The pest risk mapping and monitoring system in Taiwan

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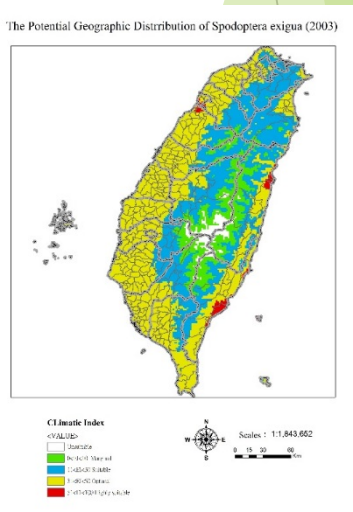


Agriculture Production in Taiwan

crop 42.98 Billion(48.87% Total agricultural production)

Item and percentage	Species or acreage	Acreage/ha. 2015	Total value/2015 Billion, USD
Rice (17%)	1st : 146,597 ha. 2nd : 105,264 ha.	143,881	12.43
Vegetables (27%)	Cabbage, small leafy vegetables, beans, melons, etc.	180,331	10.45
Upland crop(4%)	Peanut, corn, soybean, sweet potato, etc.	53,899	1.87
Mushroom			0.70
Floral crop (7%)		13,174	2.44
Fruits (38%)	Citrus, pear, peach, guava, banana, sugar apple, pineapple, carambola, wax apple, etc.	144,510	14.67
Special	Tea	11,780	0.214
Green manure	Soybean, sesbania, sun hemp, *Vicia villosa*, etc.	97,875	0.27

What is Pest?

Crops need to be protected from a variety of different pests, organisms that present a threat to the crop. While we often think of pests as insects, a pest can also be a weed, a disease or an animal (such as a rat, golden apple snail) or even bacteria.

Domestic pest

Economic importment fruit flies

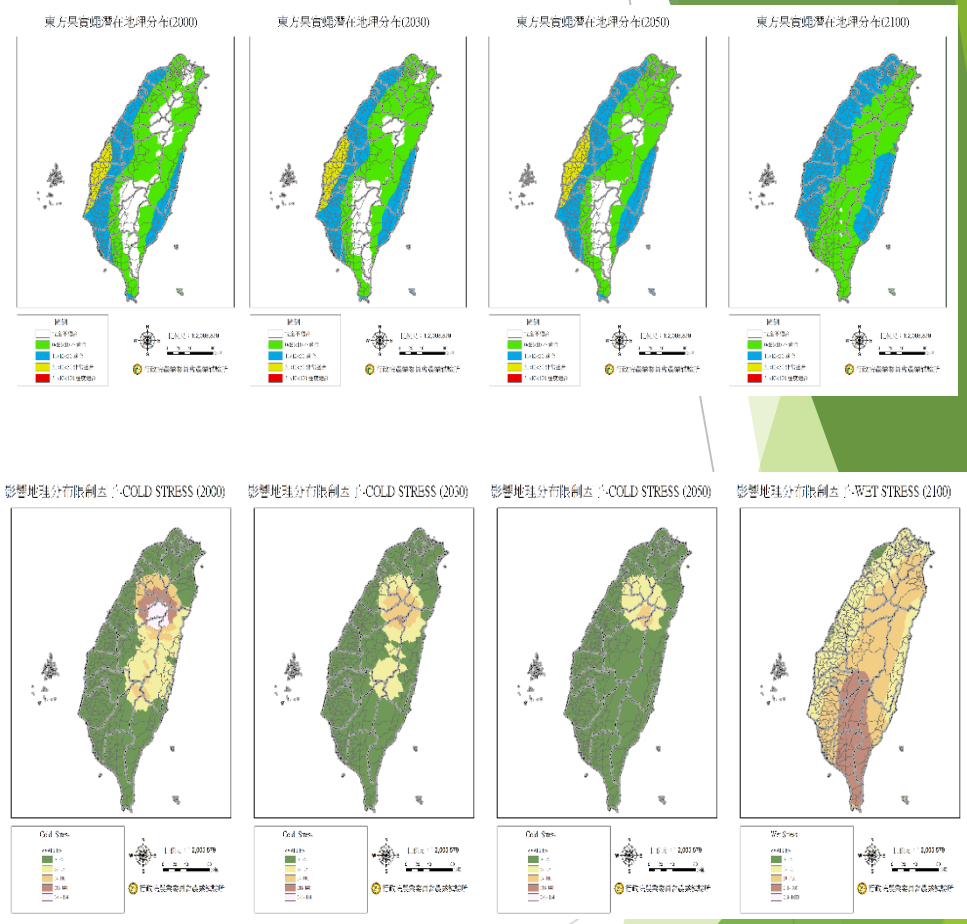
Moths

Invasive pest

(Fruit flies , Thrips,
papaya mealybugs,
lychee stink bugs
red Imported fire ants

When climate change become a major global issue, researchers start to predict the potential distributions of pest and areas which they cause economic damage based on climatic data and biological models of development. Based on the potential geographical distribution of species, ecological niche model was the assumption that the species can occur in a particular area with the appropriate survival environment, climatic factors, distribution and other biological factors.

In recent years, integrating with the application of information management platform, including spatial data, geographic analysis, artificial intelligence applications, data mining, and the development degree-day of organisms model was referred to as CLIMEX (CLIMatic IndEX).

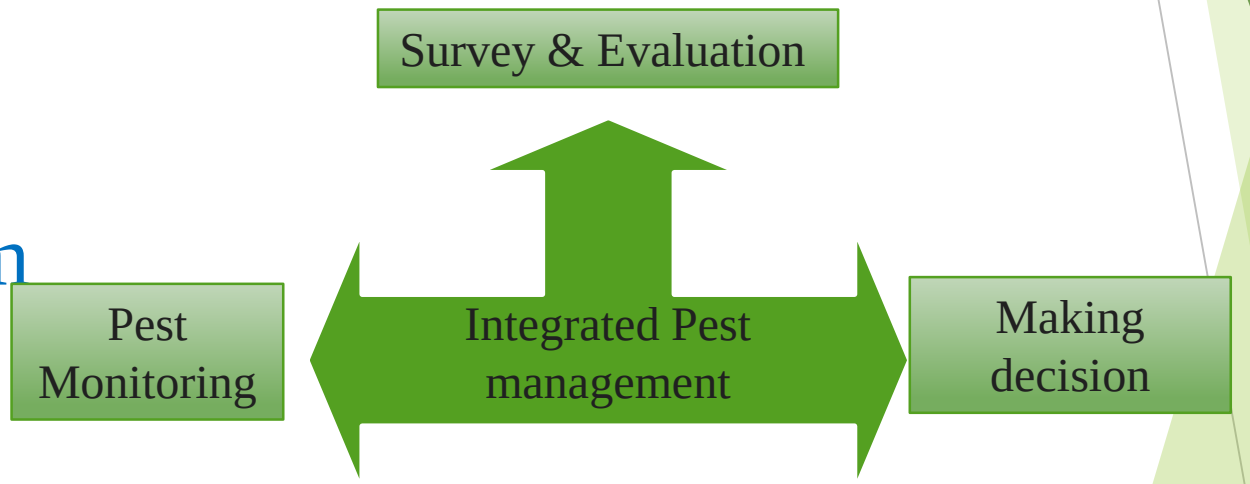


Monitoring system:
pests were established in island

How to set up the pest monitoring system in Taiwan

- Density monitoring for pest control is very important work. Understanding the dynamics of pest population, it will be able to take appropriate preventive measures in time to achieve.
- By using geographic information system(GIS), it monitored the population changes throughout the province, and provided the relevant geographical location of infested areas.
- To establish effective prevention and control timing , the pest outbreak of the monitoring to achieve the desired work.

- **Monitoring and Pest management: Insect attractant application**
  - ✓Oriental fruit fly
  - ✓Melon fly
  - ✓Cotton leaf worm
  - ✓Beat armyworm
  - ✓Tomato moth



Melon fly, Bactrocera cucurbitae

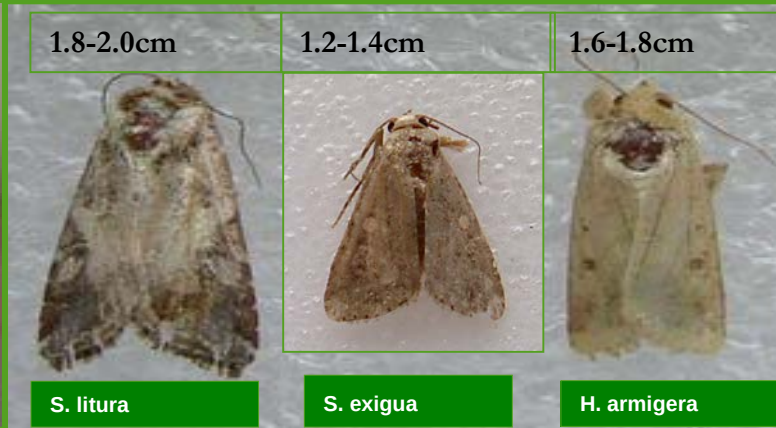
Oriental fruit fly, Bactrocera dorsalis

Three important polyphagus pests in Taiwan

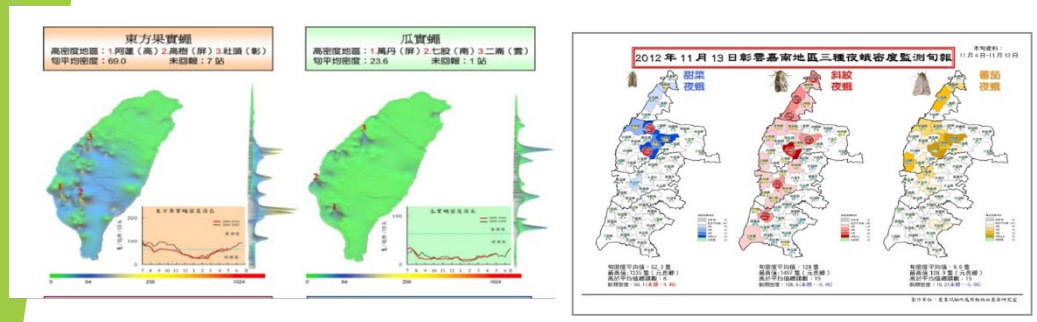
Helicoverpa armigera, tomato moth

S. litura

Sp. exigua, Beet armyworm)



Monitoring System in Taiwan



農試所網頁:http://www.tari.gov.tw/taric/modules/icontent/

- Making Decision
- OPEN DATA
- Push notification service system for farmers by Mobile phone
- Integrated Clime data and Land cover to develop early Warm system

- Long-term monitoring of Oriental fruit fly and Melon fly in the Island Since 2000

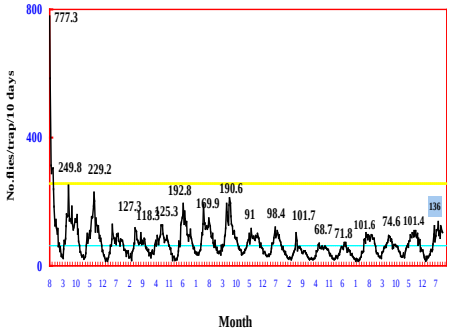
✓Set up 61 stations (549 sites) to Collect the Fruit flies

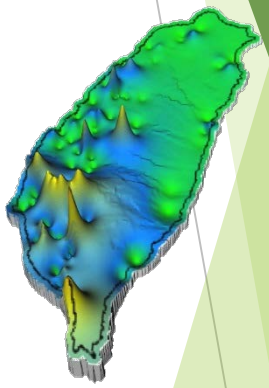
✓Replaced male attractants per 10 day every month.

✓Sent the specimens of fruit flies or mail data to TARI by volunteers.

✓Calculated the numbers of flies and GIS analysis

✓Published newsletter per 10 day

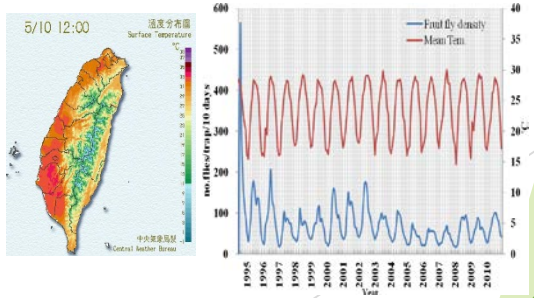




- Southwest region monitoring of 3 moths since 2006 :(*Spodoptera litura* (Fabricius))、(*Spodoptera exigua* (Hubner))and (*Helicoverpa armigera* (Hubner))

✓57 townships, 285 monitoring sites by sex pheromone trap

✓Date : June~November

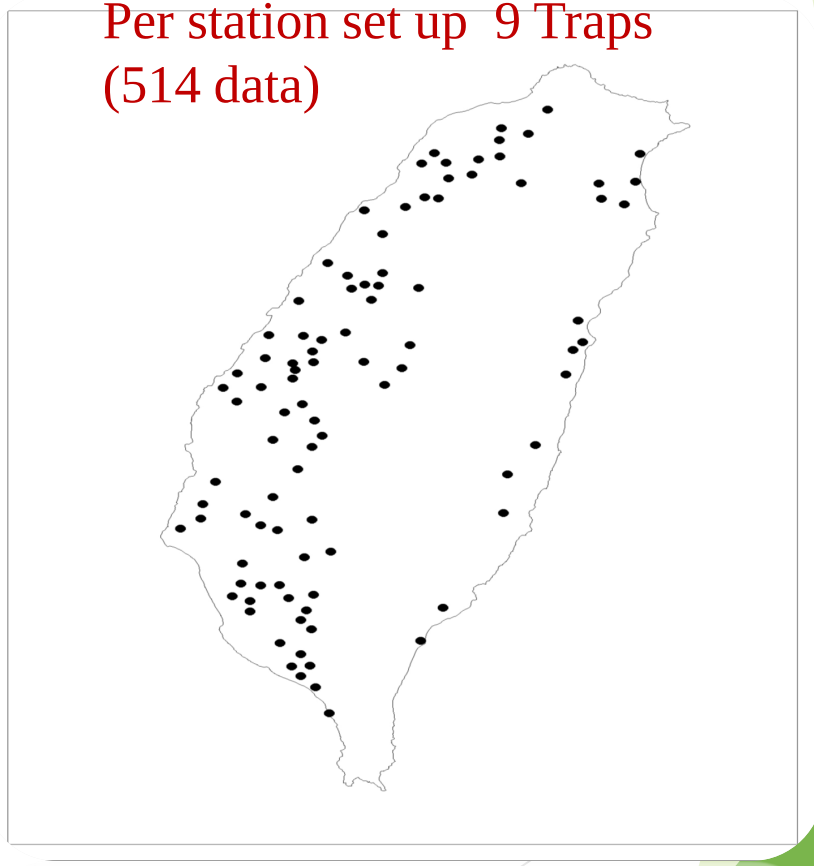


The distribution of Host plant

Monitoring system for Fruit flies in Taiwan

1.Collected Fruit fly Per 10 day ,
Replaced Male attractant per month
2. Volunteer Workers Sent the fruit fly or FAX data to TARI
3.Calculated the flies and GIS analysis
4.Published newsletter per 10day.

61 stations,
Per station set up 9 Traps
(514 data)

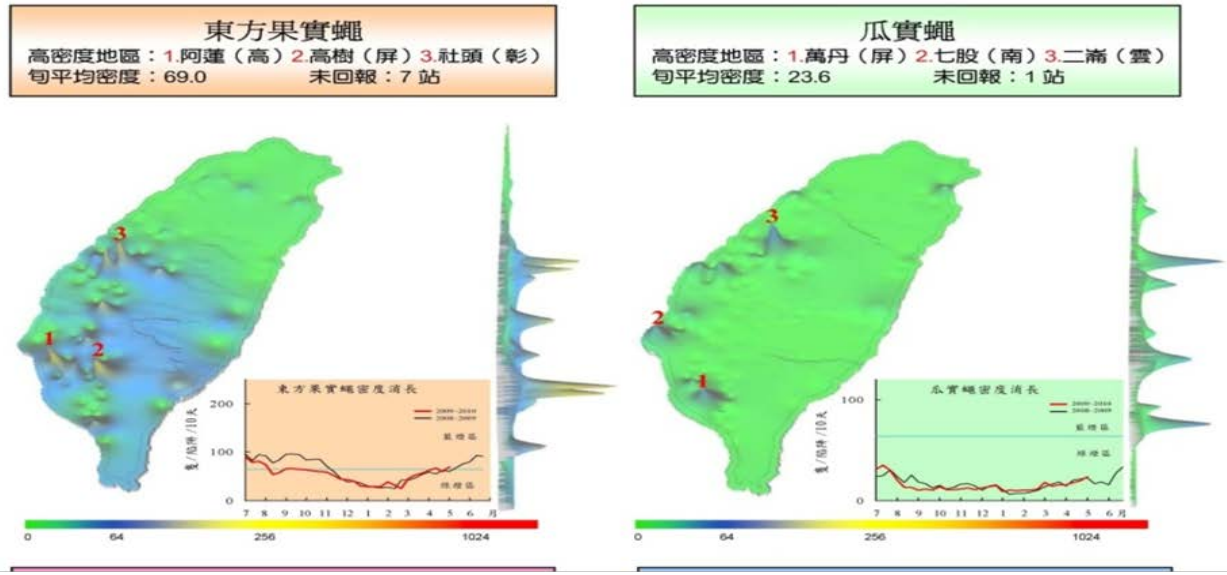


Rank by 4 density index

- 0~64 (flies/trap/10 days)
- 65~256 (flies/trap/10 days)
- 257~1024 (flies/trap/10 days)
- 1025~ (flies/trap /10 days)

(*Bactrocera dorsalis ; Bactrocera cucurbitae*

TARI website



農試所網頁:http://www.tari.gov.tw/taric/modules/icontent/

Release COA open data

http://m.coa.gov.tw/outside/PlantPests/Search.aspx

4 density index **Control measure**

- 0~64 (flies/trap/10 days) Monitoring
- 65~256 (flies/trap/10 days) Mass trapping
- 257~1024 (flies/trap/10 days) MA & Food bait
- 1025~ (flies/trap /10 days) Spay food bait & MA

Established at Monitoring System of Agricultural Pests in Taiwan

By using insect attractant traps to set up monitoring stations at major cultivated horticultural areas in Taiwan , long-term survey the densities of five important pests of the island. The aims are using geographic information system to manage the real time population change of pests.

(Oriental fruit fly)

(Melon fly)

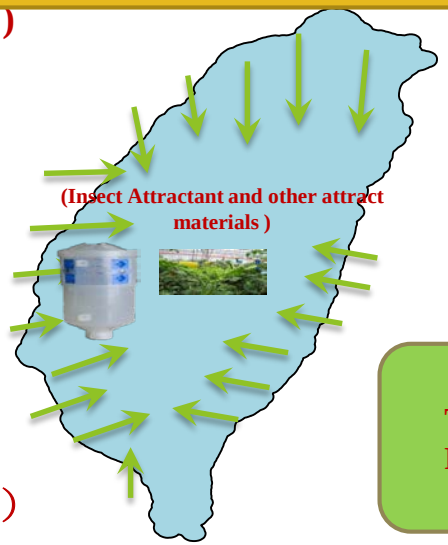
(Armyworm)

(Beet armyworm)

(Tomato fruit worm)

（Thrips)

（Silver leaf white fly）

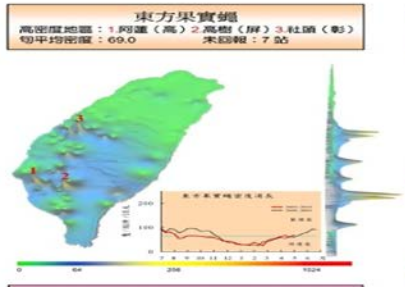


TARI

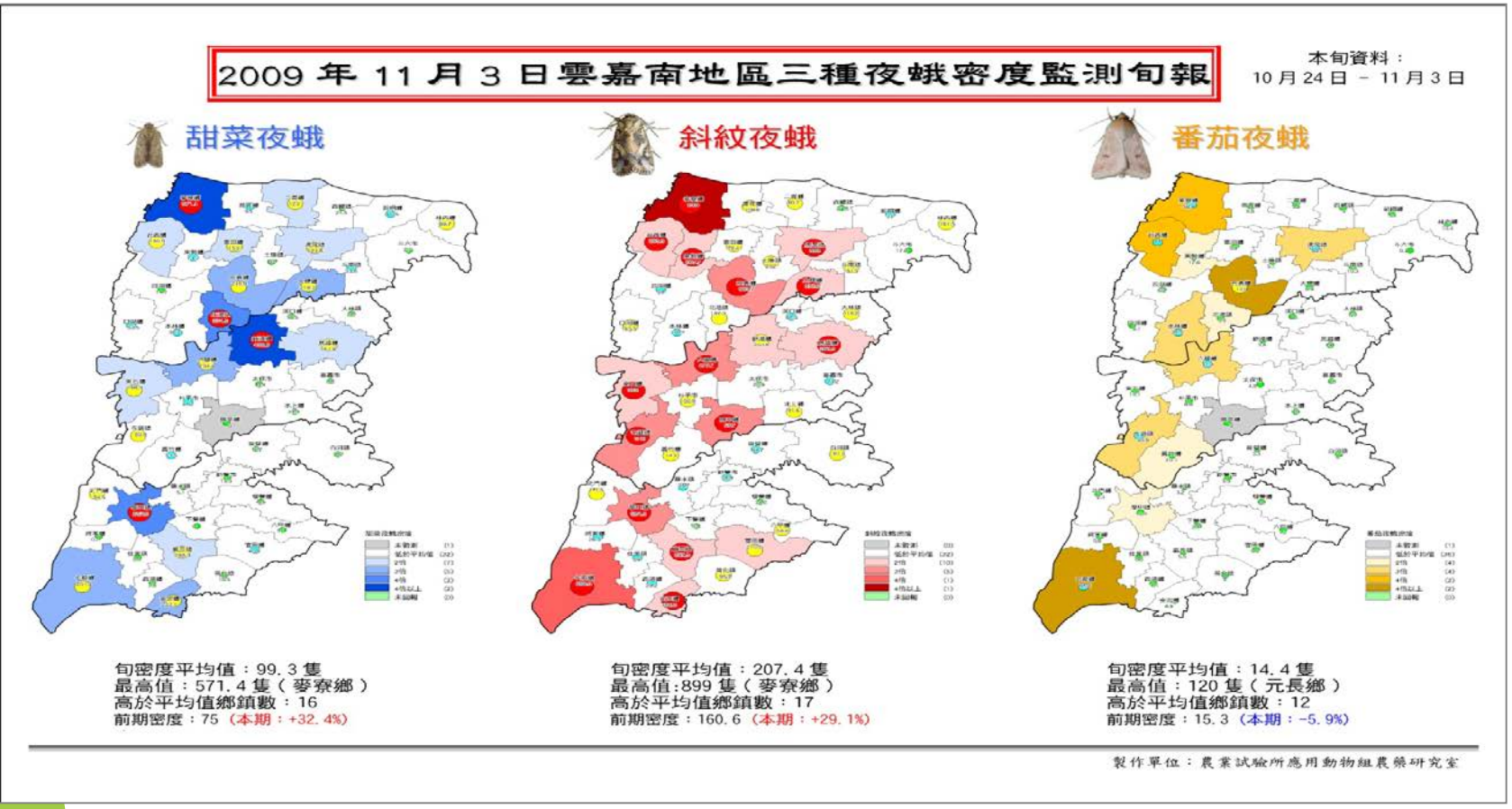
Bureau of Animal and Plant Health Inspection and Quarantine

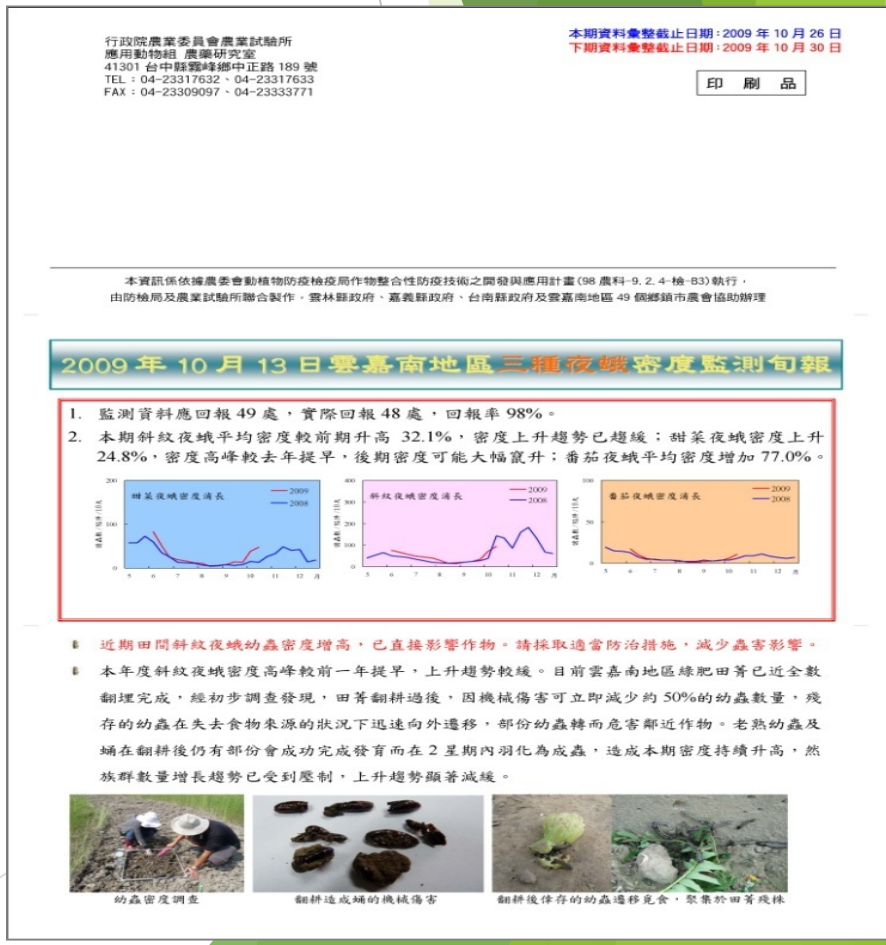
Take actions to control or early prevent measures
Protocol the control traits of pests

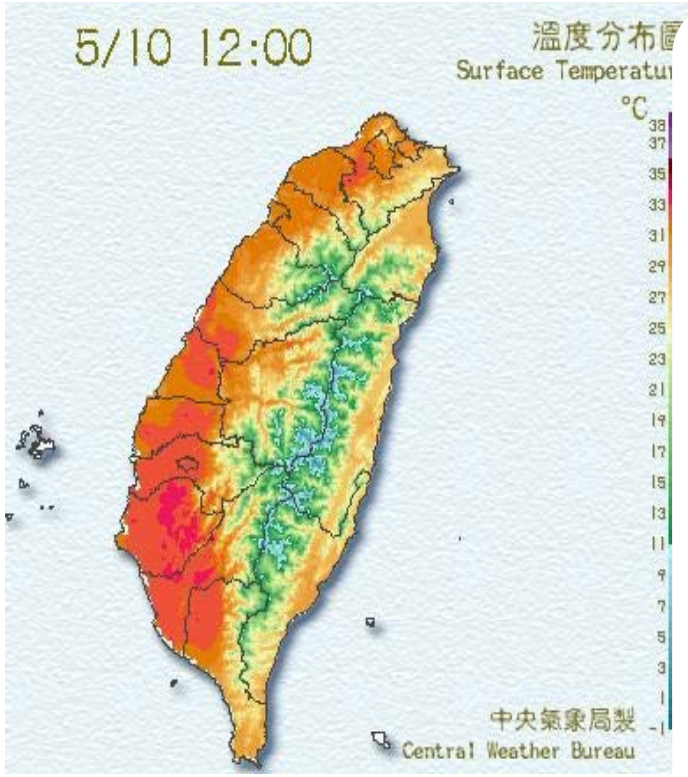
Announce densities of new letters per ten days (http://www.tari.gov.tw)



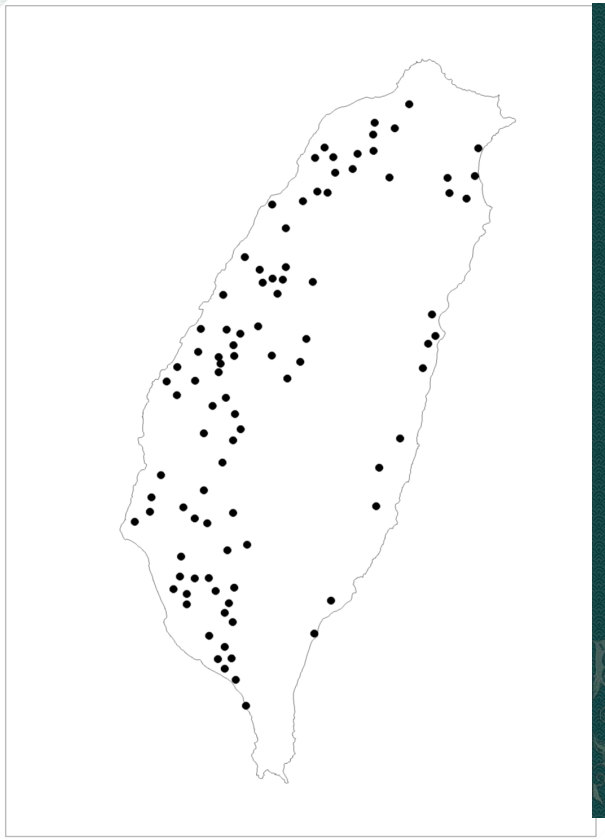
Newsletters for the density monitoring of three Lepidopterous pests in 57townships (*Spodoptera litura ; Spodoptera exigua; Helicoverpa armigera)*





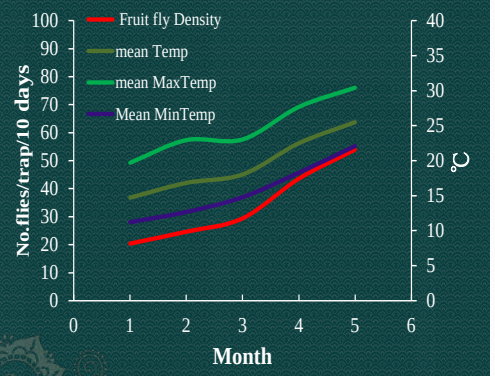


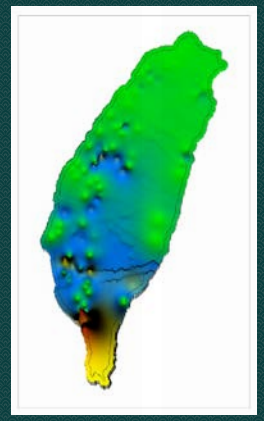
（農工組陳俊仁提供）



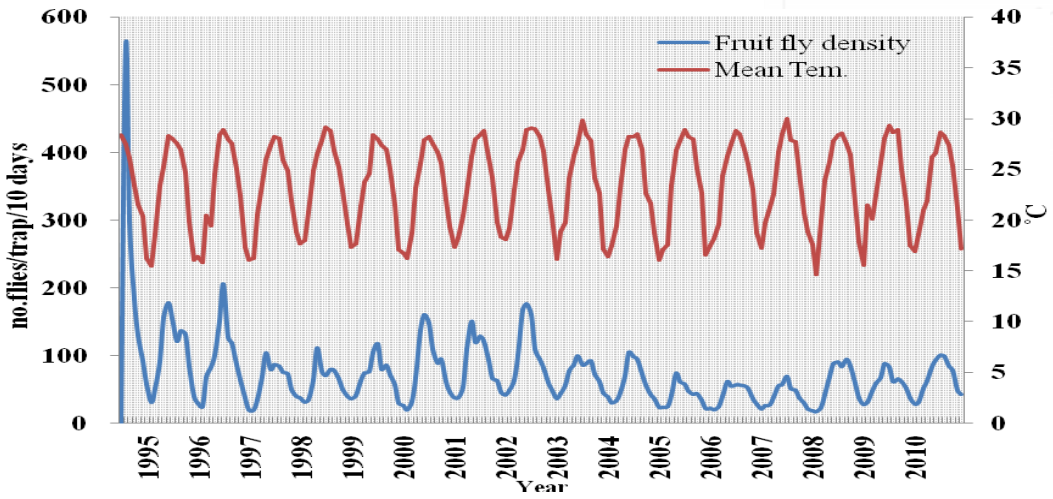
1. Application of Integrated Pest Management and GIS
(Dr. Roger I. Vargas & Dr. R. F. L Mau)

2. Environment factors data and GIS (Surface and Spatial analysis)

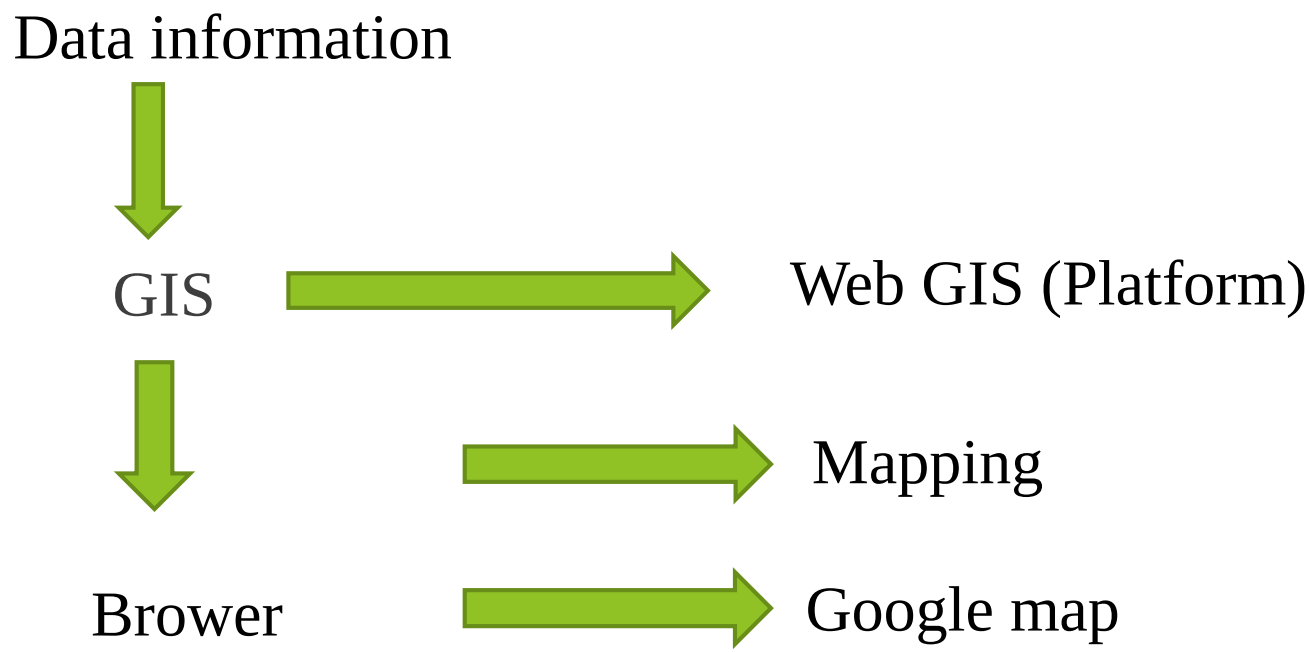




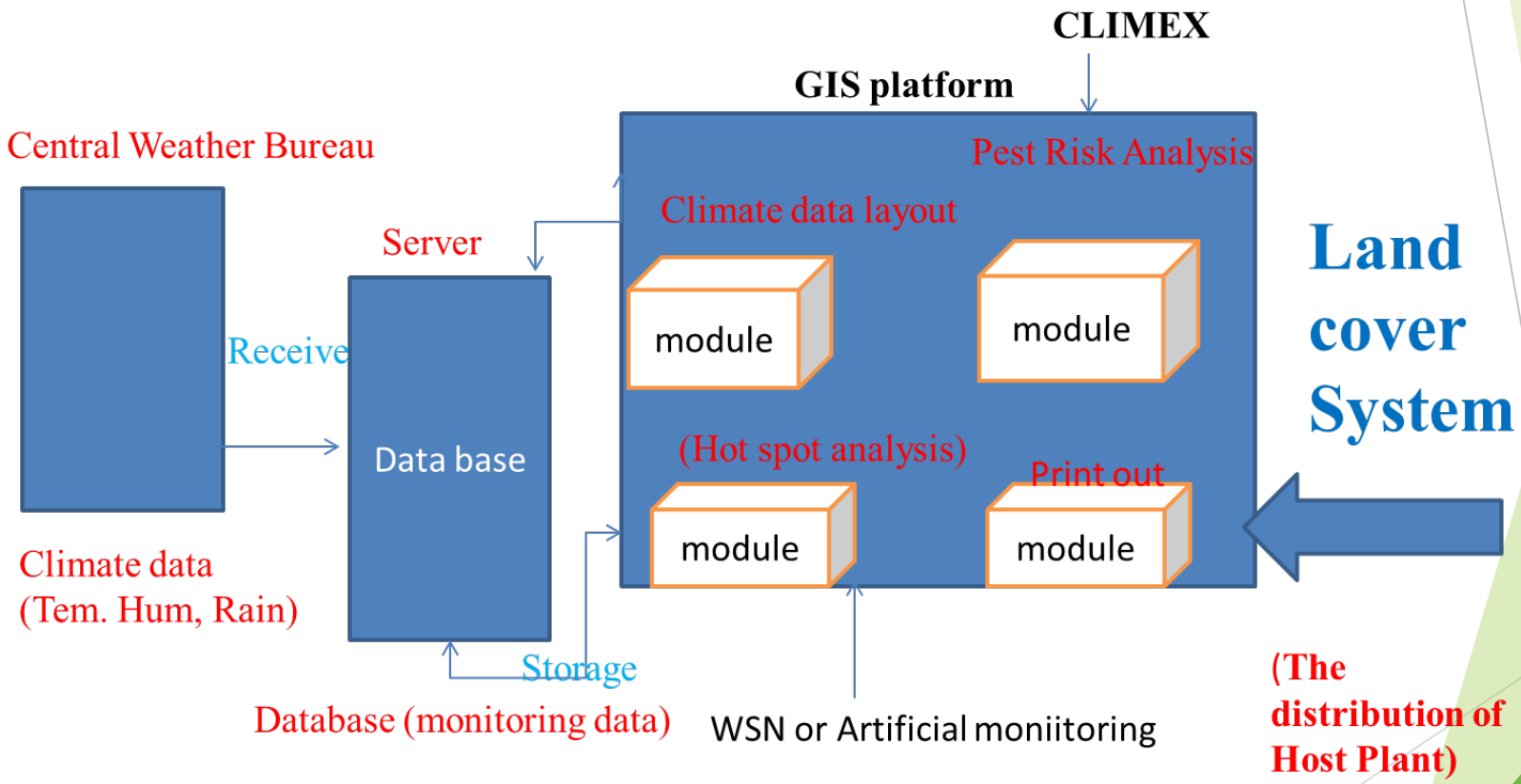
The distribution of OFF in Taiwan (on May)



PEST RISK MAPPING


Data information
GIS
Web GIS (Platform)
Mapping
Brower
Google map

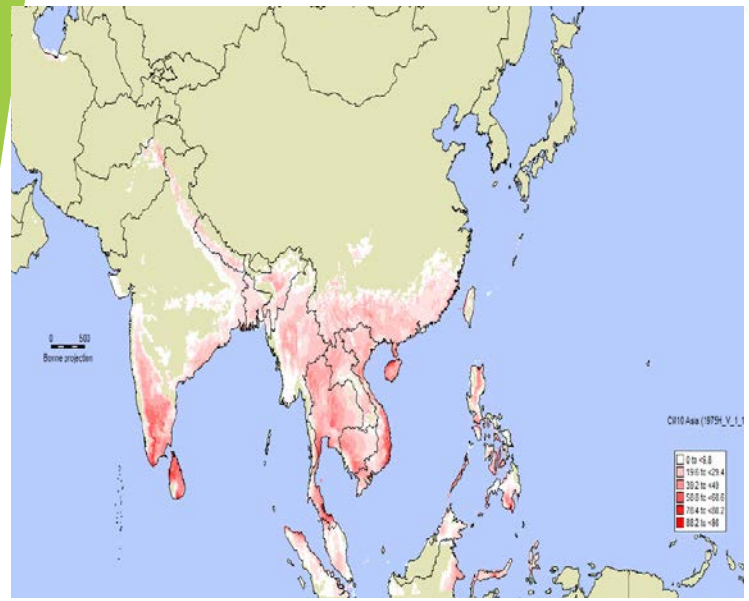
The framework of Pest Monitoring and Early Warning Information System

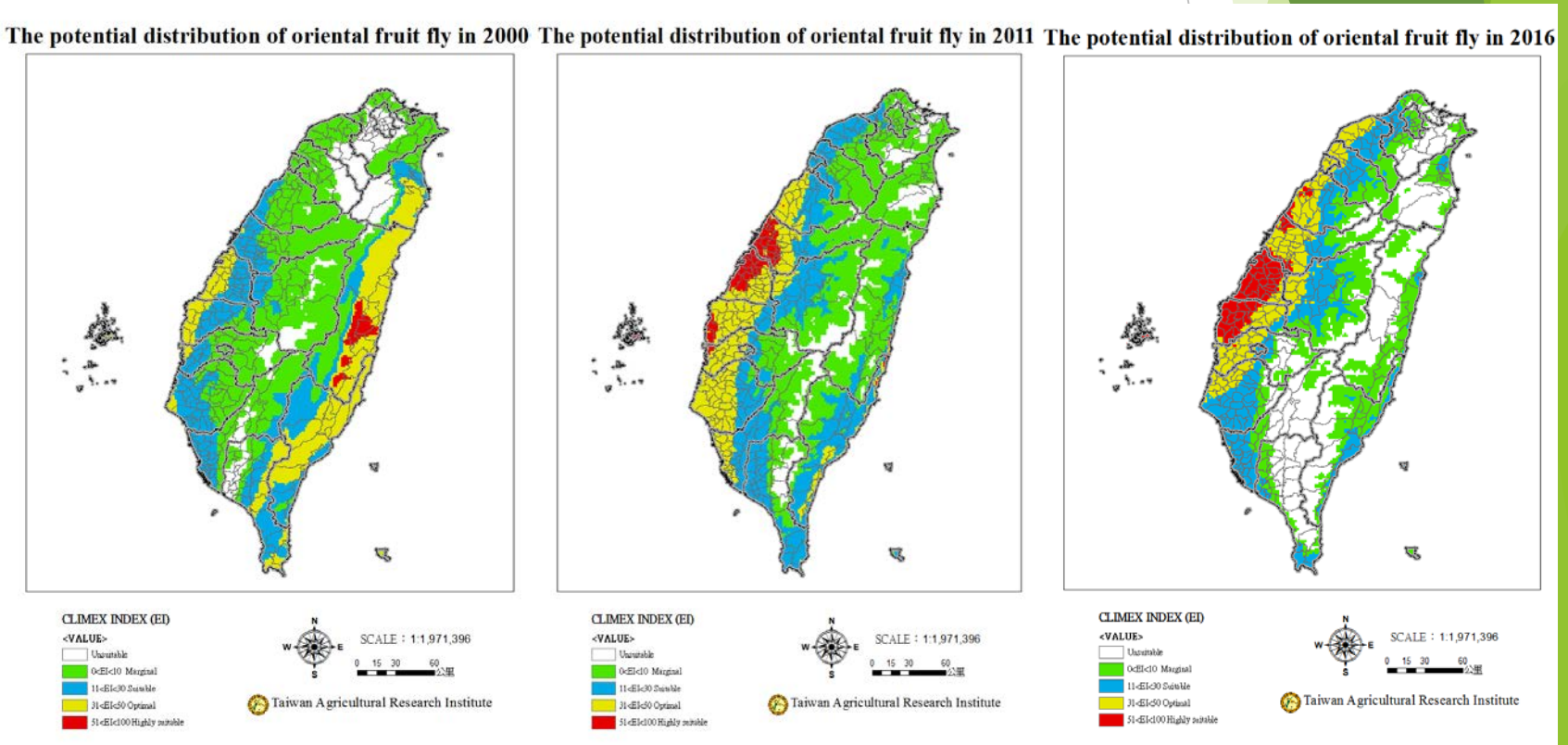


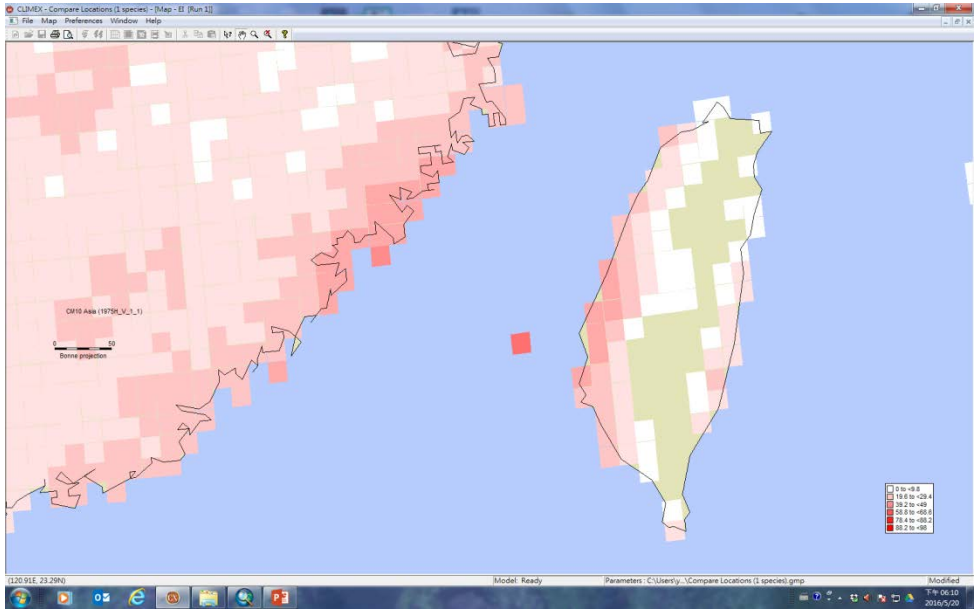
Climate change Impact on the potential geographic distribution for the pest

Based on CLIMEX model, we use climate data to assess the impact on the potential geographic distribution of the pest . For example, *Nilaparva lugens*;

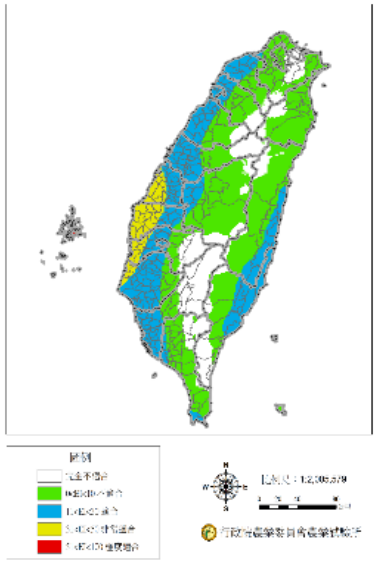
Ranked 5 index, unsuitable, marginal suitable, suitable, optimal , highly suitable



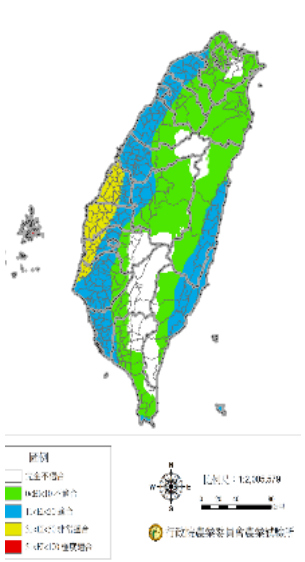




東方果宵蠅潛在地理分布(2000)



東方果宵蠅潛在地理分布(2030)



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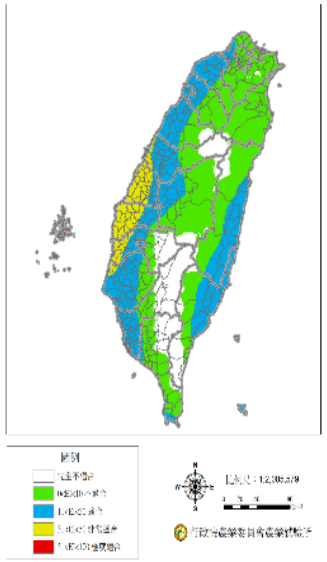
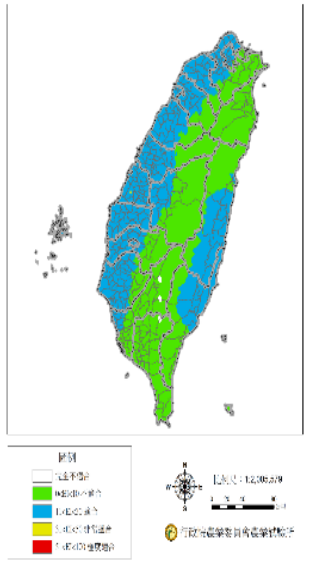


東方果宵蠅潛在地理分布(2100)



PRISM CLIMATE GROUP

Northwest Alliance for Computational Science and Engineering

Home | Normals | Comparisons | This Month | Prior 6 Months | Recent Years | Historical Past | Gallery | Explorer | FAQ

PRISM Climate Data

The **PRISM Climate Group** gathers climate observations from a wide range of monitoring networks, applies sophisticated quality control measures, and develops spatial climate datasets to reveal **short- and long-term climate patterns**. The resulting datasets incorporate a variety of modeling techniques and are available at multiple spatial/temporal resolutions, covering the period from **1895 to the present**. Whenever possible, we offer these datasets to the public, either free of charge or for a fee (depending on dataset size/complexity and funding available for the activity).

- Methods used by the PRISM model
- Descriptions of the PRISM datasets
- How we developed the PRISM model
- Publications about PRISM
- Calendar of PRISM dataset updates
- What's new at PRISM

30-Year Normals: At the end of each decade, average values for temperature and precipitation are computed over the preceding 30 years. The current set of 30-year normals covers the period 1981-2010.

Comparisons: Maps showing how observed values have been deviating from long-term conditions (also known as anomalies) - includes the new Drought Indicator tool.

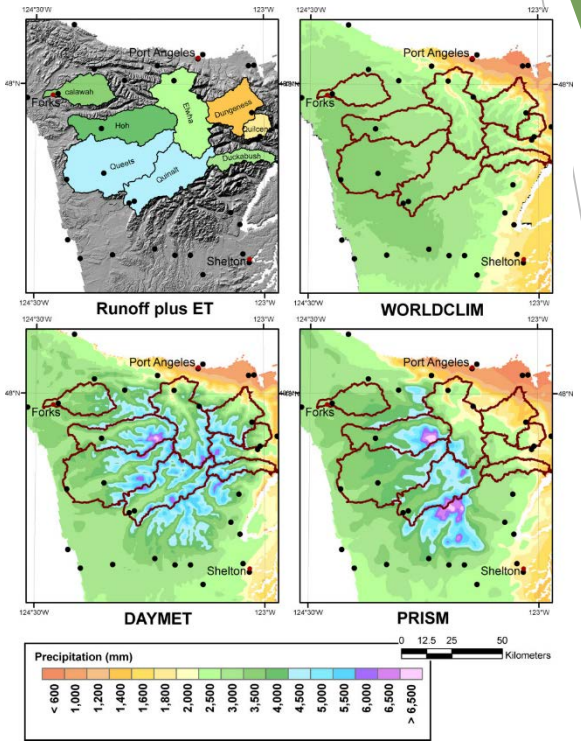
This Month: Although still very preliminary, results based on daily data readings are available for the month-in-progress.

Prior 6 Months: Provisional results based on both monthly and daily data are available for the 6 most recently completed months.

Recent Years: Daily and monthly observations become stabilized after 6 months. At that point the time series datasets are posted in this section, along with annual values computed at the end of each year.

Historical Past: Values prior to 1981 are based on less extensive observations. Time series datasets computed using monthly modeling are available for the years 1895-1990.

Gallery of State Maps: Prepared map images for each state in the continental US.

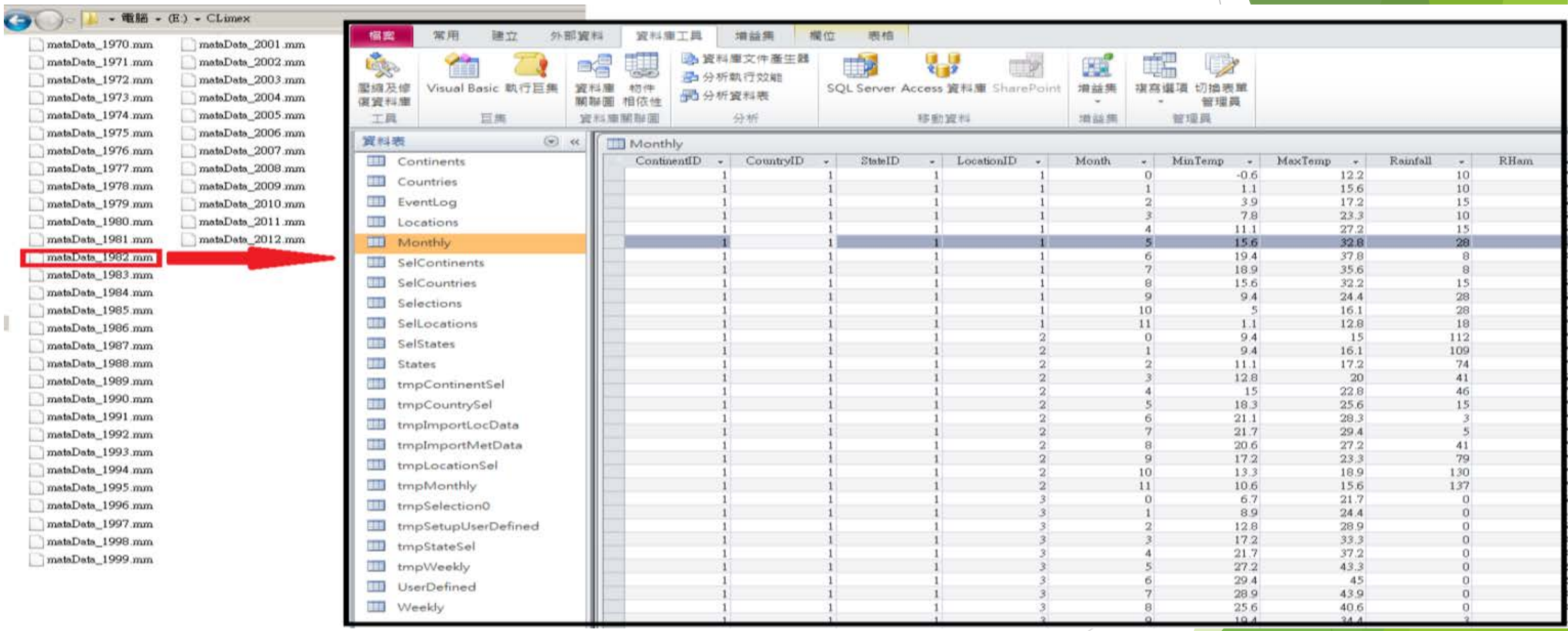


Using GIS interpolation method and PRISM model, we obtain the continuous climate grid data

Code Year Date Latitudes M Temp. H Temp. LTemp. M Hum. L Hum. S M Wind Rainfall

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	測站代	年份	日期	平均溫	平均氣	最高氣	最低氣	平均相	最大相	最小相	平均風	平均風	降水量	全天空	射量(MJ/m2)									
14977	466910	2011	0101	925.2	3.8	6.7	2.7	87	93	73	1.9	200	0	5.54									
14978	466910	2011	0102	925.9	6.9	9.3	4.6	94	99	84	2.3	160	-9998	2.49									
14979	466910	2011	0103	925	7.7	9.5	6.1	99	100	95	3.6	350	15	0.13									
14980	466910	2011	0104	925.6	7	8.6	6	100	100	98	3.3	160	4.5	0.01									
14981	466910	2011	0105	924.4	11.2	13.8	8.6	98	100	91	3.2	70	3	5.61									
14982	466910	2011	0106	927.1	6.7	11.2	3	99	100	96	3.6	340	12.5	0									
14983	466910	2011	0107	927	5.5	7	3.2	100	100	98	2.4	320	13.5	0.05									
14984	466910	2011	0108	924.7	9.6	11.4	6.9	98	100	96	3.2	130	9.5	4.45									
14985	466910	2011	0109	925.6	8.2	11.4	4.8	99	100	96	3.6	330	10.5	1.29									
14986	466910	2011	0110	924.4	6.5	7.4	5.2	99	100	98	2.4	330	37.5	0.21									
14987	466910	2011	0111	922.4	4.8	7.4	3	100	100	98	4.1	340	38.5	0									
14988	466910	2011	0112	923.2	4	6.3	2.3	100	100	99	3.2	350	23	0.34									
14989	466910	2011	0113	923.4	9.2	12	6.2	99	100	97	4.6	150	8	1.17									
14990	466910	2011	0114	922.3	12.2	15.8	10.2	97	100	90	3.4	350	5	4.94									
14991	466910	2011	0115	925.5	5.4	10.9	1.1	99	100	97	8.5	350	80.5	0									
14992	466910	2011	0116	927.7	1.5	2.9	0.2	100	100	97	3.5	340	21	0.02									
14993	466910	2011	0117	928.2	5.1	7	2.7	100	100	97	4.3	160	9.5	3.85									
14994	466910	2011	0118	925.9	10.1	14.5	6.8	97	100	81	3.2	180	8.5	8.6									
14995	466910	2011	0119	924.9	11.3	12.8	10.5	98	100	95	2	170	17.5	4.51									
14996	466910	2011	0120	922.8	11.4	13	10	98	100	95	2.8	80	16.5	4.04									
14997	466910	2011	0121	923.9	8.2	10.2	6.4	99	100	96	3.3	330	15	2.69									
14998	466910	2011	0122	925.4	7.9	10.6	6.1	97	100	82	3.7	190	2	6.3									
14999	466910	2011	0123	926	10.1	13.4	7.8	98	100	93	3.2	350	18	1.42									
15000	466910	2011	0124	927.9	6.5	8	5.4	100	100	97	3.5	170	13	0.01									
15001	466910	2011	0125	928.2	8.5	10.3	6.2	99	100	97	4.2	150	8	0.76									
15002	466910	2011	0126	929.5	9.7	10.6	8.7	99	100	97	2.5	180	33	4.48									

工作表1 工作表2 工作表3


電腦 ▸ (E:) ▸ CLimex
mataData_1970.mm
mataData_1971.mm
mataData_1972.mm
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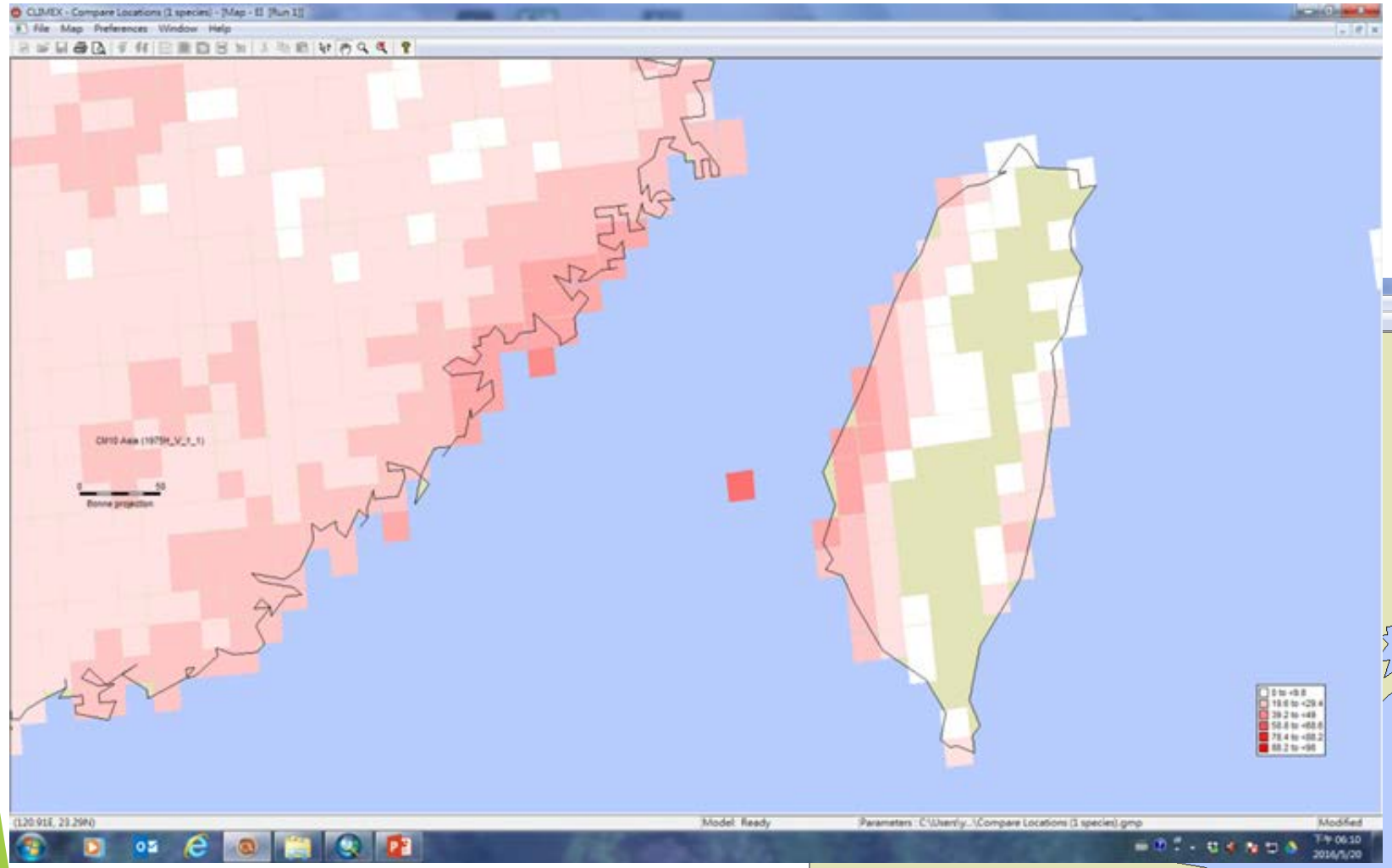
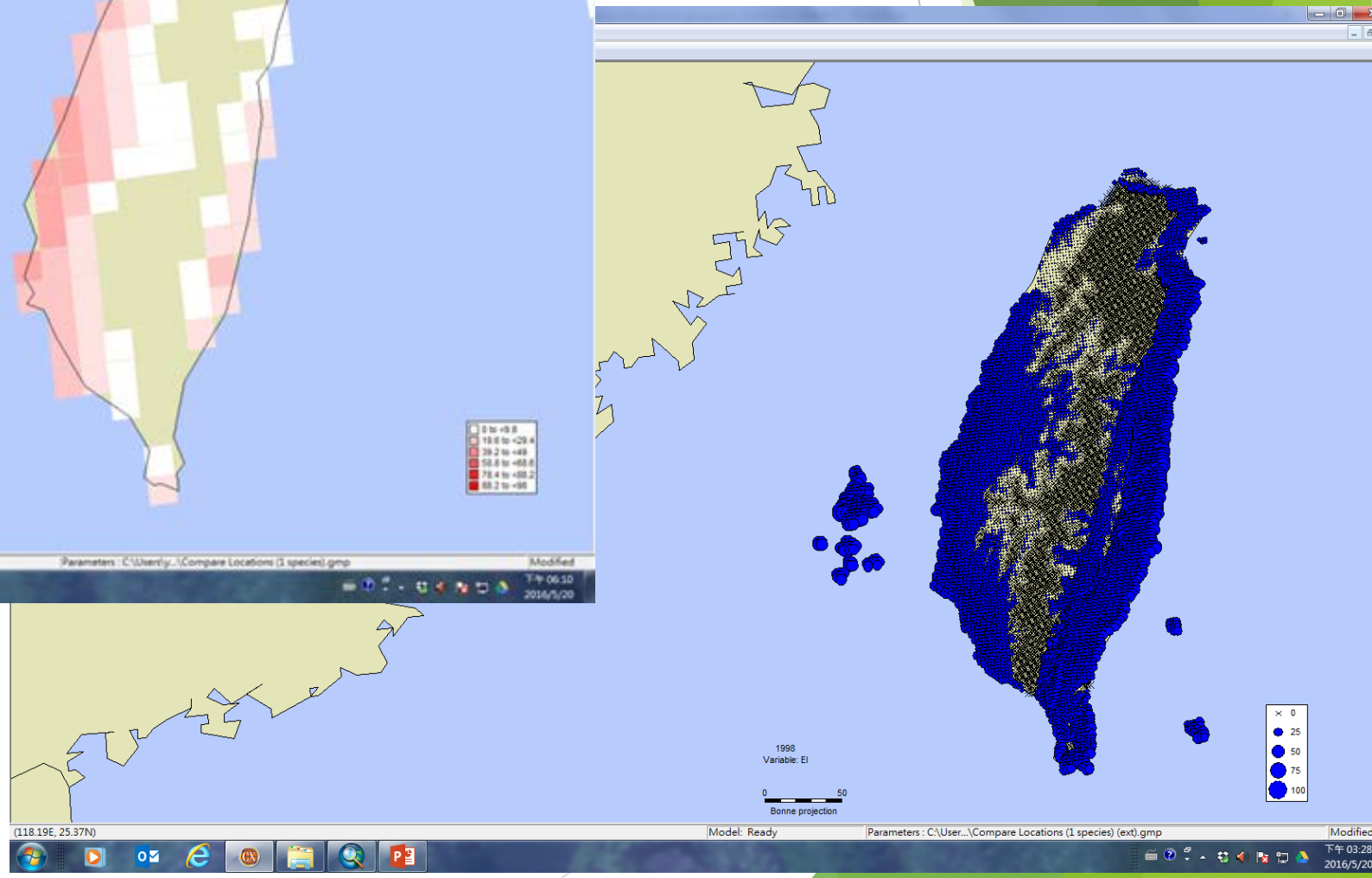
檔案
常用
建立
外部資料
資料庫工具
增益集
欄位
表格
Visual Basic
執行巨集
資料庫文件產生器
分析執行效能
分析資料表
SQL Server
Access 資料庫
SharePoint
增益集
資料表
Continents
Countries
EventLog
Locations
Monthly
SelContinents
SelCountries
Selections
SelLocations
SelStates
States
tmpContinentSel
tmpCountrySel
tmpImportLocData
tmpImportMetData
tmpLocationSel
tmpMonthly
tmpSelection0
tmpSetupUserDefined
tmpStateSel
tmpWeekly
UserDefined
Weekly
Monthly
ContinentID CountryID StateID LocationID Month MinTemp MaxTemp Rainfall RHam
1 1 1 1 0 -0.6 12.2 10
1 1 1 1 1 1.1 15.6 10
1 1 1 1 2 3.9 17.2 15
1 1 1 1 3 7.8 23.3 10
1 1 1 1 4 11.1 27.2 15
1 1 1 1 5 15.6 32.8 28
1 1 1 1 6 19.4 37.8 8
1 1 1 1 7 18.9 35.6 8
1 1 1 1 8 15.6 32.2 15
1 1 1 1 9 9.4 24.4 28
1 1 1 1 10 5 16.1 28
1 1 1 1 11 1.1 12.8 18
1 1 1 2 0 9.4 15 112
1 1 1 2 1 9.4 16.1 109
1 1 1 2 2 11.1 17.2 74
1 1 1 2 3 12.8 20 41
1 1 1 2 4 15 22.8 46
1 1 1 2 5 18.3 25.6 15
1 1 1 2 6 21.1 28.3 3
1 1 1 2 7 21.7 29.4 5
1 1 1 2 8 20.6 27.2 41
1 1 1 2 9 17.2 23.3 79
1 1 1 2 10 13.3 18.9 130
1 1 1 2 11 10.6 15.6 137
1 1 1 3 0 6.7 21.7 0
1 1 1 3 1 8.9 24.4 0
1 1 1 3 2 12.8 28.9 0
1 1 1 3 3 17.2 33.3 0
1 1 1 3 4 21.7 37.2 0
1 1 1 3 5 27.2 43.3 0
1 1 1 3 6 29.4 45 0
1 1 1 3 7 28.9 43.9 0
1 1 1 3 8 25.6 40.6 0

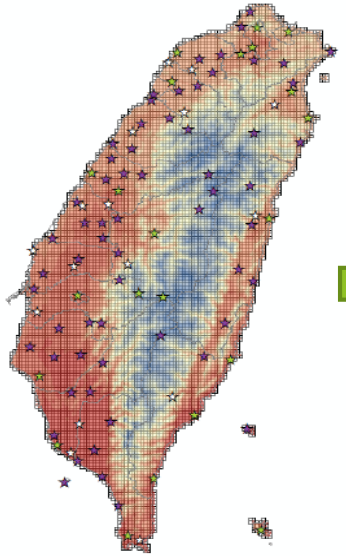

CLIMEX - Compare Locations (1 species) - [Map - EI [Run 1]]
File Map Preferences Window Help
CM10 Asia (1975H_V_1_1)
0 50
Bonne projection
(120.91E, 23.29N)
Model: Ready
Parameters : C:\Users\y...\Compare Locations (1 species).gmp
Modified

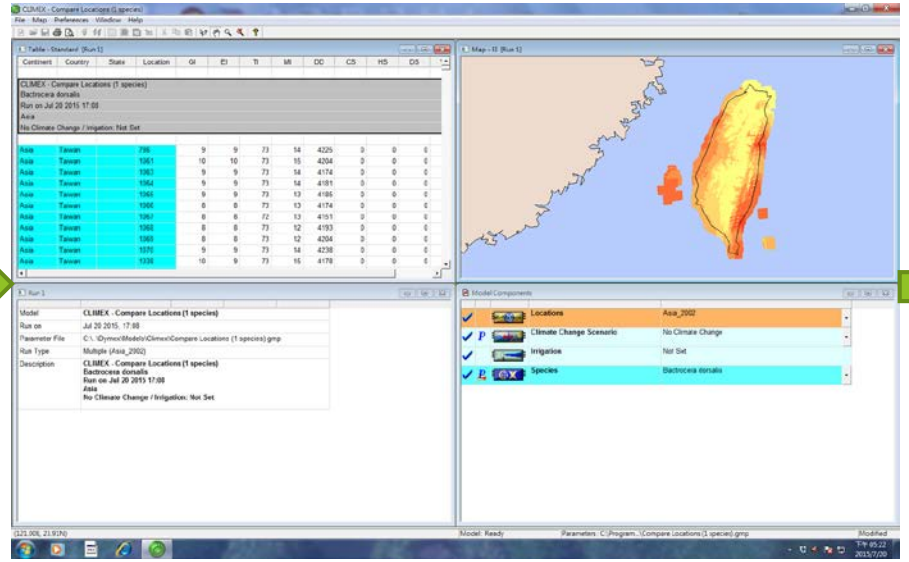

1998
Variable: EI
0 50
Bonne projection
0
25
50
75
100
(118.19E, 25.37N)
Model: Ready
Parameters : C:\User...\Compare Locations (1 species) (ext).gmp
Modified

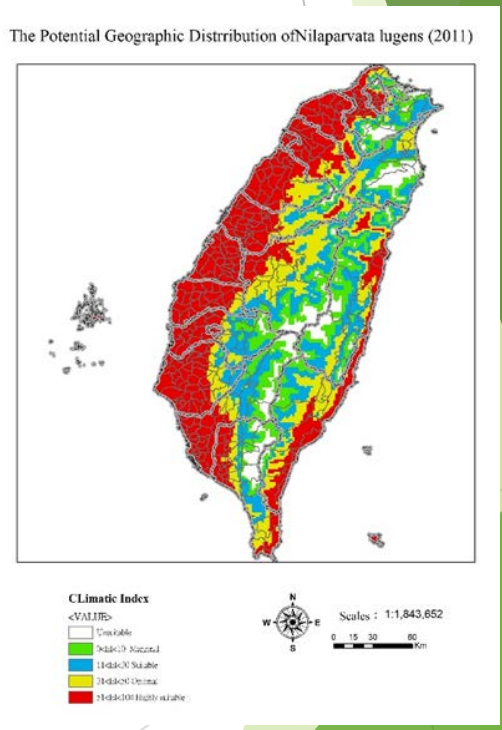
Using PRISM model is to downscale climate data (1 km)

Fit the CLIMEX (at least 30000 grid)

ArcGIS mapping

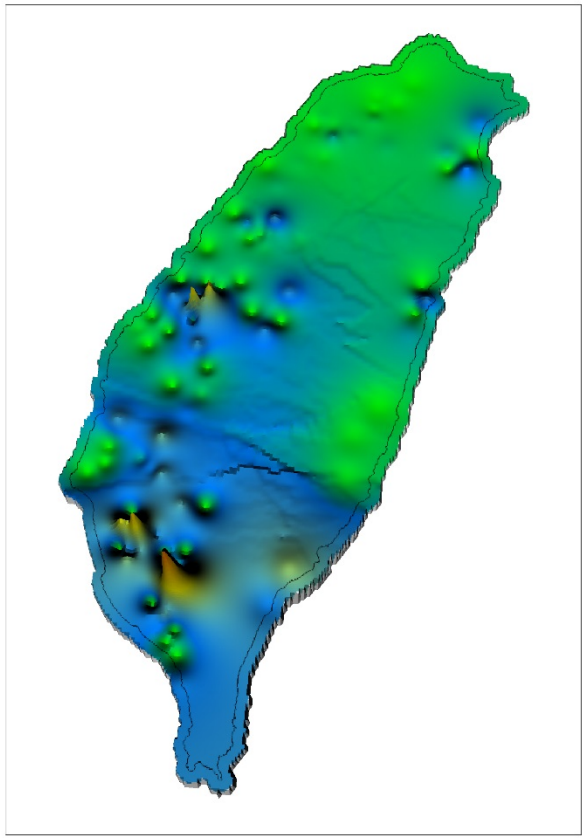




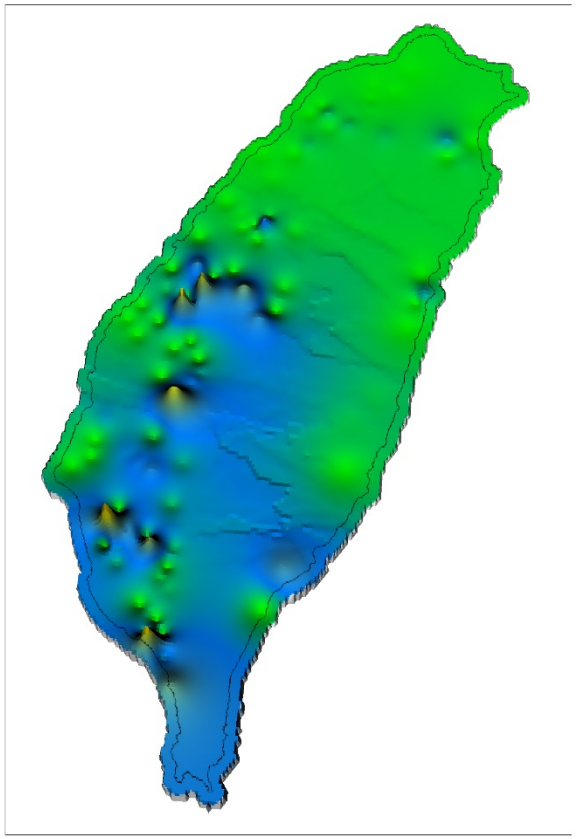


The population distribution of the oriental fruit fly in monitoring system

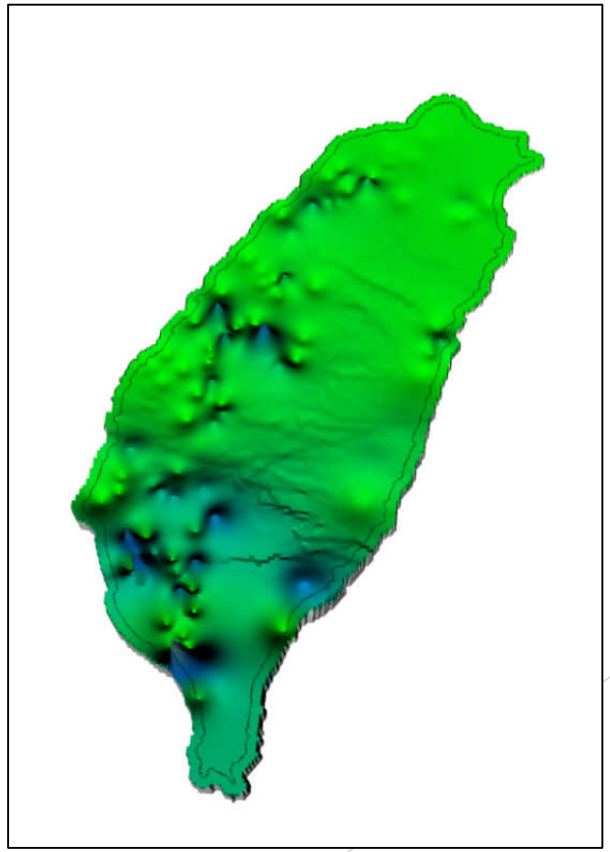
2000



2011



2016



Rank by 4 density index

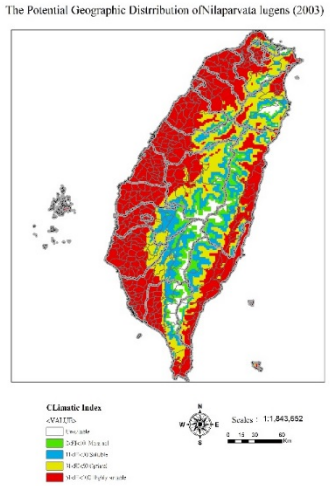
- 0~64 (flies/trap/10 days)
- 65~256 (flies/trap/10 days)
- 257~1024 (flies/trap/10 days)
- 1025~ (flies/trap /10 days)

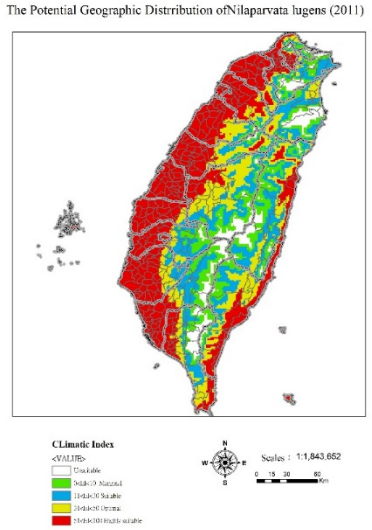
Climate change Impact on the potential geographic distribution for the pest

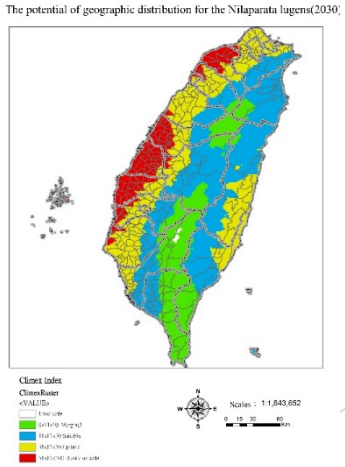
Based on CLIMEX model, we use climate data to assess the impact on the potential geographic distribution of the pest . For example, *Nilaparva lugens*;

Ranked 5 index, unsuitable, marginal suitable, suitable, optimal , highly suitable

Nilaparva lugens







Daily weather Data received Data exported Data formatted for DYMEX Analyzed

Pest risk mapping GIS Data Management Result Export

The flowchart of Pest risk mapping

Weather and Degree-day Concepts in pest risk

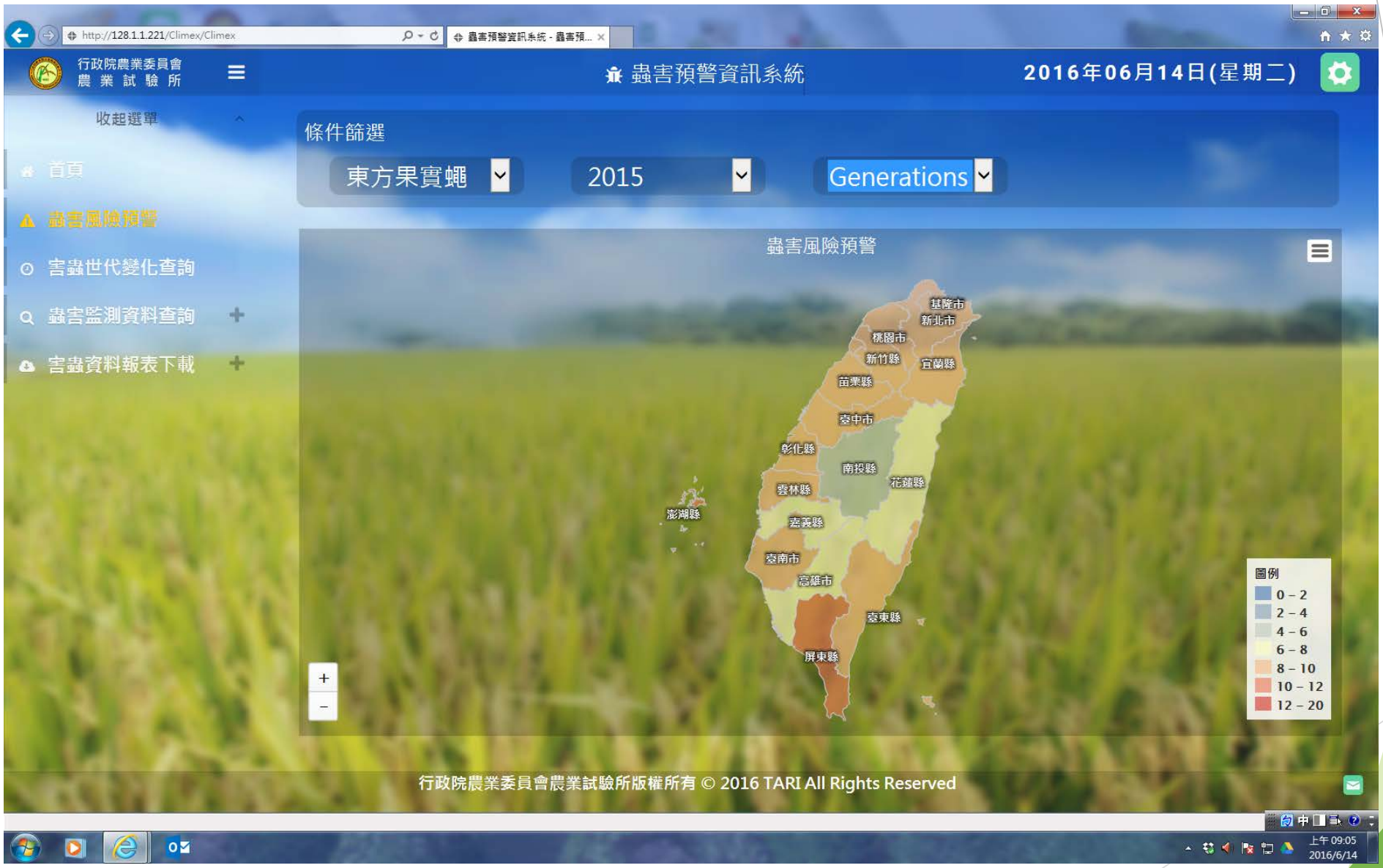
- *Degree-days*: a unit of accumulated heat, used to estimate development of insects, fungi, plants, and other organisms which depend on temperature for growth.
- Calculation of degree-days: (one of several methods)
- DDs = avg. temperature – base threshold.
- So, if the daily max and min are 80 and 60, and the threshold is 50, then we accumulate

» (80+60)/2 - 50 = 20 DDs for the day

But If daily min temperature ＜ base threshold

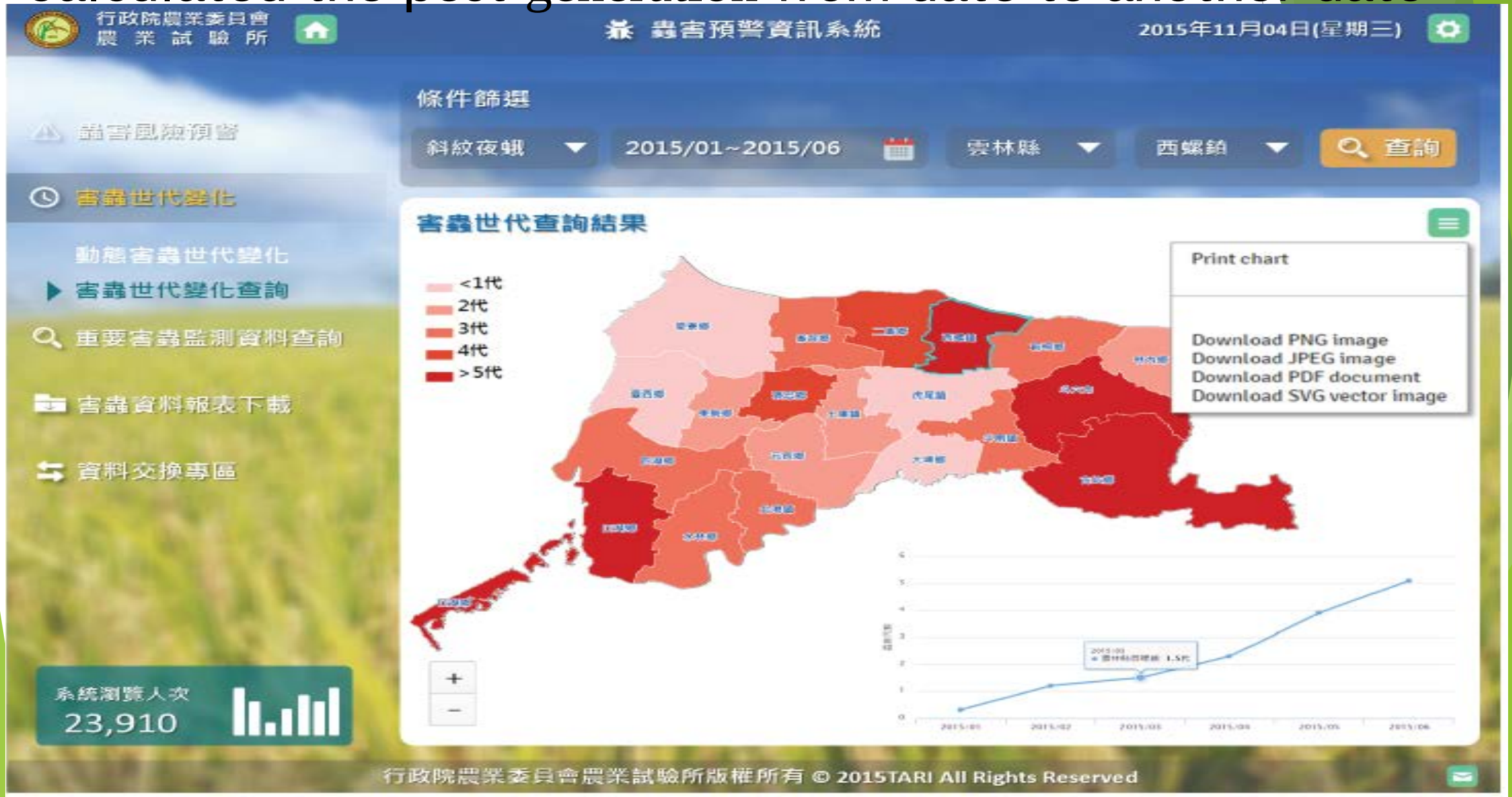
» DDs = (max tem.-base threshold tem.)– base threshold.

»If DDs ＜0 then DDs=0 for the day



http://128.1.1.221/Climex/Climex

Calculated the pest generation from date to another date

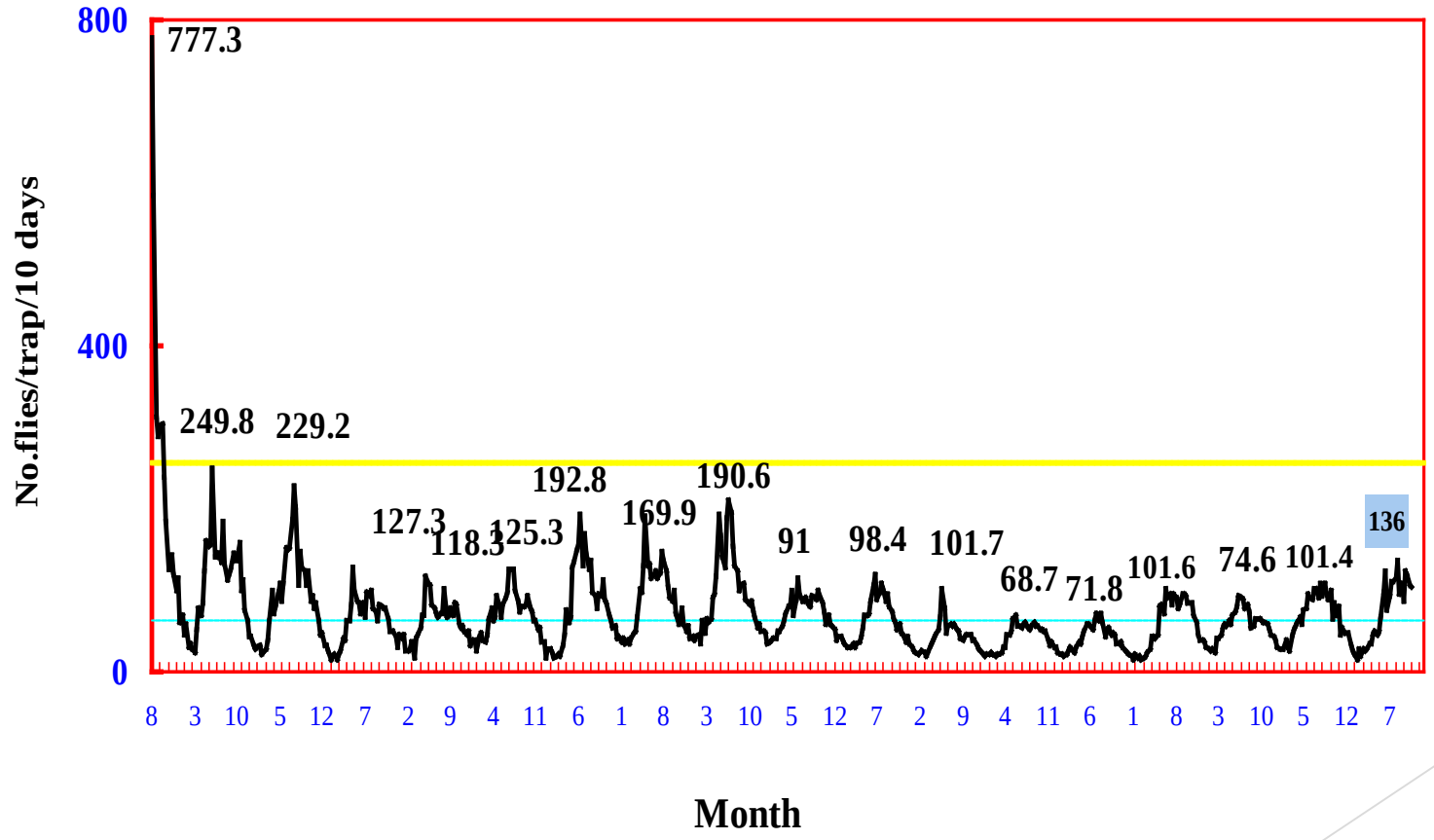


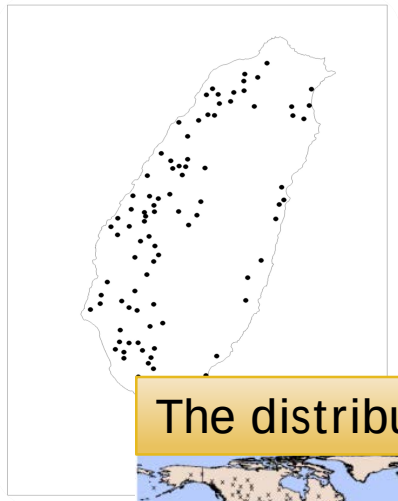
CLIMEX Index

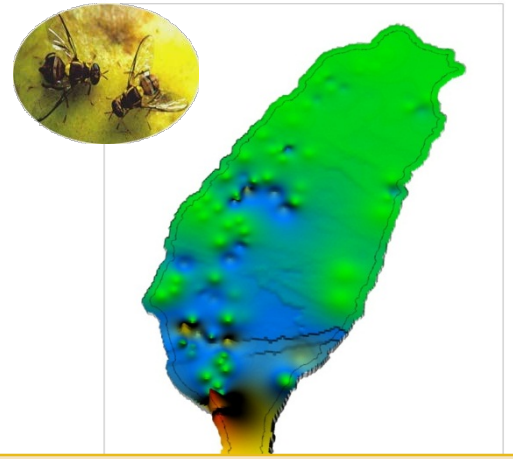
EI:the suitability of the climate for long term survival

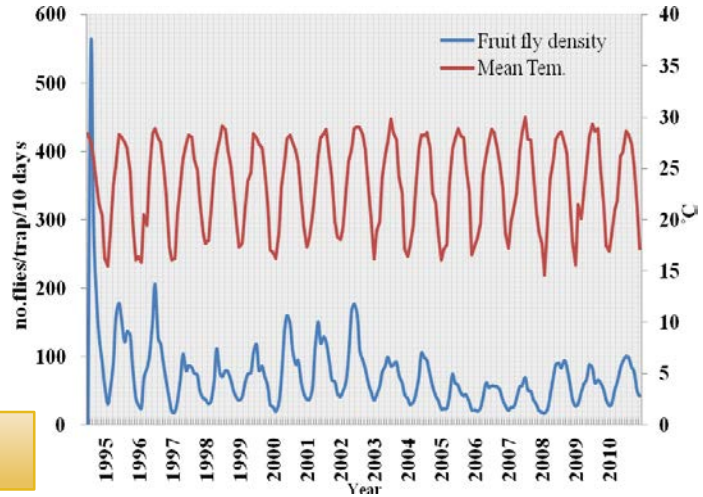
GI: the potential for population growth during favorable season

Early Detection

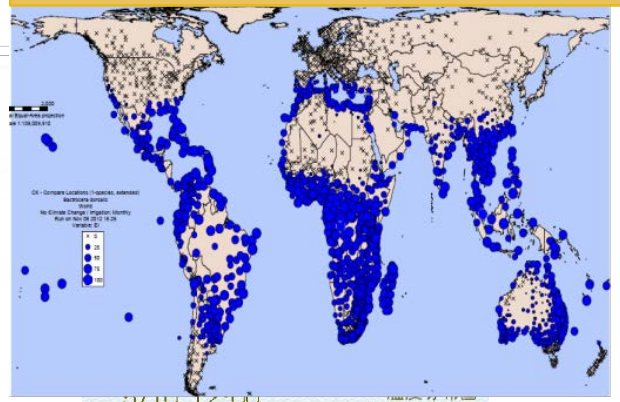


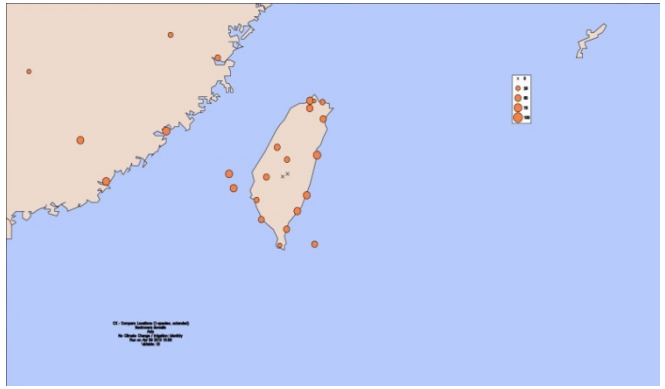


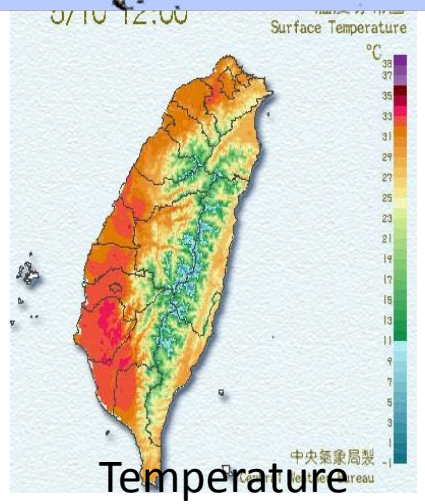




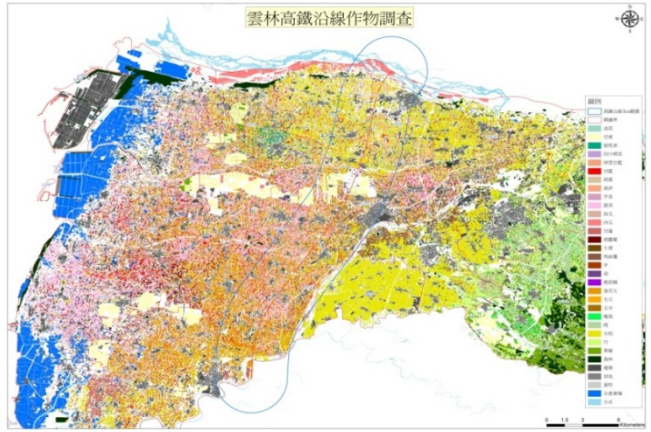
The distribution of oriental fruit fly







Temperature



The distribution of Host plant

Detecting or Monitoring the pest by Mobile Phone

http://128.1.1.221/Climex/Newpage/Index


上午6:36
渥太華河
BYWA
MARK
34
渥太華
Ottawa
Wellington St
Elgin St
Bank St
Slater St
Laurier Ave W
CENTRETOWN
31
79
36
Google
NATOWN
作物名：
甘藍
蟲名：
小菜蛾
種植日期：
2017/03/28
發現日期：
2017/08/28
防治日期：
2017/08/30
防治方法：
生物防治法