

STDF Standards and Trade Development Facility

GUIDELINES FOR THE IMPLEMENTATION OF THE SPECIFIC PHYTOSANITARY SURVEILLANCE SYSTEM CASE STUDY Xanthomonas OTYZAE DV. OTYZAE Inter-American Institute for Cooperation on Agriculture (IICA), 2018



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Maria de Lourdes Fonalleras, Florencia Sanz y José Manuel Galarza, have defined the original structure of this Guide.

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### Xanthomonas oryzae pv. oryzae

### 1. PURPOSE

Detection surveillance of *Xanthomonas oryzae pv. oryzae* in rice production and host weeds in the COSAVE region.

## 2. SCOPE

COSAVE region, considering pest records and suitable environmental conditions for the pest.

### **3. TARGET PEST**

Xanthomonas oryzae pv. oryzae, see the pest datasheet in Annex 1.

### 4. DURATION AND APPROPRIATE TIMING

The duration is one (1) growing season, during the active growing stage of the crop, with a weekly frequency between surveys.

## 5. SITE SELECTION

For the area or site selection process, the following information is required in advance:

- Cadastral map of the region
- Hydrography and geographical characteristics (forests, mountains, lakes, rivers, deserts) in the location
- Risk map for the region
- Area and production of the crop at the political and administrative level as detailed as possible
- International transport routes

## Xanthomonas oryzae pv. oryzae

#### 5.1. Environmental modeling for the development of risk maps for the region

The environmental niche modeling is commonly used to develop probabilistic maps of species distribution. Among the available modeling techniques, MaxEnt has become one of the most popular tools for modeling species distribution, with hundreds of peer-reviewed articles published each year. The popularity of MaxEnt is mainly due to the short running time, easy operation, small sample size, high simulation precision, the use of a graphical interface and automatic parameter configuration capacities (Morales et. al, 2017; Costa P., Holtz V. 2011; Wang R. et al. 2018).

Risk maps for the target pest can be managed for the risk characterization and the regional prioritization of surveillance activities. In this study case, we use the MaxEnt model, to identify the environmental risk for Xanthomonas oryzae pv. oryzae with worldwide locations that report the pest and their correlation with the bioclimatic variables from the Worldclim database

(http://www.worldclim.org/). The details of the method appear in Annex 2 and the resulting regional environmental risk map in Figure 1. The areas in red and yellow mean higher and medium risk respectively, light blue means lower estimated risk. The risk estimation is based on MaxEnt results and the comparison of the presence of the pest and the bioclimatic variables where the pest is reported.

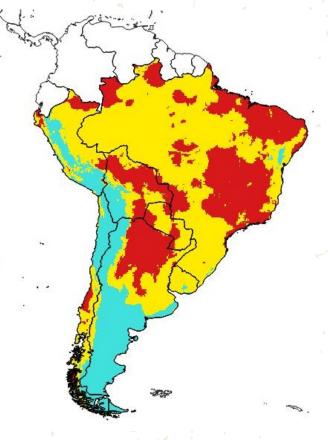


Fig. 1. Environmental risk map of Xanthomonas oryzae pv. oryzae for the COSAVE region. Higher risk in red, medium risk in yellow and lower risk in light blue. Scale 1:45,000,000. Source: Prepared for STDF/PG/502 COSAVE Project.

### Xanthomonas oryzae pv. oryzae

#### 5.2. Host area in the region

Xanthomonas oryzae pv. oryzae hosts belong to the genus Oryza as well as wild species from the Poaceae and Cyperacea family, as described in the datasheet (Annex 1). Rice production is economically important in the region. It accounts for about 214,570 hectares in Argentina; 181,497 in Bolivia; 2,162,178 in Brazil; 20,937 in Chile; 167,088 in Peru; 131,740 in Paraguay, and 164,400 hectares in Uruguay. Based on rice production information at a first administrative-geopolitical level in each COSAVE country, it is possible to develop a host risk map. As Fig. 2 illustrates, the NPPO can determine the levels as high, medium and low based on the importance of production in each identified administrativegeopolitical level. The method for its preparation is discussed in Annex 2.

Fig. 2. Host risk map—rice in the COSAVE region. High risk in red, medium risk in yellow and low risk in light blue. Scale 1:45,000,000. Source: Prepared for STDF/PG/502 COSAVE Project.

# 5.3. Regional risk for xanthomonas oryzae pv. oryzae

It is possible to integrate the environmental and host risk maps in one regional risk map, as is illustrated in Fig. 3. The method is presented in Annex 2 and is based on the reclassification of highrisk category with a value of two (2), medium with one (1) and low with zero (0); and the use of the raster mathematical multiplication function of a geographic information system like QGIS. The method for its preparation is described in Annex 2.

Fig. 3. Regional risk map of Xanthomonas oryzae pv. oryzae for COSAVE. High risk in red, medium risk in yellow and low risk in light blue. Scale 1:45,000,000. Source: Prepared for STDF/PG/502 COSAVE Project.

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## Xanthomonas oryzae pv. oryzae

#### 5.4. Selected sites for the surveillance

Considering pest reports, it is necessary to identify the potential considerations for the entry of the pest. In this regard, it is important to identify the main transporting routes and the main rivers that can spread the pest with rice seeds, as well as nearby places of production.

It is possible to integrate the regional risk of the pest and the location of routes and rivers consolidated by the Consejo Suramericano de Infraestructura y Planeamiento (COSIPLAN) (Available at:

http://www.sig.cosiplan.unasursg.org/node/15, on January 5, 2018). For a better management of field actions, the NPPO can identify squares (grids), with the appropriate size to describe a uniform population for the sampling, as shown in Fig. 4 and 5, with 100 km grids. The method for preparation is also described in Annex 2.

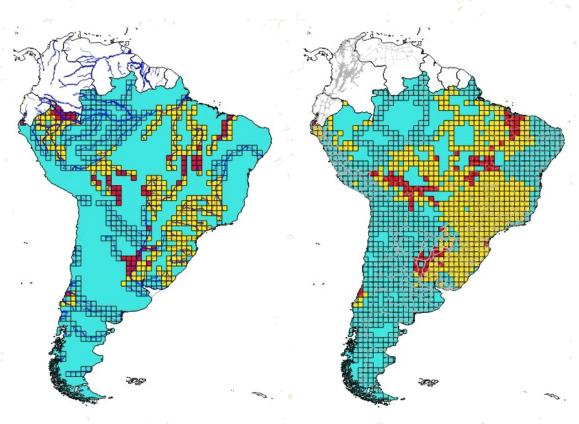


Fig. 4. 100 km squares used for the integration of main rivers location and the regional risk information of the pest (high risk in red, medium risk in yellow and low risk in light blue. Scale 1:45,000,000. Source: Prepared for STDF/PG/502 COSAVE Project. Fig. 5. 100 km squares used for the integration of main routes location and regional pest risk information (high risk in red, medium risk in yellow and low risk in light blue. Scale 1:45,000,000. Source: Prepared for STDF/PG/502 COSAVE Project.

### Xanthomonas oryzae pv. oryzae

The NPPO can identify risk squares (grids) with a code and review it with additional information and then identify the appropriate place for the surveillance.

In addition, with the rivers and transport routes information, the NPPO can identify the high-risk squares (grids). The number of squares (grids) separated by risk category is presented in table 1 and 2. This identification should be complemented with additional information from the NPPO.

# Table 1. Number of squares (grids) in major rivers by Xanthomonas oryzae pv. oryzae risk level.

COUNTRY	HIGH	MEDIUM	LOW	TOTAL
ARGENTINA	13	16	84	113
BOLIVIA	12	20	19	51
BRASIL	22	196	131	349
CHILE	1	3	23	27
PERÚ	11	37	28	76
PARAGUAY	1	3	14	18
URUGUAY		10	11	21
	60	285	310	655

Source: Prepared for STDF/PG/502 COSAVE Project.

Table 2. Number of squares (grids) in major routes by Xanthomonas oryzae pv. oryzae risk level.

COUNTRY	HIGH	MEDIUM	LOW	TOTAL
ARGENTINA	15	17	242	274
BOLIVIA	23	24	32	79
BRASIL	38	383	224	645
CHILE	2	4	75	81
PERÚ	3	18	76	97
PARAGUAY	2	9	14	25
URUGUAY	1	11	14	26
	84	466	677	1227

Source: Prepared for STDF/PG/502 COSAVE Project.

This information is available to open with the QGIS, downloading the complete folder "Qxoo" from the link: https://goo.gl/WYFe6a

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## Xanthomonas oryzae pv. oryzae

## 6. PLANNING

#### 6.1. Preliminary activities

For a better operational organization, it is necessary to recognize the national characteristics of the risk, places and supplies for surveillance implementation. This allows the NPPO to evaluate, manage and systematize the activity. In this regard, it is important to include the following:

- The annual operating plan with the inclusion of the budget, geographical distribution, task schedule and the implementation time.
- Coordination with the diagnostic laboratory, including the protocol and the number of samples to be submitted.
- Cadastral map of the region.
- Hydrography and geographical characteristics (forests, mountains, lakes, rivers or deserts) in the location.
- Hosts area and production at the administrative-geopolitical level as detailed as possible.
- Phenology of the involved hosts.
- Location of rice seedbeds, collection and storage centers, and risk areas.
- International transport routes.
- Collate pest information in a datasheet like Annex 1.
- Manage permissions to enter private property in advance.
- Ensure the required supplies and resources for the surveillance.
- Training for directly involved staff.

### Xanthomonas oryzae pv. oryzae

#### 6.2. Surveillance methodology

The visual inspection or survey can be an effective surveillance method when the characteristics or symptoms of the pest enable identification, which can be confirmed with the laboratory diagnosis. Moreover, it is important to consider:

- The surveillance of *Xanthomonas oryzae pv. oryzae* is performed with the visual inspection or survey in production locations, tissue sampling and pest isolation.
- The number of inspections or surveys can follow the recommendations of the "Guidelines for the implementation of the specific phytosanitary surveillance system".
- Identification of the varieties and other pest susceptible species.
- Ecological conditions that encourage the presence of the pest.
- Rice seedbeds.

#### 6.2.1. Required supplies

- Disposable cloths and gloves.
- Field knife for the sampling.
- Alcohol burner.
- Alcohol 70% for hand disinfection.
- Bleach 10% for sample collection.
- Identification labels.
- Plastic and paper bags for sampling.
- Entomological clamps.
- Writing pads.
- Pencil.
- Dishcloth for tool cleaning.
- Devices to capture geo-referenced field data.
- Templates for data collection.

#### 6.2.2. Sample collection and submission

In case that the visual survey (inspection) can identify Xanthomonas, it is necessary to confirm its identification safeguarding its integrity and submitting the sample to the laboratory. This official diagnosis requires prior coordination of the number of the samples that can be identified.

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#### 6.3. Recording surveillance activities

In order to collate and implement automated reports, the activities of the information record for the Surveillance System should be performed in a standardized and integrated manner. In this regard, we present a general template for the identification of the required information to record *Xanthomonas oryzae pv. oryzae* surveillance activities.

	CO	JNTRY A	ND ACTIVITY	PLA	CE	HOST AN	D RESULT	S		INCIDEN	ICE AN	ID SEVE	ERITY	
Item	País	Fecha (dd/mm/aaaa)	Actividad de Vigilancia Inspección, muestreo, trampeo, otro (especificar)	Coordenadas geográficas decimales: LATITUD	Coordenadas geográficas decimales: LONGITUD	Hospedante (Citrus sinensis, Citrus reticulata, Citrus unshiu, Citrus aurantifolia, Oryza sativa, otro	Tipo de Predio (Comercial, vivero, traspatio, aislado, otro(especificar)	Resultado (Ausente o Presente)	Incidencia encontrada	Descripción de la incidencia evaluada(% u otro(especificar)	Severidad encontrada	Severidad (Grados u otro (especificar)	Observación	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1														
2														
3														
4														
5														
6														
7														
8														
9														4
10														
11														
12														

Fig. 6. General template to record Xanthomonas oryzae pv. oryzae surveillance activities. Source: Prepared for STDF/PG/502 COSAVE Project.

In addition, this general template should have modeled fields in order to avoid mistakes in recording information and the use of computing platforms. For example, Open Data Kit is capable of collecting geo-referenced information with Android devices. The details, templates and explanations for its use are available in the ODK folder in the link: https://goo.gl/WYFe6a.

#### 6.4. Biosafety

To achieve biosecurity in surveillance actions, it is necessary to include:

- The use of new disposable cloths during the entry to each surveillance site.
- The handling of plants or samples should be done with gloves to avoid contaminating nearby locations.
- Surveillance waste should be kept in properly closed plastic bags.
- Any waste material should follow NPPO waste recommendations.
- Hand disinfection with approved supplies is required after each activity.

### Xanthomonas oryzae pv. oryzae

## 7. COMMUNICATION

It is important to produce reports with the results of the various level of decision making.

### 8. AUDIT

Through the central coordination, each NPPO will perform auditing activities at any stage of the process, analyzing the data in the system, and monitoring the quality of the field tasks performance, among others.

### 9. **REFERENCES**

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http://www.bioversityinternational.org/e-library/publications/detail/manual-decapacitacion-en-analisis-espacial-de-diversidad-y-distribucion-de-plantas/

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Wang R, Li Q, He S, Liu Y, Wang M, Jiang G. 2018. Modeling and mapping the current and future distribution of Pseudomonas syringae pv. actinidiae under climate change in China. PLoS ONE 13(2): e0192153. Available on February 26, 2018, at: https://doi.org/10.1371/journal.pone.0192153

## 10. ANNEXES

Annex 1. Data sheet of the pest Annex 2. Modeling for xanthomonas oryzae pv. oryzae

## Xanthomonas oryzae pv. oryzae

#### ANNEX 1

DATA SHEET OF THE PEST

### Xanthomonas oryzae pv. oryzae (Ishiyama 1922) Swings et al. 1990

#### Synonyms:

Bacterium oryzae (Uyeda & Ishiyama) Nak., 1928; Phytomonas oryzae (Ishiyama) Magrou 1937; Pseudomonas oryzae Ishiyama; Xanthomonas campestris pv. oryzae (Ishiyama 1922) Dye 1978; Xanthomonas itoana (Tachinai) Dowson; Xanthomonas kresek Schure 1953; Xanthomonas oryzae (Ishiyama 1922) Swings et al. 1990; Xanthomonas translucens f. sp. oryzae Jones et al; Dowson; Ishiyama; Pordesimo.

#### Taxonomic rank:

Phylum: Proteobacteria Class: Bacteria Order: Xanthomodales Family: Xanthomonadaceae Genus: Xanthomonas Species: *Xanthomonas oryzae pv. oryzae* (Ishiyama 1922) Swings et al. 1990

#### Common names:

Enfermedad bacteriana de las hojas del arroz (spanish); maladie bactérienne des feuilles du riz (french); bacterial leaf blight of rice; kresek disease; rice bacterial leaf blight; rice kresek disease (english).

#### Hosts:

Cenchrus ciliaris, Cynodon dactylon, Cyperus difformis, Cyperus rotundus, Echinochloa crus-galli, Leersia hexandra, Leersia oryzoides, Leptochloa chinensis, Megathyrsus maximus, Oryza spp., Oryza longistaminata, Oryza sativa, Paspalum scrobiculatum, Urochloa mutica, Zizania aquatica, Zizania palustris, Zoysia japonica (CABI, 2017).

#### Geographic distribution:

America: Mexico, United States, Costa Rica, El Salvador, Honduras, Nicaragua, Panama, Colombia, Ecuador, Venezuela (CABI, 2017).
Asia: Pakistan, Philippines, Sri Lanka, Taiwan, Vietnam (CABI, 2017).
Africa: Burkina Faso, Cameron, Egypt, Gabon, Gambia, Madagascar, Mali, Niger, Nigeria, Tanzania, Togo (CABI, 2017).
Europe: Russia (CABI, 2017).

Oceania: Australia (restricted) (CABI, 2017).

## Xanthomonas oryzae pv. oryzae

#### **Biology**:

Xanthomonas oryzae pv. oryzae survives during the off-season in seed, weed hosts, rice volunteers and infected rice straw and stubble. The evidence for significant seed transmission is contradictory. Survival in soil is limited to a few months at the most in relatively cool, moist conditions (the bacterium dies rapidly in hot, dry conditions) and is thus of little significance in single-crop rice systems. Transmission in irrigation water and floodwater is important during the cropping period, but survival in water is limited to a few days (CABI, 2017).

The bacterium invades rice plants through hydathodes on leaves, root-growth cracks and wounds. Seedling roots are wounded when pulled from the seedbed; and leaf tips are often cut before transplanting. When inside the plant, the bacterium enters the vascular system in which it spreads. Bacteria eventually ooze out of water pores on hydathodes (CABI, 2017).

#### Signs and symptoms:

The symptoms known as 'kresek' (wilting, desiccation of leaves and death, characteristic of systemic infection) occur with particular combinations of virulent isolates and susceptible cultivars, probably when the vascular system is blocked by bacterial cells and extracellular polysaccharide. Kresek is associated with tropical storms which spread the pathogen and also wound rice plants. High temperature (30°C) and humidity favor the disease (CABI, 2017).



Fig. 7. Symptoms of *Xanthomonas oryzae pv. oryzae* due to artificial inoculation (Source: Purdue University, 2017).

Symptoms appear on leaves of young plants, after planting out, as pale-green to grey-green, water-soaked streaks near the leaf tip and margins. These lesions coalesce and become yellowish-white with wavy edges. The whole leaf may eventually be affected, becoming whitish or greyish and then dying. Leaf sheaths and culms of more susceptible cultivars may be attacked. Systemic infection, known as kresek, results in wilting, desiccation of leaves and death, particularly of young transplanted plants. In older plants, the leaves become yellow and then die. In later stages, the disease may be difficult to distinguish from bacterial leaf streak (X. oryzae pv. oryzicola) (CABI, 2017).

## Xanthomonas oryzae pv. oryzae

#### Entry pathway:

The bacteria can only move short distances in infected crops. The bacteria can only move long distances in infected rice seeds. The bacteria are usually found in the glumes, but may also penetrate the endosperm (EPPO, 2003).



#### Survey (inspection) and detection:

Symptoms appear on leaves of young plants, after planting out, as pale-green to grey-green, water-soaked streaks near the leaf tip and margins. These lesions coalesce and become yellowishwhite with wavy edges. The whole leaf may eventually be affected, becoming whitish or greyish and then dying.

Fig. 8. Infected rice seedlings. Infected leaves wilt and roll up, turning grayish-green to yellow, until the whole seedling dies. Plants which have survived the disease are stunted and yellowish (Picture from EPPO, 2017).

Leaf sheaths and culms of more susceptible cultivars may be attacked. Systemic infection, known as kresek, results in wilting, desiccation of leaves and death, particularly of young transplanted plants. In older plants, the leaves become yellow and then die. In later stages, the disease may be difficult to distinguish from X. oryzae pv. oryzicola (CABI, 2017).

#### Pest impact:

Bacterial leaf blight is the most serious disease of rice in South-East Asia, particularly since the widespread cultivation of dwarf high-yielding cultivars (EPPO, 2003). In Japan, where figures are available, up to 400,000 ha may be affected annually, with losses of 20-30% and up to 50%. In Africa, losses of 2.7-41% in grain yield have been found (CABI, 2017).

In the Philippines, losses are estimated at 22.5% (in wet seasons) and 7.2% (in dry seasons) in susceptible varieties and 9.5 and 1.8%, respectively, in resistant crops (EPPO, 2003).

#### Pest control and mitigation measures:

Preventive phytosanitary control measures include:

- Use of healthy and treated seeds.
- Resistant varieties.
- Careful attention to crop management (for example, water control, avoidance of damage to seedlings) is very important.
- Restricting nitrogen fertilizer applications to about 80-100 kg N/ha.
- Chemical control is not recommended (CABI, 2017).

Xanthomonas oryzae pv. oryzae

#### **ANNEX 2**

### Modeling for Xanthomonas oryzae pv. oryzae

#### A. Data:

This section will discuss the origin and type of data used in the case studies. All the working files, software, references, and other data are available in the link: https://goo.gl/WYFe6a.

#### A1. Environmental raster data ("\*.tif")

For geo-referenced climate data, go to http://www.worldclim.org/ and then click on Version 2 (http://worldclim.org/version2) for updated climate data.

#### WorldClim

WorldClim is a set of global climate layers (gridded climate data) with a spatial data can be used for mapping and spatial modeling.

The new Version 2.0 is now available (current climate only --- more coming s

The old version is **Version 1.4**. For this version you can get data for past, current and future climates. 
 Below you can download the standard (19) WorldClim Bioclimatic variables for WorldClim version 2.

 They are the average for the years 1970-2000. Each download is a "zip" file containing 19 GeoTiff (.tif) files, one for each month of the variables.

 variable
 10 minutes
 5 minutes
 2.5 minutes
 30 seconds

 Bioclimatic variables
 25 minutes
 30 seconds
 30 seconds

Fig. 9. Link to Version 2 of the web page: http://www.wordclim.org.

Fig. 10. Download the 10 minutes data.

**NOTE:** The folder with this data is named "WC10y1990tiff" and is located in the link: https://goo.gl/WYFe6a.

**NOTE**: The bioclimatic variables are: BIO1 = Annual Mean Temperature, BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp)), BIO3 = Isothermality (BIO2/BIO7) (\* 100), BIO4 = Temperature Seasonality (standard deviation \*100), BIO5 = Max Temperature of Warmest Month, BIO6 = Min Temperature of Coldest Month, BIO7 = Temperature Annual Range (BIO5-BIO6), BIO8 = Mean Temperature of Wettest Quarter, BIO9 = Mean Temperature of Driest Quarter, BIO10 = Mean Temperature of Warmest Quarter, BIO11 = Mean Temperature of Coldest Quarter, BIO12 = Annual Precipitation, BIO13 = Precipitation of Wettest Month, BIO14 = Precipitation of Driest Month, BIO15 = Precipitation Seasonality (Coefficient of Variation), BIO16 = Precipitation of Wettest Quarter, BIO17 = Precipitation of Driest Quarter, BIO18 = Precipitation of Warmest Quarter, BIO19 = Precipitation of Coldest Quarter, BIO18 = Precipitation of Warmest

**NOTE**: In the link to Version 1.4, we share access to the projected future data for 2050 and 2070, under four (4) scenarios called RCP ("Representative Concentration Pathways").

## Xanthomonas oryzae pv. oryzae

#### A2. Vector data ("\*.shp")

The Consejo Suramericano de Infraestructura y Planeamiento (COSIPLAN) collated cartographic information about the following layers in the region:

Border control (CSP\_AH070\_N), Populated center (CSP\_AL105\_N), Railway Line (CSP\_AN010\_L), Railway station (CSP\_AN070\_N), Main road (CSP\_AP030\_L), Port (CSP\_BB005\_N), Lake (CSP\_BH080\_P), River (CSP\_BH140\_L, CSP\_BH140\_P), Administrative border (CSP\_FA000\_L), (CSP\_FA001\_L, CSP\_FA001\_P), 3er level administrative zone (CSP\_FA002\_P), Border crossing (CSP\_FA125\_N), Airport (CSP\_GB001\_N), and others.

This information is packed in a zip file, available on October 27, 2017 in the link http://www.sig.cosiplan.unasursg.org/node/15, unzip and save the file in a separated folder like DATA in the link: https://goo.gl/WYFe6a.

	)17 ▶ Data ▶ Herramientas Ayu	da			
rganizar 🔻 👔 Abrir	,		carpeta		
🔶 Favoritos	Nombre	*	Fecha de modifica	. Tipo	Tamaño
\rm Descargas	CSPAdmN	1	07/06/2017 11:39 a	Archivo WinRAR Z	59,958 KB
Escritorio	CSPAdmN	21	07/06/2017 11:39 a	Archivo WinRAR Z	70,820 KB
🔛 Sitios recientes	CSPAdmN	2р	07/06/2017 11:47 a	Archivo WinRAR Z	76,863 KB
😌 Dropbox	CSPAdmN	3	07/06/2017 02:12	Archivo WinRAR Z	195,754 KB
👠 Google Drive	CSPa	Abrir	.1:34 a	Archivo WinRAR Z	34 KB
🔤 Box Sync	🔚 CSPa 🔚	Extraer ficheros	.2:52	Archivo WinRAR Z	67,790 KB
MEGAsync	CSPo 🚍	Extraer aquí	.2:02	Archivo WinRAR Z	30 KB
laneDrive	CSPf 🧱	Extraer en CSPAdmN3\	.2:31	Archivo WinRAR Z	139 KB
	Sec. Sel	V LEADOR	2:36	Archivo WinRAR 7	92 551 KB

Figura 11. Descargar las capas vectoriales y descomprimirlas haciendo un clic con el botón izquierdo del mouse.

A3. Geo-referenced data of pests (use of geographic coordinates as an example)

In the CABI Invasive Species Compendium webpage, refer to: *Xanthomonas oryzae pv. oryzae* or go to the link: http://www.cabi.org/isc/datasheet/56956

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## Xanthomonas oryzae pv. oryzae

Go to the lower part of the world distribution map and to the link "Download CSV file" or "Comma separated values" that can be opened with Microsoft Excel.



Fig. 12. Download the CSV ("Comma separated values") files.

	A	В	С	[
1	species	Longitude	Latitude	
2	Xoryzaeoryza	93	10	
3	Xoryzaeoryza	79	16	
4	Xoryzaeoryza	117	32	
5	Xoryzaeoryza	93	26	
6	Xoryzaeoryza	134	-20	
7	Xoryzaeoryza	90	24	
8	Xoryzaeoryza	2.25	9.5	
9	Xoryzaeoryza	85.75	25.75	

Fig. 13. Delete the data with the "Absend" or "Restricted distribution" pest situation and arrange the elements as is shown.

Open the data in Microsoft Excel, delete the reports of the pest with the situation label as "Absent" or "Restricted distribution" and include first the column species, then longitude and after latitude. Delete the other columns.

Double-check the existence of the species column first, then the longitude and latitude columns respectively and save it as "Xoo.csv" ("Comma separated value"). This data is available in the "cXanthomonasoryzaoryzae" folder in the link: https://goo.gl/WYFe6a.

## Xanthomonas oryzae pv. oryzae

#### **B. Software:**

#### B1. QGIS

QGIS (previously called Quantum GIS) is an open source Geographic Information System (GIS) for the GNU/Linux, Unix, Mac OS and Microsoft platforms, it supports many formats and functions for shapefiles, raster files and databases. In addition, it has defined extensions

(http://plugins.qgis.org/plugins/) that make it one of the best of its kind and is in continuous development.

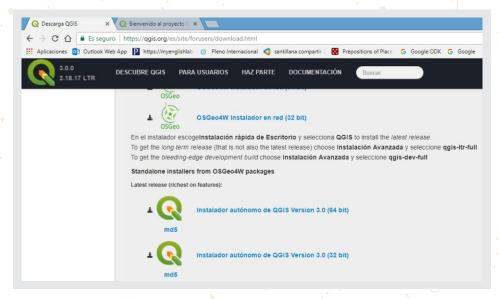


Fig. 14. Webpage to download QGIS 3.0.0 "Girona". Available on February 23, 2018 in: https://www.qgis.org/es/site/forusers/download.htmlNote. We reco

**NOTE:** We recommend reading and practicing with the training manual of the software. This is available on January 19, 2018, at: https://www.qgis.org/en/site/forusers/index.html#download and tutorial videos available on the Internet.

#### B2. MaxEnt

**B2.1.** Installing Java, if not already installed To verify if Java is installed on your computer, go to the link: https://www.java.com/es/download/installed.jsp with Internet Explorer

To install Java in Internet Explorer, go to the link: http://www.java.com/es/download/help/ie\_online\_install.xml

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To install Java in Mozilla Firefox, go to the link: http://www.java.com/en/download/help/firefox\_online\_install.xml

NOTE: Java is not supported in Google Chrome

B.2.2. Installing MaxEnt

The MaxEnt software is available on January 19, 2018, at: https://biodiversityinformatics.amnh.org/open\_source/maxent/ (with small letters and a lower hyphen between open and source).

ook Web App 📳 https://mysenglishido. 🕐 Fleno Internacional 🤷 santillane companie : 🐻 Prepositions of Flace	🕢 https://biodiversityinformatics.amh.org/open_source/maxent/   Outlook Web App 👔 https://nyenglishib (): Piero Internacional 🙆 sentiliena.comparte 2: 😸 Prepositions of Piece
Main changes in Version 3.4.1    Main changes in Version 3.4.0  Main changes in Version 3.4.0  Main changes are not lemme <sup>44</sup> Trinstolet durates are not lemme <sup>44</sup>	Main changes in Version 3.4.1 • Minor bug fires to the 3.4.0 wiense Main changes in Version 3.4.0 • Relaxed under a MIT learner • Therebrid features on one thread of by defeat
A A doglog transform has been added and new constitutes the default transformation for model output (tormerly the logistic transform)     Download	<ul> <li>A cloging transform has been added and now constitutes the default transformation for model output (tomerly the logistic transform)</li> <li>Download</li> </ul>
Current version 3.4.1 Pixese hal us a title about yourself! Name Institution Email Common thereaded Use* *Optional Subret	Current version 3.4.1  Devoked Maret  Citation  Provise the application for analyses that result in a publication, report, or online posting, the following represents a proper classo the software better  Server J. Philips, Morolaw Dudk, Robert E. Schapre [Internal] Maret software for modeling species incless and distributions (Version 3.4.1. Available form u: High/Iso/Version/shr/maret/linearet software for modeling species incless and distributions (Version 3.4.1. Available form u: High/Iso/Version/shr/maret/linearet software for modeling species incless and distributions (Version 3.4.1. Available form u: High/Iso/Version/shr/maret/linearet software for modeling species incless and distributions (Version 3.4.1. Available form u: High/Iso/Version Server for the moless maret application)

Fig. 15. Link to download MaxEnt software and optional requirement of user personal data.

Fig. 16. Download Version 3.4.1. and the cited reference of the MaxEnt software.

#### C. Activities

C1. Opening a shapefile (or vector layer) and converting the raster data files ("\*.tiff" to "\*.asc") for the use of MaxEnt software in the modeling.

C1.1. Opening a shapefile in QGIS:

A shapefile has (at least) three files with the same name but with a different extension. The file with the SHP ("\*.shp") extension is the main file and includes spatial features.

Open the QGIS with the short option: add vector layer (left margin) or the "Layer" tab, as shown in the below figure:

## Xanthomonas oryzae pv. oryzae

Project Edit View	Layer Settings Plugins Vector Raster	Database Web MMQGIS SCP	Processing
n 📂 🖩 🔜	Create Layer	·	A1 100
	Add Layer	🕐 🗸 Add Vector Layer.	Ctrl+Shift+
W. / B 16	Embed Layers and Groups	Add Raster Layer	Ctrl+Shift-
ana <mark>ng</mark> ananan	Add from Layer Definition File	Add PostGIS Layers	Ctrl+Shift-
V. 💭 🖕	Copy style	Add SpatiaLite Layer	Ctrl+Shift+
R. PO	Paste style	Add MSSQL Spatial Layer	Ctrl+Shift+
9	Open Attribute Table	Q. Add Oracle Spatial Layer	Ctrl+Shift-
	/ Toggle Editing	Add WMS/WMTS Laver	Ctrl+Shift+
Po	B Save Layer Edits	Add WCS Laver	
JPR 1	// Current Edits	Add WFS Layer	
9	Save As	2. Add Delimited Text Laver	
	Save As Layer Definition File		
	Remove Layer/Group Ctrl+D		
•	Duplicate Layer(s)		
ND	Set Scale Visibility of Layer(s)		

Source ty	pe		
• File	O Directory	O Database	O Protoco
Encoding	System		
Source			
		2017\Data\CSPAdmN1\CSP	

Fig. 17. Search for the DATA folder and unzip \*.shp files.

Fig. 18. Locate the shapefile (\*.shp) and click on "Open".

In the "Project" tab in QGIS, select "Save as" to save the project.

**NOTE**: Check the right lower edge for the CRS "Coordinate Reference System" in World Geodetic System 1984 - WGS84 with the code: 4326, recommended because is a world-standardized system.

#### C.1.2. Converting raster data ("\*.tif" to "\*.asc"):

A raster is a set of pixels with the same size; each pixel has a different value for a variable (including temperature, type of soil). The size of the pixel is called "resolution", and its selection depends on the geographical scope and the objective of the project. To open the raster file, choose the "Add Raster Layer" option on the left side, as shown in the figure below. Locate, select and open files like "bio10m01.tif" from the "WC10y1990tiff" file.

	of geographic units rounded (in km)
Degrees	Size
1 degree	111 km
10 minutes	18 km
5 minutes	9 km
2.5 minutes	5 km
30 seconds	1 km

Fig. 19. Correspondencia aproximada entre grados y kilómetros en el Ecuador (de: Sheldeman X. & van Zonneveld M. 2011).

## Xanthomonas oryzae pv. oryzae

Project Edit View	Layer Settings Plugins Vector Raster	Database Web MMQGIS SCP	Processing Help		
) 🖿 🗖 🐻	Create Layer		An 🐖 🚓		
	Add Layer	V <sub>a</sub> Add Vector Layer	Ctrl+Shift+V		
i 🛝 🥖 📑 Va	Embed Layers and Groups	Add Raster Laye	Ctrl+Shift+R		
nana nananana	Add from Layer Definition File	Read Add PostGIS Layers	Ctrl+Shift+D		
Va 🔬 💿 🍸	Copy style	Add SpatiaLite Layer	Ctrl+Shift+L		
	Paste style	Add MSSQL Spatial Layer	Ctrl+Shift+M		
Q	Open Attribute Table	Add Oracle Spatial Layer	Ctrl+Shift+O		
	🥖 Toggle Editing	Add WMS/WMTS Layer	Ctrl+Shift+W		

Fig. 20. Command to open raster ("\*.tif") files, indicated with the red arrows in the Layer/Add layer/Add Raster Layer tab.

For the conversion, select the "Raster/Conversion/Translate" option, as shown in Fig. 20, in the box "Input Layer" select each file "\*.tif" and in the box "Output file" the location of the "\*.asc" files in a folder like WC10y1990asc (not the WC10y1990tiff folder) and select the Spatial Reference System (SRS) EPSG:4326, as illustrated in Fig. 22.

🗖 🖥 🖓 🖓 🕅 🖓 🌮 🌶	Raster Calculator	A 2 👶 🗈 🖉 🖨			
	Heatmap MOLUSCE	🗏 🖾 Σ 🚔 🖓 😘	Batch mode (	(for processing whole directory)	
	Projections +		Input Layer	bio10m01 💌	Select
XCSP FA000 L	Extraction + Analysis +	Rasterize (Vector to Raster) Polygonize (Raster to Vector) Translate (Convert Format)	Output file	C10y1990asc/bio10m01.asc	Select
-51.615 28.5646	Miscellaneous GdalTools Settings	RGB to PCT	X Target SRS	EPSG:4326	Select

Fig. 21. Command "Translate" to convert raster "\*.tif" files to "\*.asc".

Fig. 22. Details of the conversion, specifying the "\*.asc" extension.

Double check extension "\*.asc" in the output file and the selection of the Spatial Reference System.

Repeat the same procedure with the 19 layer of the bioclimatic variables downloaded in the section A1, which are available in the link: https://goo.gl/WYFe6a and the WC10y1990tiff folder.

**NOTE:** The raster "\*.asc" files are also available in the WC10y1990asc folder in the link: https://goo.gl/WYFe6a.

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#### C2. Using MaxEnt for the modeling.

To open the MaxEnt software, click on the "maxent.jar" file. Then open the "Settings" option, select "Basic" and include the standard option and the box "Random test percentage" write 25 for an additional software test with 25% of the samples. Then close the window.

Basic Advanced Experimen	Ital	Samples			ironmental layers	
		File plo/cBactroceradorsalis/Bdorsalis.csv		Directory/File iaEne2017\Tal	llerJun2017/WC10y1990asc	Browse
				✓ bio10m09	Continuous	-
Random seed				✓ bio10m10	Continuous	-
Give visual warnings				✓ bio10m11	Continuous	-
Show tooltips				✓ bio10m12	Continuous	-
Ask before overwriting				✓ bio10m13	Continuous	-
Skip if output exists		Bdorsalis		⊯ bio10m14	Continuous	•
Remove duplicate presence re	cords			✓ bio10m15 ✓ bio10m16	Continuous	-
				bio10m17	Continuous	
Write clamp grid when projecti				bio10m18	Continuous	- -
Do MESS analysis when project						
andom test percentage	25			Select all	Deselect a	ll
egularization multiplier	1	✓ Linear features			Create respons	se curves
ax number of background points	10000	✓ Quadratic features			Make pictures of pr	
eplicates	1	Product features		Do jack	knife to measure variable in Output format	
eplicated run type	Crossvalidate	Threshold features			Output format Lo	-
est sample file	Browse	✓ Hinge features	Output director	y hts\COSAVE2017\GuiaEne		Browse
		Auto features	Projection layer	s directory/file		Browse
		Run		Settings	Help	

Fig. 23. In "Settings" and "Basic", include the standard options, as illustrated here.

Fig. 24. Main screen where geo-referenced data and bioclimatic variables are included in "\*.asc" format.

In the main screen, in the samples option, select the "\*.csv" ("Comma separated values" not "\*.xls") file with the geo-referenced pest data. This was discussed in section A3.

Next, select "Auto features", "Create response curves", "Make pictures of predictions", "Do jackknife to measure variable importance", "Logistic format" and "asc file type", and select a folder for the output of the files, thus ordering a complete modeling, with figures like "Do jackknife" that visually describe the contribution of each bioclimatic variable to the final model. In the other part with the environmental layers option, choose the folder with the converted variables to the "\*. asc" format, i.e. a raster file like the one described in section A1.

For practical purposes, record warning messages like "Unused field" or "Missing environmental data" and click "Ok".

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Unused field in Bdorsa	alis.csv Suppress similar visual warnings	Sample at -24.0, 16.0 in Bdorsalis.csv	is missing some environmental data (e.g. bio10m01) Suppress similar visual warnings

Fig. 25. Record messages like: "Unused field" o "Missing environmental data".

Fig. 26. After checking the repetition of messages, you can select the "Suppress similar visual warnings" option.

The results of the environmental modeling are available in the Xoryzaeoryzae.html file, which can be opened with any web browser. The raster file of the map is available in the Xoryzaeoryzae.asc file, as illustrated in the figure below.

Nombre	Fecha de modifica	Tipo
plots	17/06/2017 04:06	Carpeta de a
maxent.log	17/06/2017 04:06	Documento
a maxentResults.csv	17/06/2017 04:06	Archivo de v
Xoryzaeoryzae.asc	17/06/2017 03:52	Archivo ASC
Xoryzaeoryzae.asc.aux.xml	19/06/2017 06:55 a	Archivo XM
Xoryzaeoryzae.html	17/06/2017 04:06	Archivo HT
Xoryzaeoryzae.lambdas	17/06/2017 03:52	Archivo LAN
Xoryzaeoryzae_explain.bat	17/06/2017 03:52	Archivo por
Xoryzaeoryzae_omission.csv	17/06/2017 03:52	Archivo de v
Xoryzaeoryzae_sampleAverages.csv	17/06/2017 03:52	Archivo de v
Xoryzaeoryzae samplePredictions.csv	17/06/2017 03:52	Archivo de v

dorsalis	Abrir	-	Arc	hivo ASC	17,521 KB
dorsalis	Editar		Arc	hivo HTML	15 KB
dorsalis			Arc	hivo LAMBDAS	4 KB
dorsalis, 🥗	SkyDrive Pro		Arc	hivo por lotes	1 KB
dorsalis, 🗸			Arc	hivo de valores	30 KB
dorsalis			Arc	hivo de valores	1 KB
dorsalis 🔐	Edit with Notepad++		Arc	hivo de valores	7 KB
lorsalis	Abrir con	,		Bloc de notas	
lorsalis	Compartir con	,	G	Google Chrome	
axent.le axentRe	Analizar ficheros seleccionados con Avira		0	Internet Explorer	
	Añadir al archivo			Elegir programa p	redeterminado
3	Añadir a "Bdorcalic rar"		-	3131	

Fig. 27. File with the results of the MaxEnt modeling.

Fig. 28. Opening the "\*.html" file with the modeling. The "\*.asc" file is a raster, as those described in section A1.

C3. Open a map in geographical coordinates, creating a 100 km reference grid, and a centroid in each grid.

Develop a grid with a reference size of 100 Km or 0.9 decimal degrees, based on the equivalences of grades and kilometers from Sheldeman X. & van Zonneveld M. 2011, shown in the Fig. 19.

First, open a shape vector layer from COSIPLAN (http://www.sig.cosiplan.unasursg.org/node/15).

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Proyecto     Edición     Ver     Capa     Configuración     Complementos     V       Image:	- • 💌
Añadir capa Empotrar capas y grupos Añadir desde archivo de definición de Copiar estilo Pegar estilo	Caja de herramientas de Procesos 🔊
Fig. 29. Open a reference vector layer with the "*.shp" extension.	Fig. 30. Find the "Create Grid" function in the "Processin toolbox" (see the note below) and click it.

**NOTE**: If the Processing toolbox is not available, please select it in tab "View", "Panels" and then "Processing toolbox".

In the "Grid type" choose the "Rectangle (polygon)" option in the "Grid extent" choose "select extent on canvas" dragging the mouse on the map to create the grid. Complete "Vertical spacing" and "Horizontal spacing" with the 0.9 data. Check that EPSG 4326 – WGS84 is in "Grid CRS" and provide a route to save the grid file. Finally, click on "Run in Background" as illustrated in the figure below.

arámetros Registro		WCS	
Tipo de cuadrícula		- W WFS	Establecer SRC del proyecto a partir de ca
Rectángulo (poligono)	-		
Extensión de la cuadrícula (xmín, xmáx, ymín, ymáx)		. WMS	Estilos
-88.08651942288299,-31.18663140496588,-59.17389879569798,4.6491695	13372563 [EP5G:4326]		Abrir tabla de atributos
Espaciado horizontal			Abili tabia de atilbutos
0,900000	(3) \$		🥖 Conmutar edición
Espaciado vertical			Construction
0,900000	61 \$		Guardar como
Superposición horizontal	2010		Guardar como archivo de definición de car
0,000000	\$		Filtrar
Superposición vertical			Filtrar
0,000000 Grid CRS	\$		
EPSG:4326 - WGS 84	- 💿	Panel de capas	
Diadricula	- 102	🎝 🔻 🖧 💌 🏨 🎸	Propiedades
C:/Users/Jose/AppData/Roaming/QGIS/QGIS3/profiles/default/processing/outp	uts/100kgrid.shp		Cambiar nombre
Abrir el archivo de salida después de ejecutar el algoritmo		Cuadrícula	
Abrir el archivo de salca despues de ejecutar el agonimo		-X AmericaGrd21ut	tm
		- X CSP_FA002_P	
	0% Cancelar		
Run as Batch Process	Run in Background Close Help		

Fig. 31. Details included in the "Create grid" function. Fig. 32. This is the grid file in the "Layers" panel. To make it transparent, select "Properties" with the right button.

**NOTE:** If the Processing toolbox is not available, please select it in tab "View", "Panels" and then "Processing toolbox".

In the "Layers" panel, you can change the grid file appearance and its location in the map with a right click on its name. To make it transparent, select "Options", "Style", "Single symbol", "Fill", "Simple fill", and in "Fill style" select "No Brush". Front or background movement on the map is commanded with a change in file position in the "Layers" panel.

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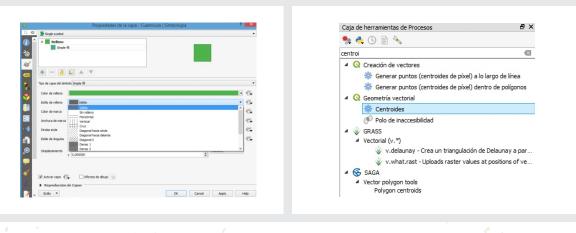


Fig. 33. To make the grid transparent, select "Single symbol", "Fill Style", then "No brush".

Fig. 34. To obtain centroids in each grid, look for the "Centroids" function ("Vector geometry" set) in "Processing Toolbox".

**NOTE:** If the Processing toolbox is not available, please select it in tab "View", "Panels" and then "Processing toolbox".

Using this vector "\*.shp" file of centroids, you can extract values from the modeling.

		Centroides de polígonos	
Parámetros	Registro	Ejecutar como proceso por lotes	Polygon centroids
apa de entr	ada		This algorithm creates a new point layer, with
100Kgrid (EF	'SG:4326]	• 🦻	points representing the centroid of polygons of an input layer.
entroides			The attributes associated to each point in the output layer are the same ones associated to the
/Users/Jose	/Contacts/Documents/COSAVE2017	(GuiaEne 2017/Taller Jun 2017/Proce 7/100KgridCentro 1. shp	original polygon.
		0%	
			Run Cerrar



Fig. 35. Details in of the use of the "Centroids" function ("Vector geometry").

Fig. 36. Results of the "Centroids" functions.

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#### C4. Integrating information with QGIS

**C4.1.** Development a vector shapefile with the crop production information in the geo administrative geopolitical units of each co Develop a vector shapefile with crop production information in the administrative geopolitical units of each country:

First, open the file for the second level administrative geopolitical unit "CSP\_FA001\_P.shp" downloaded in section A2. Then with the right click on the file, select "Open attribute table" and "Toggle edition tool" by clicking on the pencil in the top left corner of the screen.

1	N H C 15			8 10 a 1		-				
٢.	N 10 0 10		10 % T #	* P   0	10 10 16					
	IDUSCO	ACC	NAM	RFC	230	277	ACC_LBL	RPC_LEL	397 J.B.	Ces
1	1601300008.00		1 Montevideo	2	Departamento	11	Execte	Definitio	LIRCY	Oficial - Validada
2	16013000001.00		1 Artiges	2	Departamento	11	Diacta	Definido	URY	Oficial - Validada
5	16013000002.00		1 Carelones	2	Departamento	11	Execta	Definido	URY	Offical - validada
•	16013000003.00		1 Cens Largo	2	Departamento	11	Execta	Definido	UKY	Ofical - Validada
5	16013000004.00		1 Coloria	2	Departamento	11	Exacta	Definido	URY	Oficial - Validada
6	16013000005.00		1 Durame	2	Departamento	11	Exacta	Definido	URY	Official - Validada
,	16013000006-00		1 Rores	2	Departamento	11	Execta	Definido	URY	Offical - validada
	39011000007/00		1 Plonde	2	Departamento	11	Execta	Definido	URY	Oficial - Validada
,	1601200008.00		1 Lavalisja	2	Departamento	11	Ducta	Definido	URY	Oficial - Validada
20	16013000009.00.		1 Neldonado	2	Departamento	11	Exacta	Definido	URY	Oficial - Validada
11	16013000010-00		1 Paysandu	2	Departamento	11	Execte	Definido	URY	Official - validada
12	16013000011.00		1 Rehegro	2	Departamento	11	Exacta	Definido	LIKY	Official - Validada
13	16013000012.00		1 Rhena	2	Departamento	11	Execta	Definido	URY	Oficial - Validada
14	16013000013-00		1 Radie	2	Departamento	11	Exacta	Definido	URY	Oficial - Validada
15	16013000014-00		1 Saho	2	Departamento	11	Execta	Definido	URY	Official - validada
26	16013000015.00.		1 San Jose	2	Departamento	11	Exacta	Definido	URY	Oficial - Validada
17	16013000018.00		1 Soriene	2	Departamento		Exects	Definido	URY	Oficial - Validada
13	36011000017.00		1 Tacuarenbo	2	Departamento	11	Exacta	Definido	URY	Ofical - Validada
19	16013000018-00		1 Trenta r Tres	2	Departamento	11	Exacta	Definido	URY	Offical - validada
20	1600 3000020.00		1 Contentes	2	Provincia	1	Execta	Definido	ARG	Oficial - Validada
21	1600 2000021.00		1 Chaop	2	Provincia	1	Exects	Definido	ARG	Oficial - Validada

Q					
/	2 6 2 6	â 🗧 🧧	S 💊 🍸 🗷	🏘 🏳 🚳 🕻	2
Co	onmutar el modo edición	(Ctrl+E)	NAM	RPC	T
1	16011000000.00	1	Montevideo	2	2
2	16011000001.00	1	Artigas	2	2
3	16011000002.00	1	Canelones	2	2
4	16011000003.00	1	Cerro Largo	2	2

Fig. 37. Open the "CSP\_FA001\_P.shp" shapefile downloaded in section A2 and with a right click on the "Open attribute table" option".

Fig. 38. Select the "Conmutar edición" with the pencil in the top left corner of the screen.

The vector file "CSP\_FA001\_P.shp" can include an additional column, where you can record the host area or a host risk index value like 0, 1 or 2 (2 as the maximum value). The host area can be also a "Whole number (Integer)" having as many digits as the largest production area record. Both files are available in the https://goo.gl/WYFe6a folder.

Ø					CSP_FA00	1_P :: Ob
1	🗾 🕞 🕄 📆	💼 🗧 🧮	S 🔩 🕇 🗷	🏶 🔎 📦 I	8 🚯 🛍	
1.2	IDUSCO 🔻 = E				Campo nuevo	(Ctrl+W)
	IDUSCO	ACC	NAM	RPC	ZJD	ZPF
1	16011000001.00	1	Artigas	2	Departamento	

Nombre	HospIndice
Comentario	
Тіро	Número entero (entero)
Tipo de proveede	or integer
Longitud	1

Fig. 39. With the "New field" option you can include a column with the host area or a host risk index 0, 1 or 2; where 2 is the maximum value.

Fig. 40. Select the name, the "Whole number (Integer)" type, the "Length" of 1 and a click "Ok".

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#### C4.2. Converting a vector shapefile in a raster.

In order to integrate the host risk index, first convert the vector "\*.shp" file to raster with a function in the tap "Raster", "Conversions" and then "Rasterize (vector to raster)". To do this, use the column with the host risk index for the value of the raster. The illustration of this function is shown in the figure below.

For a better view of model raster values, with a right click on the layer, open the "Properties" then "Style", "Singleband pseudocolor" with the "Spectral" option. Include the modification of the label as HIGH, MEDIUM or LOW, as illustrated in the figure below.

Archivo de entrada (archivo shape)	COSAVECitrus	Seleccionar
Campo de atributos	RiesgoHosp	
rchivo de salida para los vectoriales rasterizados (ráster)	17/Proce7/SupCitriRast11.tif	Seleccionar
Mantener el tamaño y resolución del ráster existente Tamaño del ráster en píxeles		
Anchura 3000	Altura 3000	
Horizontal 1.00000000	Vertical 1.00000000	×
Cargar en la vista del mapa cuando se termine		
dal_rasterize -a RiesgoHosp -l COSAVECitrus ::/Users/Jose/Contacts/Documents/COSAVE2017/GuiaEne :/COSAVECitrus.shp	2017/Taller Jun 2017/DataSHP/Su 2017/Taller Jun 2017/Proce7/Sup(	6

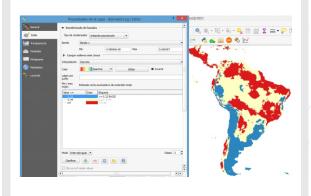


Fig. 41. With the "Rasterize" function, convert the "CSP\_FA001\_P.shp" file using the host risk index as a value.

Fig. 42. For a better presentation of the bioclimatic risk model, change the properties with a right click on the layer.

C4.3. Reclassifying the raster of the model for its integration.

Similarly to the host risk index, index 0, 1 or 2 is required in the environmental modeling. For this purpose, use the "Reclassify values (simple)" function from SAGA (System for Automated Geoscientific Analysis) in the "Processing toolbox" on the right side of QGIS. In the function, select the "Fixed Table 3x3" option with the values 0, 1 or 2. These details are illustrated in the figures below.

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	🤾 Reclassify values (simple) ? 🛛 🗙	ø	reclass	Tabla fija		? ×
Caja de herramientas de procesado	Parámetros Registro Ejecutar como proceso por lotes					-
edass 🚳	Grid		Low Value	High Value	Replace	Añadir fila
Algoritmos usados recientemente v.reclass - Crea una capa de mapa nueva cuyos valores de categoría están ba	Bdorsals Log [EPSG:4326]	1 0		0,22	0	Eliminar fila(s)
Vordenes de GRASS GIS 7 [314 geoalgoritmos]     Ráster (r.*)	Replace Condition	2 0.	22	0.44	1	Eliminar todos
Raster (r. ^) r.reclass - Crea una capa de mapa nueva cuyos valores de categoría está	[2] Low value <= grid value < high value	3 0.	44	0.7	2	
	Lookup Table				-	Aceptar
v.redass.area.lesser - Reclasifica una capa raster, seleccionando áreas me	Fixed table 3x3					Cancelar
v.reclass - Cambia valores de categoría vectorial para un mapa vectorial e	Changed Grid					
SAGA (2.1.2) [235 geoalgoritmos]     Raster analysis	[Guardar en archivo temporal]					
Kaster anayses     Gol texture dassification     Reater tools     Gedestry values	X Abrir el archivo de salida después de ejecutar el algoritmo					
Reclassify values (simple)     Terrain Analysis - Morphometry						
Curvature classification					• •	

Fig. 43. Location of the "Reclassify values (simple)" function in SAGA.

Fig. 44. Details of the "Reclassify values" function and the "Fix table 3x3".

Moreover, it is possible to integrate the environmental risk with the host risk index or others with the "Raster calculator" function, which develops math between raster layers. With this tool, you can also integrate information on land cover or Normalized Vegetation Index (NDVI), which are raster files too. When raster layers are multiplied, the grids with a lower value are integrated with the zero (0) value, while higher categories are integrated with maximum values, as shown in Table 3.

#### <u>Table 3. Integrating raster files with the reclassification of the value in</u> the grid and the multiplication function in the "Raster calculator".

RASTER INTEGRATION	LOW INDEX B = 0	MEDIUM INDEX B = 1	HIGH INDEX B = 2
LOW INDEX A = 0	LOW = 0	LOW = 0	LOW = 0
MEDIUM INDEX A = 1	LOW = 0	MEDIUM = 1	MEDIUM = 2
HIGH INDEX A = 2	LOW = 0	MEDIUM = 2	HIGH = 4

Source: Prepared for STDF/PG/502 COSAVE Project.

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The figure below illustrates the use and results of the "Raster calculator" function:

Bandas ráste	er			Capa de i	esultado						
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						00000			180.00000	4	
						00 🗘	90.00000				
				Columnas	2160	2160		Filas	1080	\$	
				SRC de salida SRC seleccionado (EPSG:4326, WG					G:4326, WGS 84	- 4	
Operadore	s										
+	•	raíz cuadrada	COS	se	n	tan		log10	(		
	1	<b>^</b>	arcos	arcs	en	arctan		In	)		
-						>=		Y	0		
•	>	-	!=	<:	-	>=					
		=	!=	<:		>=					
Expresión de		ra de campos	!=	<		2=					
Expresión de	la calculador	ra de campos	!=		-	>=					



Fig. 45. Details in the "Raster calculator" function for the integration of raster layers.

Fig. 46. Regional Risk map. Higher risk in red, medium risk in yellow and lower risk in light blue. Scale 1:45,000,000.

C4.4. Obtaining risk values with a vector shapefile

Open the centroid layer developed in section C3 to extract risk values to a vector (point) layer.

To include geographical coordinates, make a right click on the vector file and select "Open attributes table". Then use the "Field calculator" as shown with the red arrow in the figure below and the "Geometry" option selecting \$x for the field "longitude" and \$y for the field "latitude". It is important to check that the format of the field is "Decimal number (real)" and with 5 decimals of precision.

1		8 8 8	🖸 🔩 🝸 🗷	8 P 8	16 16 1	8	
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2	20002000084.00	Internacional Do	Exacta	Internacional	Transporte	En Oper	
3	20002000049.00	Internacional Pre	Exacta	Internacional	Transporte	En Oper	
4	20002000070.00	Internacional Au	Exacta	Internacional	Transporte	En Opera	
5	20002000218.00	Internacional Zu	Exacta	Internacional	Transporte	En Oper	
6	20002000183.00	Presidente Joao	Exacta	Nacional	Transporte	En Oper	

ě	Calcula	dora de campos	?
Actualizar solo 0 objetos i     Crear un campo nuevo     Orear campo virtual		🗌 Actualizar campo	existente
Nombre del campo de salida	xlong	Inusco	
Tipo del campo de salida	Número decimal (real)	•	
Longitud del campo de salida	10 Precisión 5	٢	
Expresión Editor de fu	nciones		
	II ( ) W Buson		[
-+-/-	II ( ) "W" Buscar		función \$x

Fig. 47. With a right click on the vector shapefile, open the "Attributes table" and the "Field calculator", as indicated with the red arrow.

Fig. 48. Create a field called "longitude" as "Decimal number (real) with 5 decimals and the "Geometry" function, then "\$x" and similarly with "\$y" for the "latitude".

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In the "Processing toolbox" on the right side, find the "v.sample" function and obtain raster values from the results of sections C2 or C4.3, as illustrated in the figures below.

Parámetros	Registro	Ayuda	Ejecutar como proceso por lotes.
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iector layer a	stribute colum	to use for comparison	
1D			
Raster map to	o be sampled		
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Sampled rasts	er values will b	multiplied by this factor	
1.000000			÷
Sampling inter	polation meth	4	_
nearest			•
Extensión de	la región de G	ASS GES 7 (xmin, xmáx, ymin, ymáx)	
(Dejar en bla	enco para usa	a extensión de cobertura mínima)	
Paráme	tros avanza	05	
Sampled			
	se/Contacts/D	aments/COSAVE2017/GuiaEne2017/Taller Jun2017/Proce6/AeroRisk8d.sh	hp []
X Abrir el ar	chivo de salid	después de ejecutor el algoritmo	
		0%	
			Bun Cerrar

v (E)
Pessan 2   3   19
) (Presson 2 (g) 🗆 Tr
Classes 3 Advanced

Fig. 49. Sampling risk values with a vector shapefile in a new file "Sampled" in a new route for the file.

Fig. 50. The developed shapefile has points and values that can be graphically shown, changing layer properties.

This layer "Sampled" can be integrated with another vector shapefile, like the 100 km grid that created the centroids. For this, find the "Join attributes by location" function in the "Processing toolbox". Select the "Sampled" layers and the "Grid" shapefile and save it, as illustrated in the figure below.

	Unir atributos por localización	7 🗙
	Parámetros Registro Ejecutar como proceso por lotes	Join attributes by location
Caja de herramientas de procesado	a herramientas de processado    a herramientas de processado     a herramientas de processado     a herramientas de processado     a herramientas de processado     a herramientas de processado     a herramientas de processado     a herramientas de processado      a herramientas de processado      a herramientas de processado      a heramientas de processado      a her	
		version of the input one, with additional attributes
	Unir capa vectorial	
unir 🛛 🛛	Sampled (\$P\$G: 4326) • - 9	
Algoritmos usados recientemente		layer in the resulting one.
🦉 Unir tabla de atributos		
	Predstón	
🖹 🚀 Geoalgoritmos de QGIS [116 geoalgoritmos]	0.00000	
🖃 Herramientas generales vectoriales		
	Estadísticas para resumen (separado por comas) [opcional]	
W V Lloir tabla de atributos		
outos por localización		
	Abriv el archivo de salida después de ejecutar el algoritmo	
	0%	

Fig. 51. Find the "Join attributes by location" function in order to integrate vector shapefiles.

Fig. 52. Select the layers to integrate with the "intercept" option and name this integrated layer.

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This integrated information can be shown in a map, selecting with a right click the "Layer properties", "Style" and "Categorize" in reference to the values of the modeling, as shown in the figures below.

It is also feasible to integrate other geo-referenced information, like the river layer "CSP\_BH140\_L.shp", available in https://goo.gl/WYFe6a using the "Intersection" function in the "Vector" tab and "Geoprocessing tools" group.



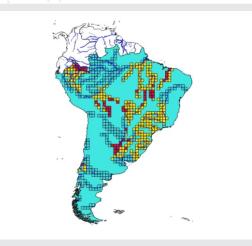


Fig. 53. With the "Layer properties" function you can change the style display of the 100 km grid for risk value (high risk in red, medium risk in yellow and low risk in light blue). Fig. 54. With the tool "Intersection", located in the "Vector" tab, "Geoprocessing tools", you can integrate vector shapefile information from the river layers.

The vector shapefile resulting layer contains origin and modeled risk information. This information can be exported with the right click on the layer, as illustrated in the figures below:

🛛 Zum a la capa	G	ardar capa vectorial como	s 👿
Mostrar en la vista general	File name ents/COSAVE2017/GuaEn		Explorer
Duplicar		1326, WGS 84)	- 👧
Establecer visibilidad de escala de capas Establecer SRC de la capa Establecer SRC del proyecto a partir de capa Estilos			•
Abrir tabla de atributos Conmutar edición	Escala Commetria Tipo de geometria Comme distance	1:5000 Automatic	•
<ul> <li>Mostrar en la vista general</li> <li>Mostrar en la vista general</li> <li>Eliminar</li> <li>Duplicar</li> <li>Establecer visibilidad de escala de capas</li> <li>Establecer SRC de la capa</li> <li>Establecer sRC de l</li></ul>			
Filtrar	Opciones de capa     CREATE_CSVT NO		•
Propiedades Cambiar nombre		Aceptar Cancelar	Ayuda

Fig. 55. To collect the information in another format, you can select the layer with a right click and choose "Save as".

Fig. 56. Save the information in CSV ("Comma separated values") format, which can be opened in Microsoft Excel.

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In Microsoft Excel, the NPPO can assess the risk parameters in based on expert criteria. The figure below provides an example.

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Pe	egar ✓	1	N K	( <u>s</u>	-	- 🖄	-	▲ - = = =	∉≢	🗄 Combinar y centr	ar •	<b>9</b> - 1	% 000	←0 0 00 →	0
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6		2773		0.6394	101	Jujuy		Provincia		Definido	ARG		ALTO		
7		3061		0.6370	)55	Santiago I	Del	Provincia		Definido	ARG		ALTO		
8		2989		0.634	188	Santiago I	Del	Provincia		Definido	ARG		ALTO		
9		2845		0.6293	384	Jujuy		Provincia		Definido	ARG		ALTO		
10		2774		0.627	704	Salta		Provincia		Definido	ARG		ALTO		
11		2702		0.6197	745	Boqueron		Departamento		Información No D	PRY		ALTO		
12		2846		0.6071	173	Chaco		Provincia		Definido	ARG		ALTO		
13		2917				Santiago I		Provincia		Definido	ARG		ALTO		
15		2630				Boqueron		Departamento		Información No D			ALTO		
16		2844				Jujuy		Provincia		Definido	ARG		ALTO		
17		3060				Santiago I	)el			Definido	ARG		ALTO		
18		2701		0.5881	112	Tarija		Departamento		Información No D	BOL		ALTO		

Fig. 57. Raster risk value and the identification ID of each generated grid.

**NOTE:** All this case study information is available in the cXanthomonasoryzaeoryzae folder in the link: https://goo.gl/WYFe6a.

**NOTE:** The QGIS generated map, "Bdorsalis.qgs", is available in the "QBdorsalis" folder in the link: https://goo.gl/WYFe6a. To use it, download the "QBdorsalis" folder containing all the involved layers.



### Xanthomonas oryzae pv. oryzae

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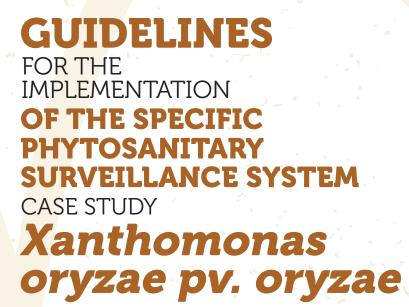
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http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=681 http://download.ceris.purdue.edu/file/3055 http://pest.ceris.purdue.edu/pest.php?code=FBZAXBM







STDF Standards and Trade Development Facility

