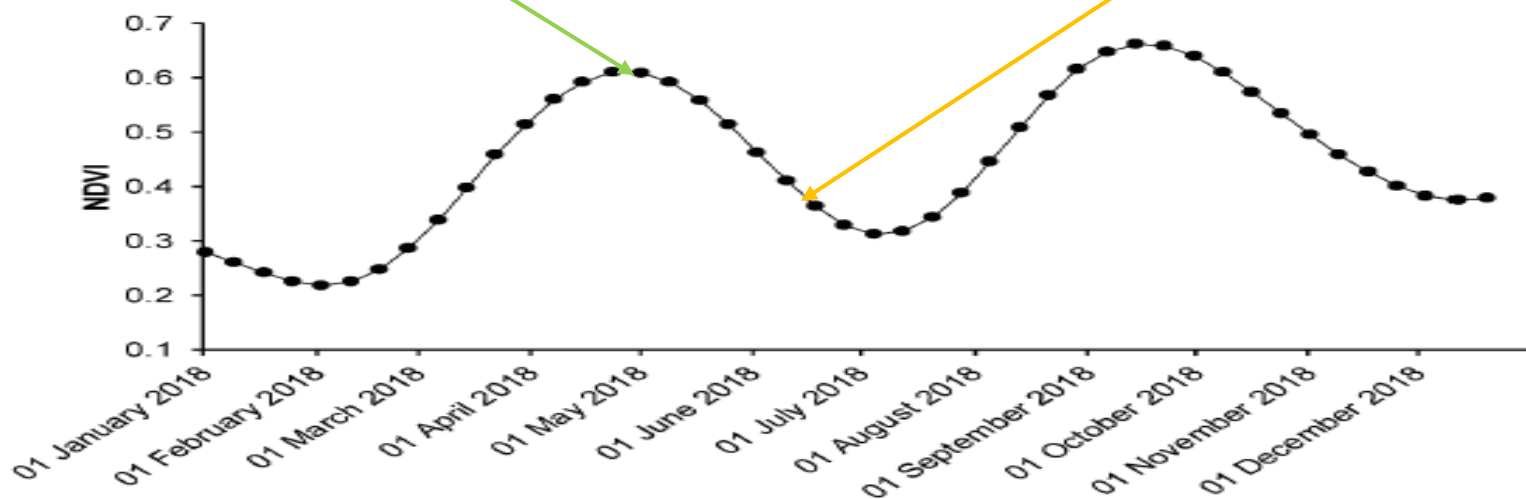(second crop)**

Optical Data for Rice Yield Prediction

Heading

Harvesting

Time-series optical signal profile

AI Model Development for Rice Yield Prediction

Time series optical data

Yield statistics

Machine Learning (RF)

Input data

... Average

Output

AI Rice Yield Prediction Model

Yield prediction

AI Rice Yield Prediction Result

1st rice

2nd rice

0   25   50   100 km

Legend (ton/ha)

- >7.8 - 8.5
- >7.4 - 7.8
- >6.7 - 7.4
- >5.9 - 6.7
- 4.5 - 5.9

Legend (ton/ha)

- >6.5 - 7.2
- >5.8 - 6.5
- >5.1 - 5.8
- >4.1 - 5.1
- 3.1 - 4.1
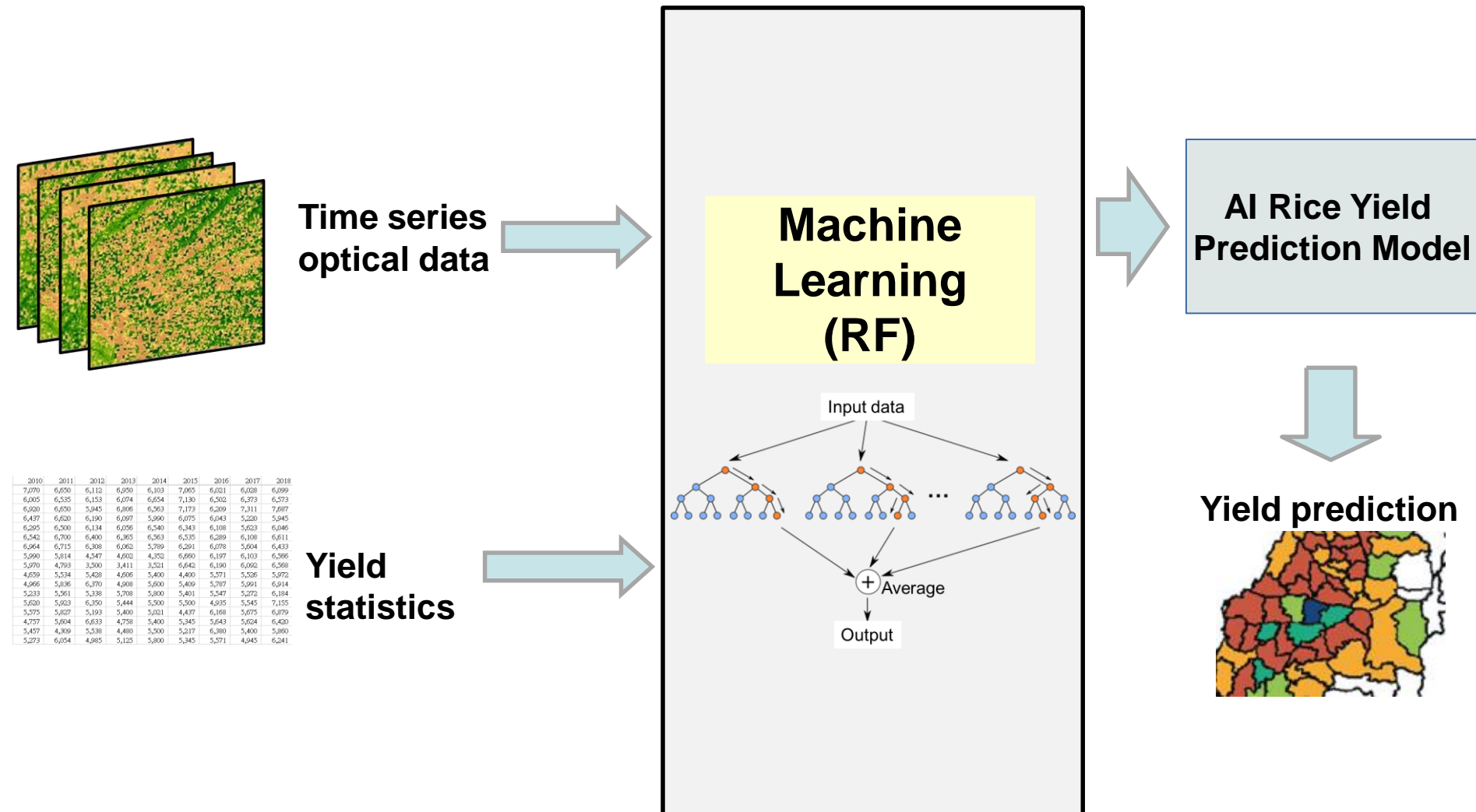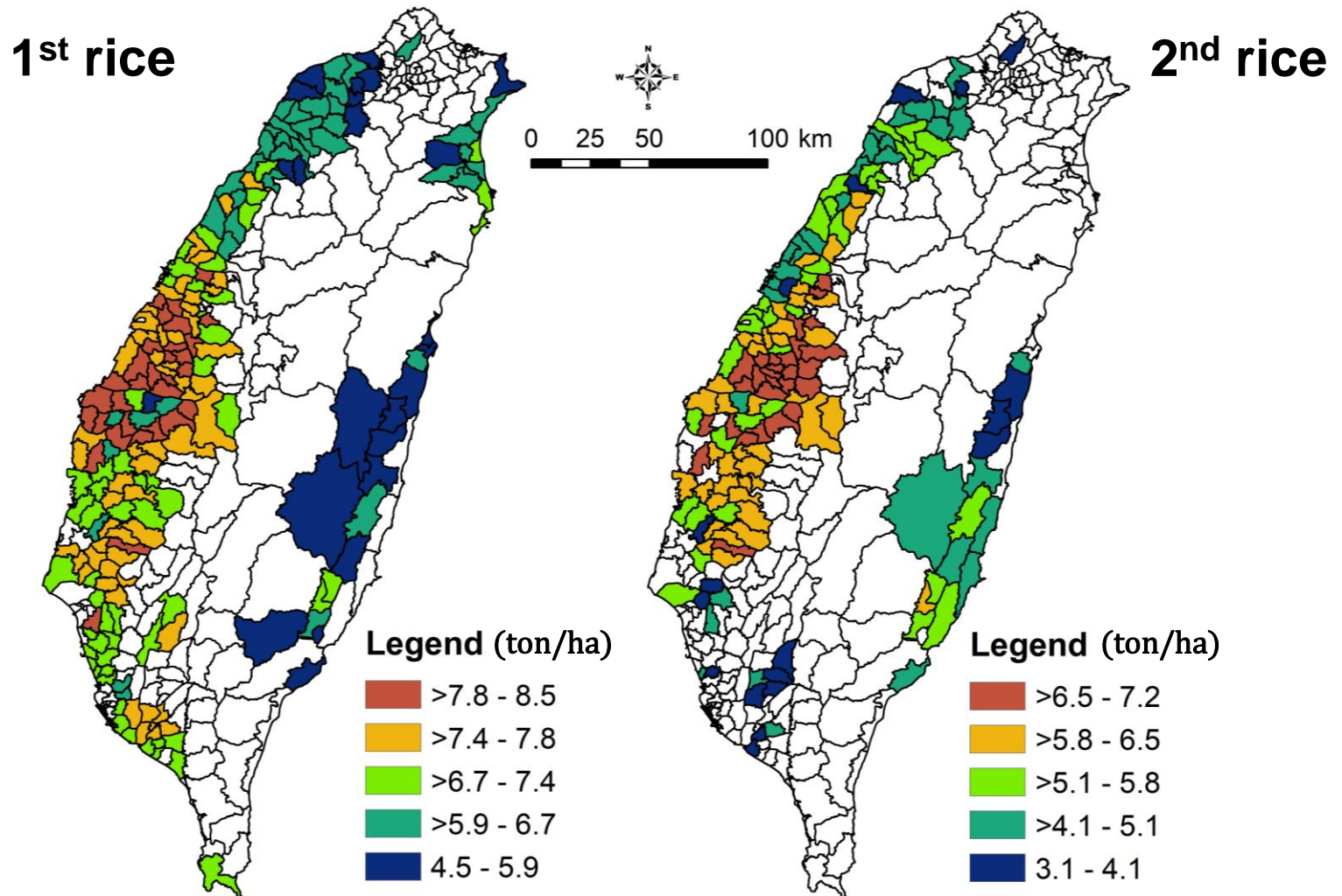
ICDF's GIS/EO technologies and AI applications

Forest Pest Management in Honduras
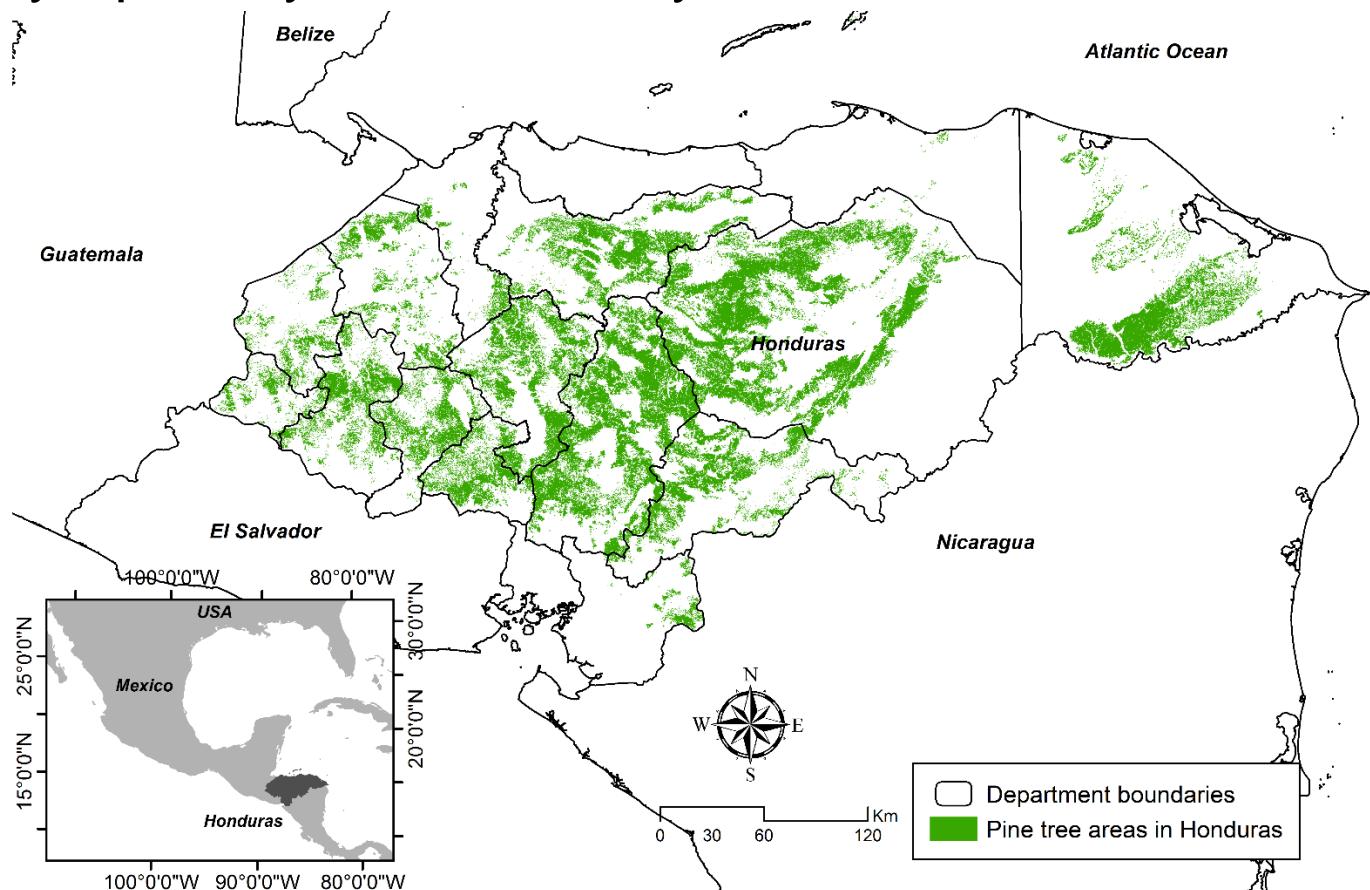

Dr. Chi-Farn Chen | Professor, NCU

Introduction

- Bark beetle (BB) is an insect present naturally, which has caused major ecological disasters during climate extremes in the pine tree forests of Honduras.
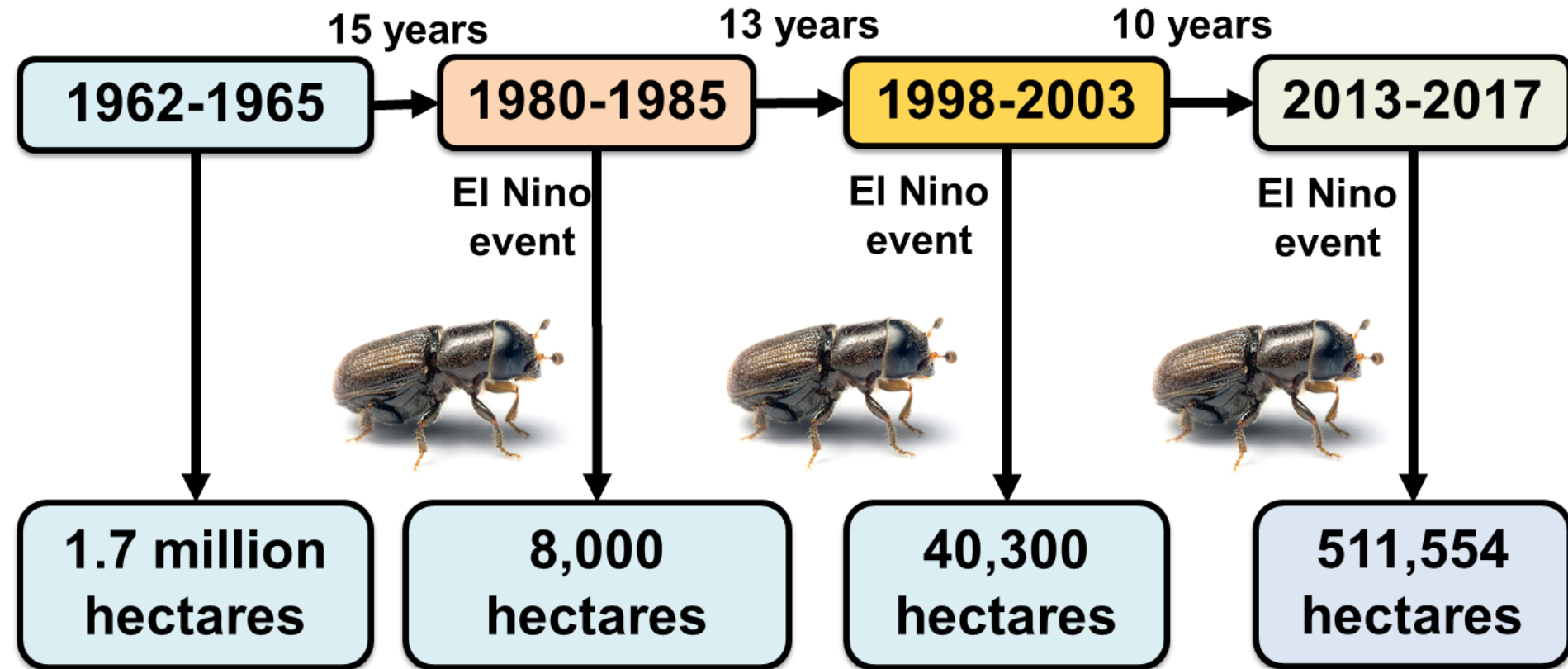
Study area

- Honduras has 6.6 million hectares of forest, pine tree forests represent 30% of the total forests in Honduras and are the basis of the country's primary forest industry.

Background

Pine tree bark beetle historical attacks

	15 years	13 years	10 years
1962-1965	1980-1985	1998-2003	2013-2017
	El Nino event	El Nino event	El Nino event
1.7 million hectares	8,000 hectares	40,300 hectares	511,554 hectares

Background

- From 2012-2016, ICDF with NCU-CSRSR and the Forest Institute (ICF) from Honduras, implemented a Project of Satellite Monitoring of Forest and Natural Resources using GIS and Remote sensing.

1   Environment Monitoring

- **Forest Monitoring**
- **Wildfire Monitoring**

- **Forest Pest Monitoring**

2   Emergency Monitoring

3   RS/GIS Training and Capacity Building

International Cooperation and Development Fund (ICDF)

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REPÚBLICA DE HONDURAS

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INSTITUTO DE CONSERVACIÓN FORESTAL
ICF

Forest Pest Monitoring

Prior and subsequent satellite images of the area affected by pest

Forest affected by pest

Prior(10/06/2014)

Subsequent(05/18/2015)
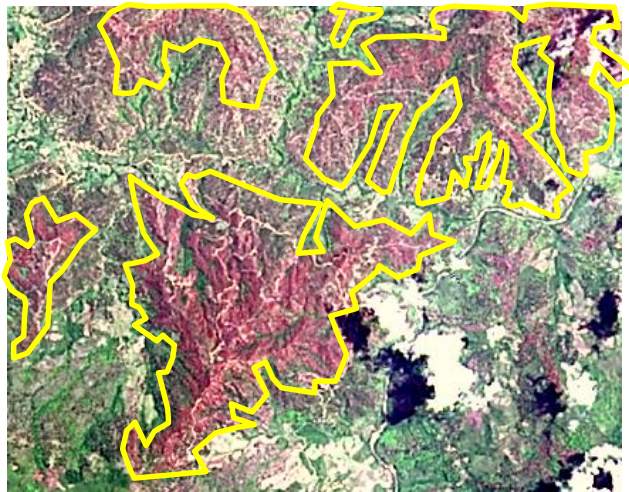
Affected Area

Forest Pest Monitoring

Bark beetle outbreak in the 2014-2016 period

03/2014 ~ 09/2016

□ **monitoring area** ■ **pest-affected areas**

5,115 km²

Total area of the pest-affected area in the municipalities

Pie chart:
- Yoro 9%
- Comayagua 14%
- Francisco Morazán 46%
- Olancho 29%
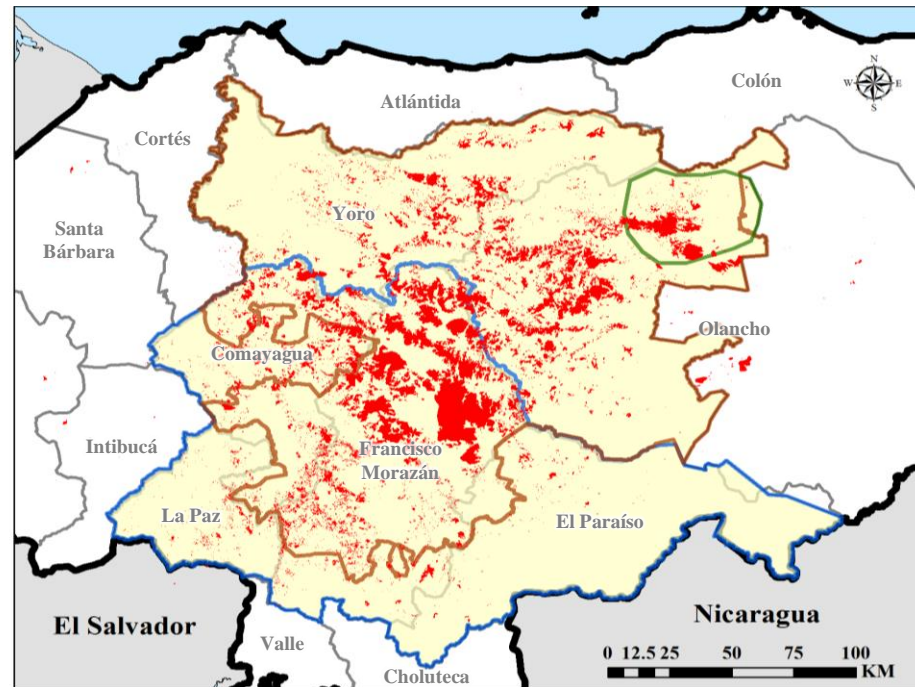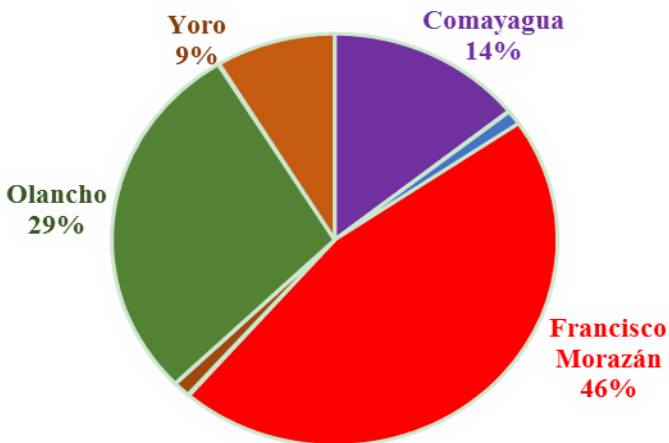
Insect Pest of Pine Forests Map Honduras

Legend
- ■ Forest Pest
- ▢ 2014 AOI
- ▢ 2015 AOI
- ▢ 2016 AOI
- ▢ Monitoring Area

0 12.5 25 50 75 100 KM

CoordinateSystem WGS84 - UTM16N

Forest risk pest management

- From 2018-2021, ICDF with NCU-CSRSR and the Forest Institute (ICF) from Honduras, are executing a Project for **Forest Pest Management in Honduras.**

1. The development of forest health monitoring data.

2. The making of forest insect pest (bark beetle) risk maps in Honduras.

3. Decision Support Platform for Pest and Forest Health Management.

4. Technology transfer and training program.

International Cooperation and Development Fund (ICDF)

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★ ★ ★ ★ ★

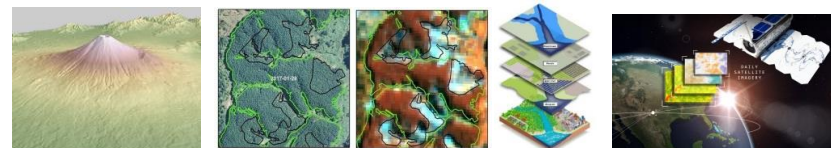INSTITUTO DE CONSERVACIÓN FORESTAL
ICF

Methodology flowchart

Bark beetle outbreak locations (2018-2021 period).
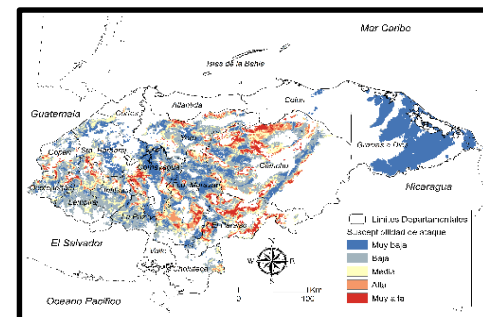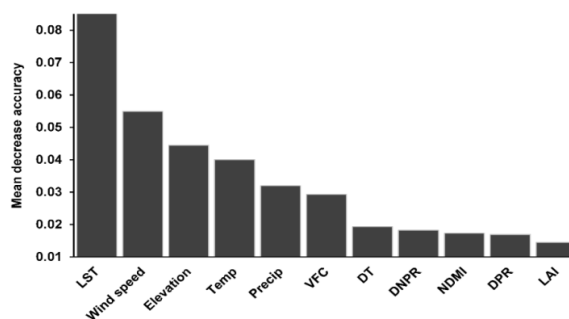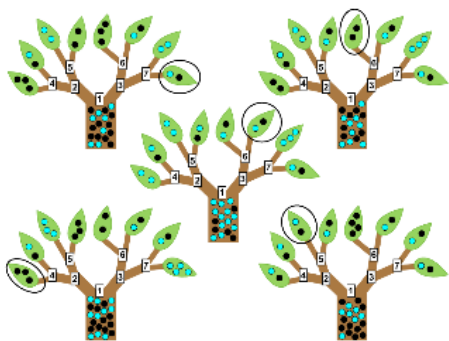
Variables:
- **Climatic (precipitation, temperature, wind speed)**
- **Vegetation condition (EVI, NDMI)**
- **Human activities (wildfires and proximity to roads)**
- **Topography**

Random Forest (Machine learning-AI) → **Variable importance.** → **Pine bark beetle high probability areas.**
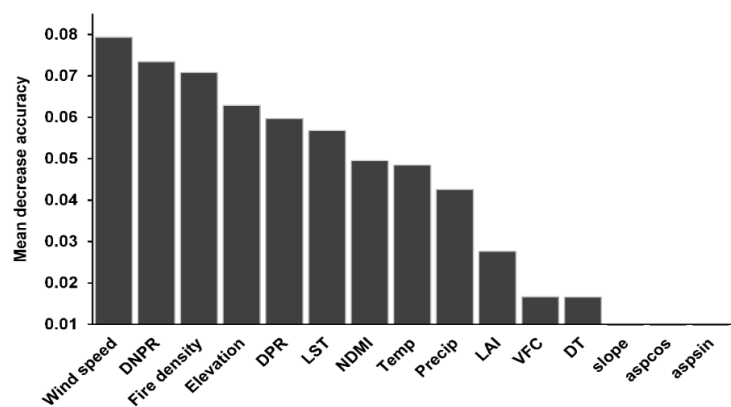
Results

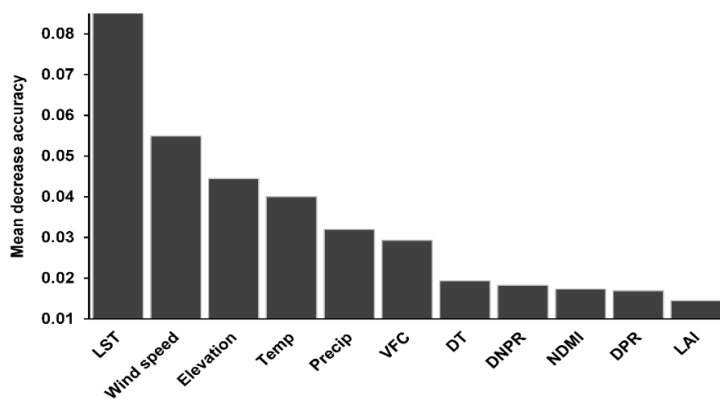**Relevant variables for the occurrence of bark beetle outbreaks in the dry season:**

1. Wind speed.
2. Distance to non-paved roads.
3. Fire density.

Relevant variables for the occurrence of bark beetle outbreaks in the rainy season :

1. Land surface temperature.
2. Wind speed.
3. Elevation.

Dry season model variable importance. Mean decrease in accuracy

Rainy season model variable importance. Mean decrease in accuracy

Results

Pine Bark Beetle Outbreak Probability Map
Dry season 2018
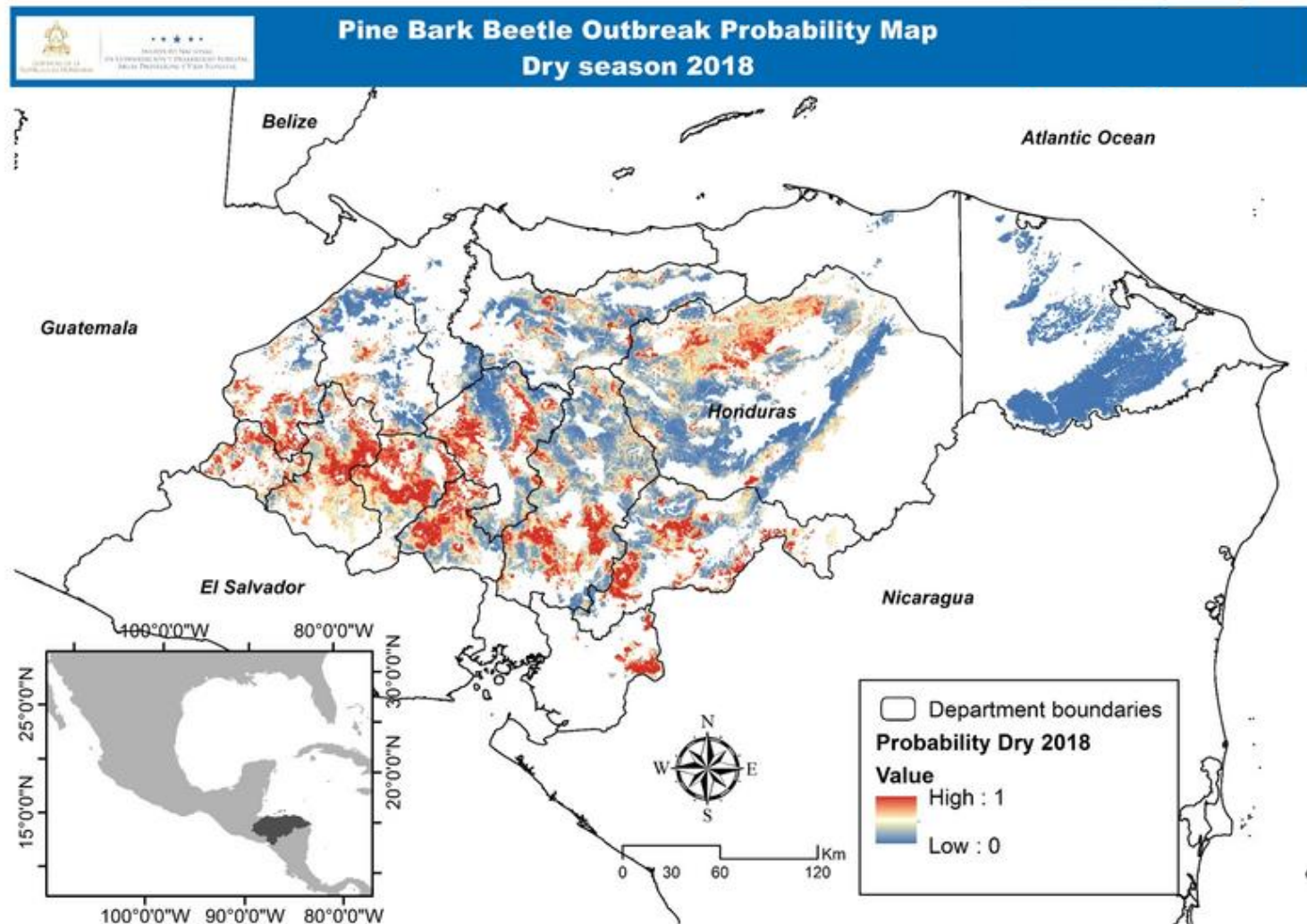
Dry season model. BB outbreak probability for Honduras (2018-2021)

Results

Pine Bark Beetle Outbreak Probability Map
Rainy season 2018
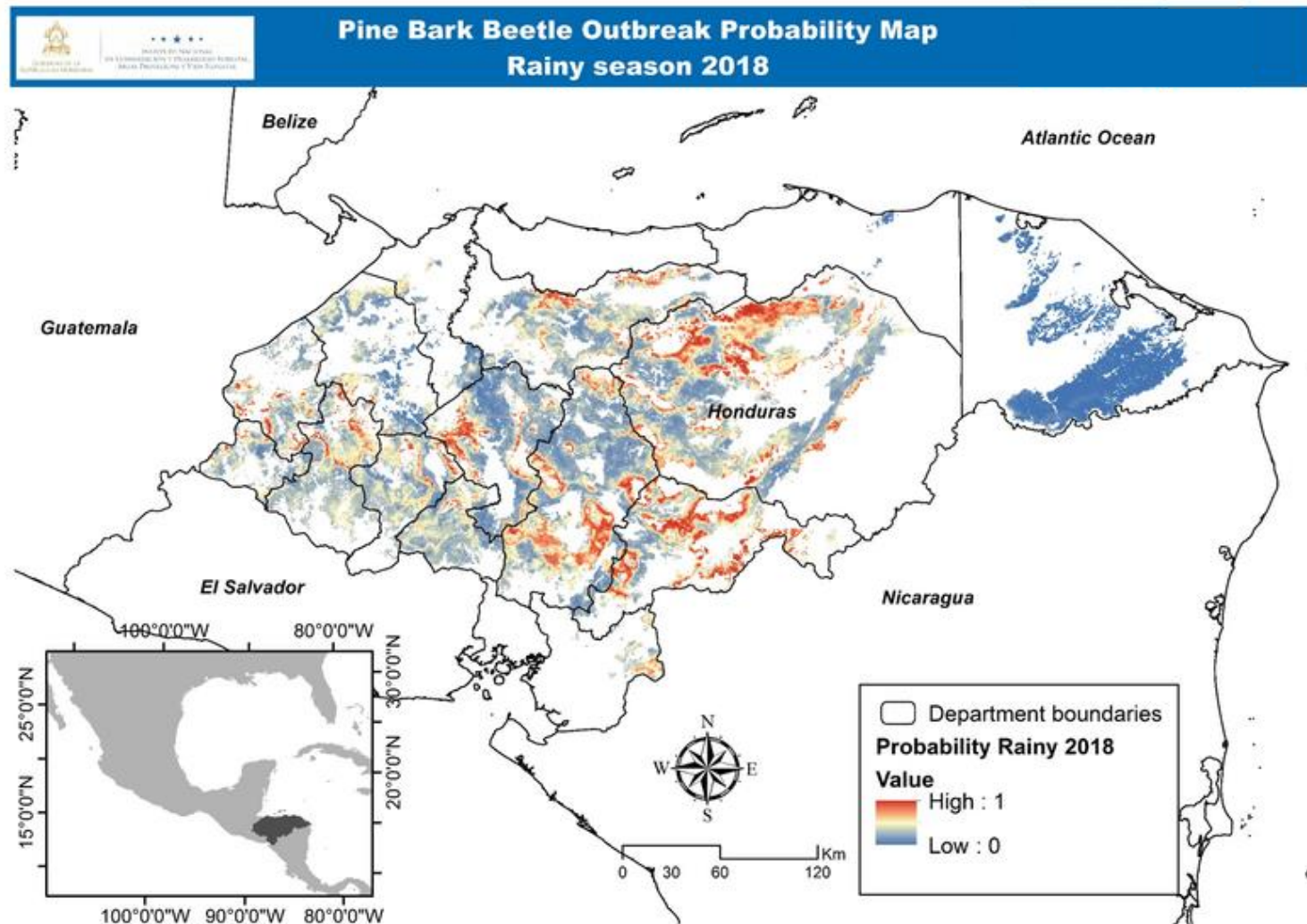
Rainy season model. BB outbreak probability for Honduras (2018-2020)

Thank you!

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A Better World, A Brighter Future