



# Application Manual

version 1.2

This manual is a part of the project :  
spatiotemporal analysis with  
application development for  
epidemiological study of  
suicide mortality.



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# 01 What is STEHealth ?

 **STEHealth** (It stands for Spatiotemporal Epidemiological Health) is an application for analyzing space-time pattern and association with risk factors of suicide and other health outcomes, which allows users to import their own data, analyze, and visualize.



Photo by fauxels from Pexels:  
<https://www.pexels.com/photo/person-using-a-laptop-computer/>

## Objectives

To develop a user-friendly interface to facilitate visualization and analysis for spatial and spatiotemporal epidemiological studies

# 02 System Requirements

## **Minimum:**

Requires a 64-bit processor and operating system

**OS:** Windows OS only (Windows 10 or above)

**Processor:** AMD Athlon Gold 3150U with Radeon Graphics 2.40 GHz

**Memory:** 4 GB RAM

**Storage:** 1.5 GB available space

## **Recommended:**

Requires a 64-bit processor and operating system

**OS:** Windows OS only (Windows 10 or above)

**Processor:** AMD Ryzen 5 2600 Six-Core Processor

**Memory:** 8 GB RAM

**Storage:** 1.5 GB available space

**\*Note that:** If you got “out of memory” when using our app, it might be because your computer doesn't have enough resources or using the application too quickly, for example, plotting a map too often without completing the previous plot. Try closing any other programs you're not using at the moment.

# 03 How to Download This Application

There are three installation methods.

## 1 STEHealthApp package

This method is suitable for **users who already have R and RStudio and prefer not to load the .zip file**, especially those who have been using RStudio for a while.

Step

1

Install **STEHealthApp package** by running the following line of code in RStudio:

```
devtools::install_github("mill-ornrakorn/STEHealth-Application", ref="STEHealthApp")
```

Step

2

Install **R-INLA** and **capture** packages by running the following line of code in RStudio:

```
install.packages("INLA", repos=cgetOption("repos"), INLA="https://inla.r-inla-download.org/R/stable"), dep=TRUE)
```

```
remotes::install_github("dreamRs/capture")
```

Step

3

After the packages have been installed, type the following in RStudio, and the application window will appear.

```
library(STEHealthApp)  
run_app()
```

## 2 .R file Application

This method is suitable for **users who already have R and RStudio and may use RStudio for some time.**

note that: This application can work with R versions **4.2.0** and **4.2.2**

### Step 1

Go to  [STEHealth GitHub repository](#) in [releases page](#) or [this link](#) to download the .zip file.



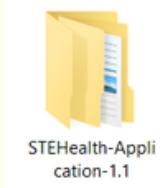
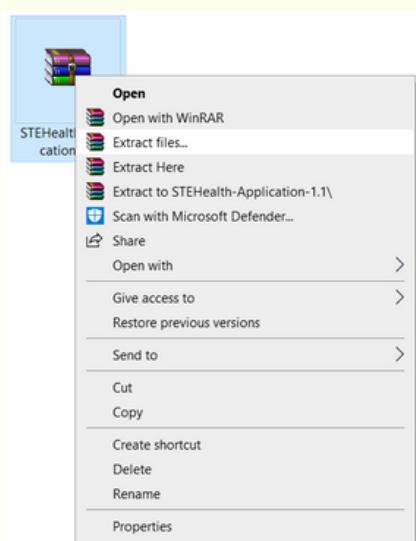
[GitHub repository](#)



[link](#)

### Step 2

Extract the downloaded file.



## Step

3

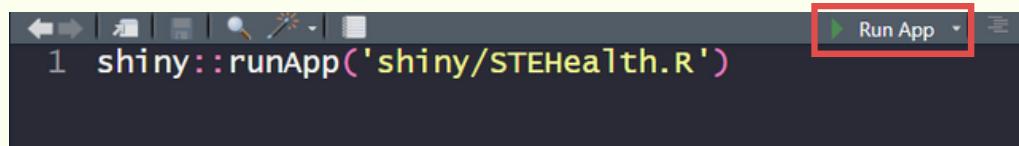
Open "runShinyApp.R" via RStudio

Name	Date modified	Type	Size
📁 pic for readme	19/7/2566 22:46	File folder	
📁 sample data	11/5/2566 2:52	File folder	
📁 shiny	21/7/2566 1:55	File folder	
⚙️ .gitignore	19/7/2566 22:46	Git Ignore Source ...	1 KB
📄 README	21/7/2566 0:51	Markdown Source ...	14 KB
🇷️ runShinyApp	21/7/2566 1:51	R File	1 KB

## Step

5

Press "**Run App**" and wait for a moment. The program will automatically install the **libraries required\*** by the application.

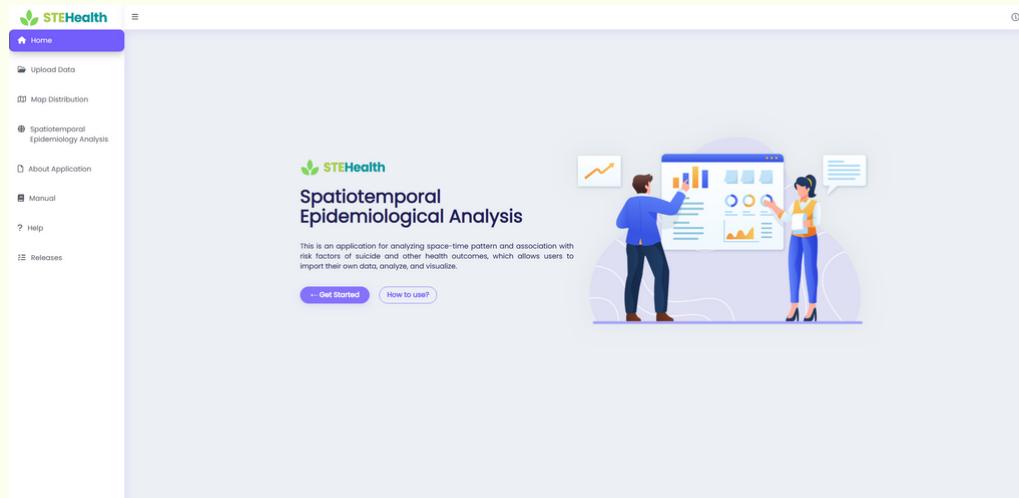


\*For a list of libraries, please refer to [page 40](#).

## Step

6

Now you can use the application.



### 3 Portable Application (supported Windows OS only)

This method is suitable for **users who do not have R and RStudio at all** because in this method we have already installed them all (including R packages) in portable application.

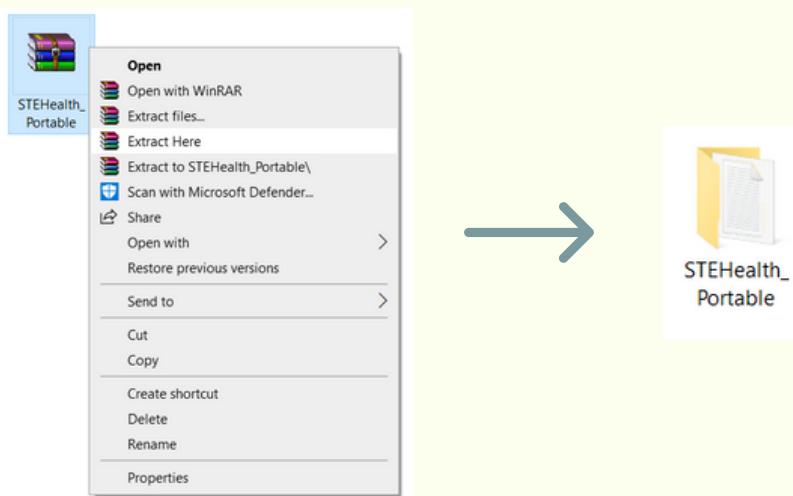
#### Step 1

Go to this link to download the  **STEHealth** portable.  
[https://drive.google.com/drive/folders/1gKW8w891qTPaKvu2-IGe38mEXaXtG39W?usp=share\\_link](https://drive.google.com/drive/folders/1gKW8w891qTPaKvu2-IGe38mEXaXtG39W?usp=share_link)



#### Step 2

Extract the downloaded file.



## Step

3

Go to `\STEHealth_Portable\dist\` and open "**run.vbs**"\*

Name	Date modified	Type	Size
R-Portable	2/7/2566 19:35	File folder	
sample data	2/7/2566 19:35	File folder	
shiny	2/7/2566 19:35	File folder	
.RData	27/3/2566 14:51	R Workspace	3 KB
.Rhistory	10/7/2566 18:12	R History Source Fi...	1 KB
run	3/3/2566 1:05	VBScript Script File	1 KB
runShinyApp	6/7/2566 20:27	R File	1 KB
STEHealth_Application_Manual	11/5/2566 20:27	Adobe Acrobat D...	8,484 KB

**\*Note that:** If you open "run.vbs" and the web application doesn't open or the web application is blank, **please press "run.vbs" several times.**

## Step

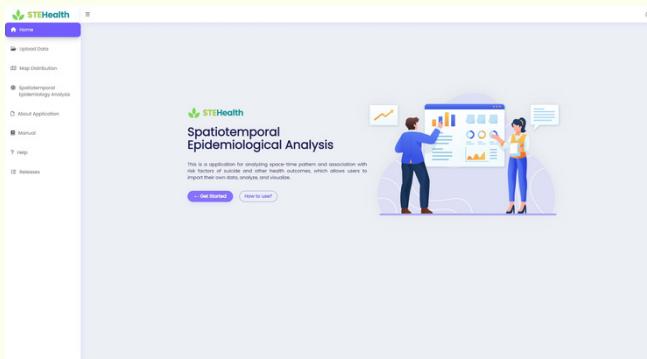
4

Now you can use the application.



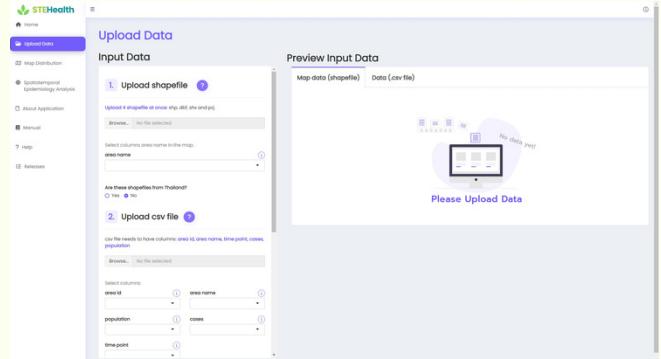
# 04 Application Pages

The application consists of eight pages:



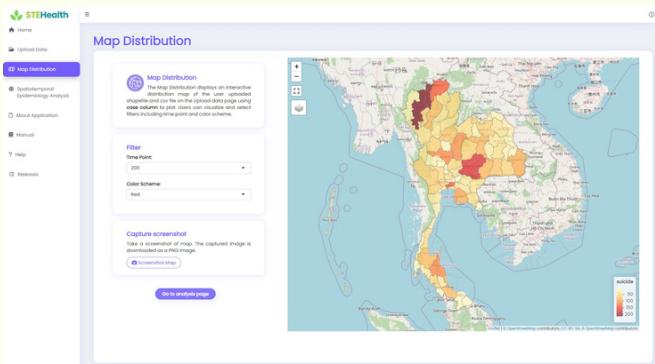
1

## Home Page



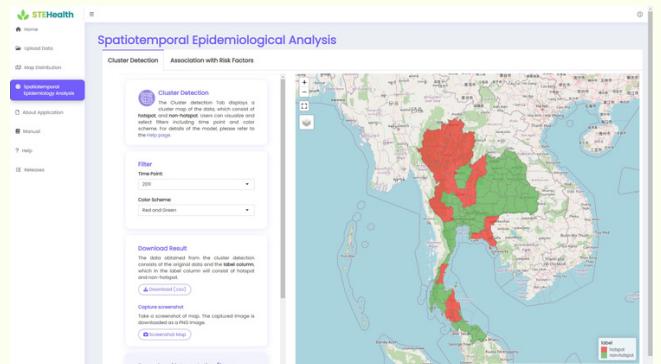
2

## Upload Data Page



3

## Map Distribution Page



4

## Spatiotemporal Epidemiological Analysis Page

**About Application**

## Background

The interface to spatiotemporal analytical tools is currently limited for public health workers and researchers, as user interface using Kirby will also be developed to increase accessibility and facilitate visualization and analysis for future spatiotemporal epidemiological studies. In addition, Kirby is effectively incompatible with R-INLA which is the main tool used by researchers to perform Bayesian spatial-temporal modeling. To overcome this limitation, we will develop user interfaces in the form of web applications with interactive features. However, the interface will be developed for specific needs of public health workers and researchers. In addition, the developed user interfaces will not provide specific features, such as proper cluster detection and space-time association analysis. The main purpose of this application is to facilitate visualization and analysis for future spatiotemporal epidemiological studies. In addition, though this interface will be built in the context of mental health as a case study, this interface can be applied to other diseases.

**Statement** *STB Health is a Spatiotemporal Epidemiological Analysis* is an application for visualizing space-time patterns, cluster detection, and association with risk factors of health outcomes, which allows users to import their own data, analysis, and visualizations. This application is part of *“spatiotemporal Analysis with Application Development for Suicide Mortality”* project of the *King Mongkut’s University of Technology Thonburi*.

## Purpose

To develop an application to facilitate visualization and analysis for spatial and spatiotemporal epidemiological studies.

## Developer

1. Ingan Thanuttharatap. Space-time pattern detection model and association with risk factors for suicide.  
2. Ingan Thanuttharatap. Insights information of spatiotemporal epidemiology of suicide mortality and association with risk factors analysis.  
3. Oranrat Mekphongsap. Application design and development.

## Advisor

1. Dr. Uncharoen Thongpol  
2. Asst. Prof. Dr. Chaweon Rojanaorosart



A screenshot of a web-based application titled "STEHealth". The left sidebar contains a navigation menu with items: Home, Report home, Map distribution, Spatiotemporal epidemiology studies, About application, and Manual (which is highlighted with a purple background). The main content area has a header "Manual" and a sub-header "This manual includes step-by-step instructions on how to use each page of the application. If this manual is not displayed, you can view it by [click here](#). Below this is a toolbar with icons for zoom, orientation, draw, and read aloud. The central part of the screen displays a slide titled "Application Manual" with a green header and a large blue title. A green footer at the bottom right of the slide reads: "The content is a part of the project: 'Spatiotemporal studies with geostatistical methods for environmental health' funded by the Ministry of Science and Higher Education of the Republic of Poland".

## About Application Page

**6** Manual Page

The application consists of eight pages:

### Home page

The home page is the first page of the application, explaining what this app does. On this page, there are two buttons: "Go to upload data page" and "How to use?" The "Go to upload data page" button can go to the "upload data" page. The "How to use?" button can go to the "Manual" page, which explains how to use the application in format that is easier to understand than the technical details.

### Upload data page

The "upload data" page allows users to upload their data to be analyzed. This page consists of two sections: Input Data and Previous Risk Data. The input data section includes sections to upload individual data and household data. The previous risk data section has a dropdown menu from where the user can select the columns from the demographic menu for further analysis. The previous risk data section provides an option to preview input data where users uploaded all data. Once the data has been successfully uploaded, users can view the analysis results on the "epidemiological epidemiological analysis" page.

### Manual

The "Manual" page displays an interactive descriptive map of the user uploaded shapefile and csv file on the uploaded data page using case column to plot. Users can visualize and select filters including time period and color scheme.

### Epidemiological epidemiological analysis page

The "epidemiological epidemiological analysis" page is the page that occurs after the user has successfully uploaded the data on the "upload data" page. This page includes two tabs: Cluster detection and Association with Risk Factors.

- Cluster Detection Tab**
  - Cluster detection is an important tool for identifying signs of high-risk and developing hypotheses about health outcomes [1]. Cluster detection used to compute probabilities that the risk in certain areas or locations are higher than others.
- Association with Risk Factor Tab**
  - Association analysis is commonly expected to change as a risk factor increases over time. When the probability is positive, it means that as the risk factor rises, so will the outcome, whereas when the probability is negative, it means that if the risk factor increases, the outcome decreases. The data are assumed to be unrelated when the probability is zero, the association implying no association between risk factors and disease and outcome.

From the output, the coefficient of the risk factors obtained from the fit model, which is in the log scale, must be exponentiated and minus 1 and multiplied by 100. Therefore, the value is obtained as a percent increase.

### Select application

STEHealth

Home

Upload Data

Map Distribution

Spatiotemporal Epidemiological Analysis

Manual

Help

Issues

## Releases

### Version History

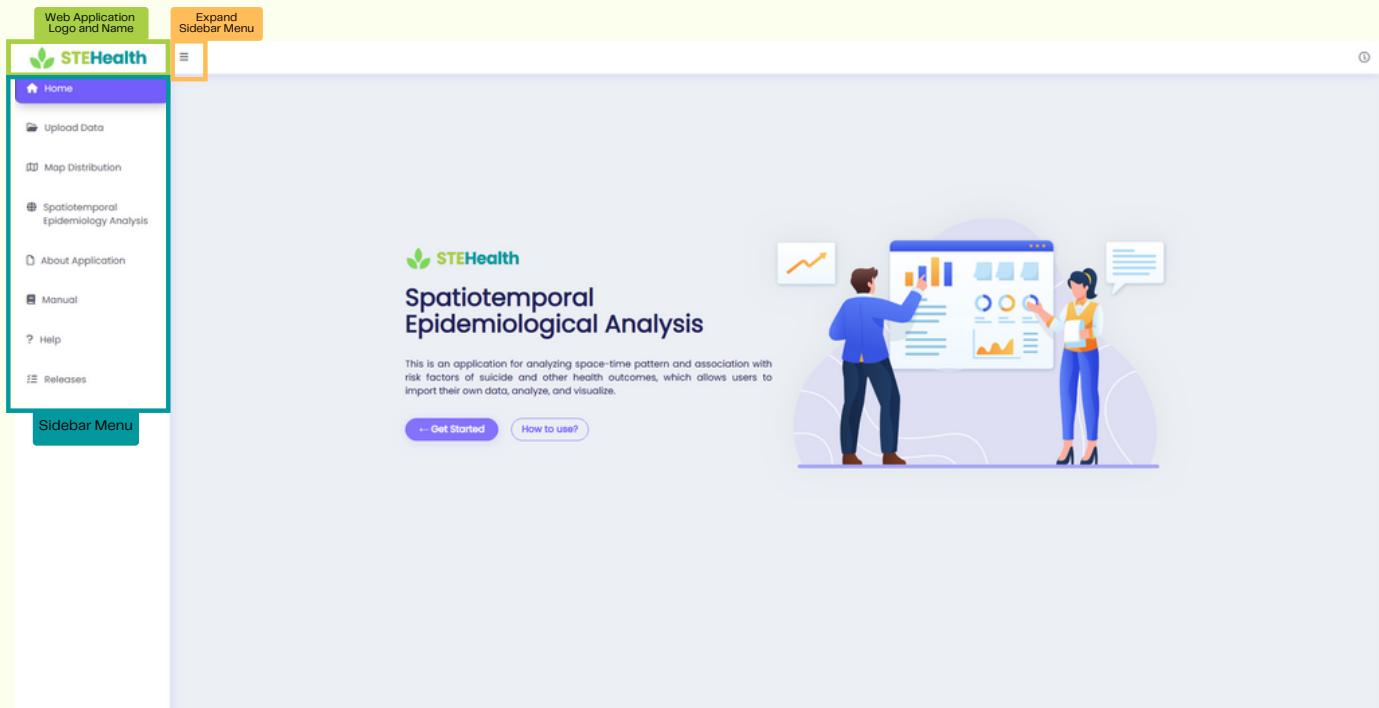
- version 1.1  
May 2023
  - Added according to the usability test:
    - Added calculate expected value
    - Added "Screenshot" button in all maps
    - Added "Download" button in all maps in Association with Risk factors tab.
    - Added download map option by pressing "Screenshot map" button.
    - Added detailed about analysis in Upload Data page.
    - Added examples of interpretation on "Spatiotemporal Epidemiological Analysis" page.
    - Added approach line to internal pages.
    - Changed background color
    - Changed font size
    - Changed date range period filter from slider to dropdown.
    - Changed button and title color on these pages Map Distribution and Spatiotemporal Epidemiological Analysis.
  - Edited the version name on Association with Risk factor tab from "percent\_increase\_riskfactor" to "Riskfactor\_percent\_increase". According to the usability test, some users are unable to choose the Risk factor tab because the names are similar, so we change the version name.
  - Fixed bug of Download results on Association with Risk factor tab that cannot be downloaded if less than 2 coordinates are included.- version 1.0  
27 March 2023
  - This version is initial release.

7 [Help Page](#)

8 **Releases Page**

# Application Pages

## 1 Home Page



The home page is the first page of the application, explaining what this app does. On this page, there are two buttons:

1. [← Get Started](#) This button can go to the "**upload data**" page.

2. [How to use?](#) This button can go to the "**Manual**" page, which explains how to use the web application in a format that is easier to understand than the "help" page and also have a demonstration of how to use application.

# Application Pages

## 2 Upload Data Page

The screenshot shows the 'Upload Data' page of the STEHealth application. The page is organized into two main sections:

- Input Data Section:** This section is highlighted with a pink border. It contains two main steps:
  - 1. Upload shapefile:** A field to "Browse..." a shapefile is shown, with "No file selected". Below it, a dropdown menu is set to "area name". A note asks if the shapefiles represent Thailand's 77 provinces. A radio button for "Yes" is selected.
  - 2. Upload csv file:** A field to "Browse..." a CSV file is shown, with "No file selected". Below it, a dropdown menu lists columns: "area id", "area name", "population", "time point", "cases", and "expected value". A note specifies that the CSV must have columns: "area id", "area name", "time point", "cases", and "population". A radio button for "Yes" is selected. A dropdown menu for "Select column" is also present.
- Preview Input Data Section:** This section is highlighted with a blue border. It displays a preview of the input data. A tab labeled "Map data (shapefile)" is selected, showing a small map icon. A tab labeled "Data (.csv file)" is also present. Below the tabs, there is a message: "Please Upload Data".

The "upload data" page allows users to upload data to be analyzed. This page consists of two sections:

### 1. The input data section

### 2. The preview input data section

**1. The input data section** comprises areas for uploading both shapefiles and CSV files related to health outcomes. After uploading the files, users need to choose specific columns from dropdown menus for subsequent analysis.

### • shapefile

**1. Upload shapefile** 

Upload 4 shapefile at once: shp, dbf, shx and prj.

Browse... No file selected

Select column area name in the map.  
area name 

Are these shapefiles from Thailand and do they include all 77 provinces, representing provincial boundaries (Level 1)?  
 Yes  No

Thai geographic coordinates, Thai provincial boundaries data (shapefile) will be obtained from the GEO package file in the Global Administrative Region Database (GADM). Shapefile upload allows users to upload all 4 files at the same time only: 1. shp 2. dbf 3. shx and 4. prj. Then, the user has to select the area id in the dropdown which must match the area name in the csv file.

In addition, users can view additional details, including the description of the shapefile and loading preview data, by pressing a button .

### Screenshot of sample shapefile (Thailand Shapefile)

ID_0	COUNTRY	ID_1	NAME_1	VARNAME_1	NL_NAME_1	TYPE_1	ENGTYPE_1	CC_1	HASC_1	ISO_1	geometry	
0	THA	Thailand	THA.1_1	Amnat Charoen	จังหวัดอัมnatชารอน	Changwat	Province	37	TH.AC	None	POLYGON ((104.58696 15.60588, 104.58676 15.605...	
1	THA	Thailand	THA.2_1	Ang Thong	จังหวัดอ่างทอง	Changwat	Province	15	TH.AT	None	POLYGON ((100.38371 14.74216, 100.38600 14.742...	
2	THA	Thailand	THA.3_1	Bangkok Metropolis	Bangkok Krung Thep Krung Thep Maha Nakhon Phra...	จังหวัดกรุงเทพมหานคร	Changwat	Province	10	TH.BM	None	POLYGON ((100.51929 13.66410, 100.51927 13.663...
3	THA	Thailand	THA.4_1	Bueng Kan	บึงกาฬ	Changwat	Province	None	TH.BK	None	POLYGON ((103.99140 17.87424, 103.99107 17.874...	
4	THA	Thailand	THA.5_1	Buri Ram	Buri Rum	จังหวัดบุรีรัมย์	Changwat	Province	31	TH.BR	None	POLYGON ((102.73676 14.13985, 102.73386 14.139...
...	...	...	...	...	...	...	...	...	...	...	...	
72	THA	Thailand	THA.73_1	Udon Thani	จังหวัดอุดรธานี	Changwat	Province	41	TH.UN	None	POLYGON ((102.90189 16.85360, 102.90183 16.853...	
73	THA	Thailand	THA.74_1	Uthai Thani	จังหวัดอุทัยธานี	Changwat	Province	61	TH.UT	None	POLYGON ((99.52662 14.97926, 99.52472 14.98022...	
74	THA	Thailand	THA.75_1	Uttaradit	จังหวัดอุตรดิตถ์	Changwat	Province	53	TH.UD	None	POLYGON ((100.05381 17.18046, 100.05165 17.179...	
75	THA	Thailand	THA.76_1	Yala	จังหวัดยะลา	Changwat	Province	95	TH.YL	None	POLYGON ((101.09618 5.70161, 101.09572 5.70217...	
76	THA	Thailand	THA.77_1	Yasothon	จังหวัดยะโส	Changwat	Province	35	TH.YS	None	POLYGON ((104.35171 15.34208, 104.35113 15.342...	

77 rows x 12 columns

[click here to download sample shapefiles](#)

- **csv file**

**2. Upload csv file** 

csv file needs to have columns: [area id](#), [area name](#), [time point](#), [cases](#), [population](#)

Browse... No file selected

Select columns:

area id		area name	
population		cases	
time point			

The user can only upload one csv file, which must contain:

1. **area id** (a number starting at 1, used to identify provinces).
2. **area name** (name of province)
3. **cases** (outcomes)
4. **time point**
5. **population**

- **Select Expected Value (Optional)**

**The expected value** is number of outcomes in the provided area and period which may vary due to the types of diseases.

Does this CSV file have an expected value column?

Yes  No

If the CSV file lacks an expected value column, the calculation will use the 'cases' and 'population' columns to derive an expected value.

Does this CSV file have an expected value column?

Yes  No

Select column:

expected value 

If the CSV file has an expected value column, the user can choose the expected value column using a dropdown, and this value will be used in the calculation.

## ◦ Select Covariates (Optional)

In select covariates section, user must putting covariates in the dropdown is to put them in order from 1 to 7, with no blanks.

Put covariate in order from 1 to 7, with no blanks.

Select column(s):

covariate 1	covariate 2
<input type="text"/>	<input type="text"/>
covariate 3	covariate 4
<input type="text"/>	<input type="text"/>
covariate 5	covariate 6
<input type="text"/>	<input type="text"/>
covariate 7	
<input type="text"/>	

- If the user select 1 covariate, the analysis is **univariate**.
- If the user selects covariates more than 1, all covariates will be calculated at the same time, which is a **multivariate** analysis.

## Screenshot of sample csv file (Thai suicide mortality and risk factors 2011-2021)

	province	province_id	year	suicide	population	debt	income	poverty	expenditure	homicide crime	property crime	shocking crime
0	Amnat Charoen	1	2011	15	372241	15816.29521	15619.29521	19.465428	14093.59122	93.803267	103.259996	11.132917
1	Ang Thong	2	2011	15	284061	23426.86803	23229.86803	11.370984	19134.75280	132.802670	249.675410	21.027569
2	Bangkok Metropolis	3	2011	136	5674843	49759.27425	49562.27425	3.971482	31896.10984	3478.753667	9877.476599	493.980976
3	Buong Kan	4	2011	16	407634	17420.63623	17223.63623	4.419098	15850.78284	97.173624	103.904513	18.819348
4	Buri Ram	5	2011	82	1559085	16775.13139	16578.13139	34.641094	13042.21393	370.039319	279.426377	28.979629
...	...	...	...	...	...	...	...	...	...	...	...	...
842	Udon Thani	73	2021	164	1559860	25454.97746	25257.97746	6.712360	30506.27100	171.799921	371.360346	34.148120
843	Uthai Thani	74	2021	19	325025	23302.91004	23105.91004	3.962674	23866.78137	77.163457	71.663962	6.758570
844	Uttaradit	75	2021	36	446349	23139.96822	22942.96822	7.977242	21975.76472	84.386137	134.992120	13.473962
845	Yala	76	2021	11	538960	10747.17634	10550.17634	18.491871	10899.73612	248.055302	1115.498036	116.100956
846	Yasothon	77	2021	27	533604	23520.83817	23323.83817	9.359222	20389.94348	98.303706	193.468316	13.071078

847 rows x 12 columns

[click here to download sample csv files](#)

The sample csv file contains the following 12 columns:

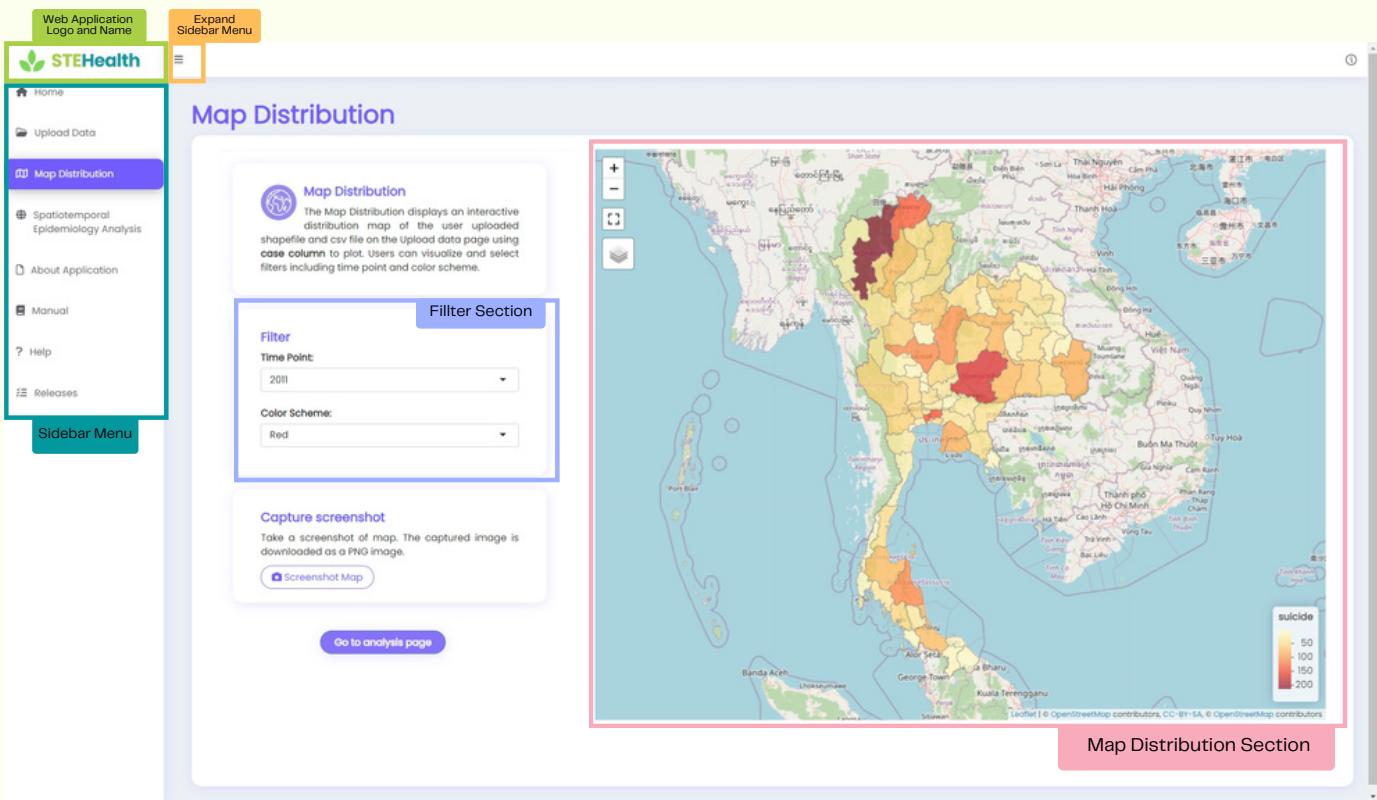
1. **province** is the name of province which has a total of 77 provinces.
2. **province\_id** is the number of province starting at from 1 to 77.
3. **year** is the number of year starting at from 1 to 11.
4. **suicide** is the number of suicides.
5. **population** is the population in each area.
- 6-12. **7 covariates:** debt, income, poverty, expenditure, homicide crime, property crime and shocking crime.

**2. The preview input data section** allows users to preview the uploaded data, which can include shapefiles and CSV files.

Once the data has been successfully uploaded, users must press [Preview Map Distribution](#) button then user will go to "Map Distribution" page.

## Application Pages

# 3 Map Distribution Page



The Map Distribution page displays an interactive distribution map of the user uploaded shapefile and csv file on the Upload data page using **case column** to plot.

- **Filter Section** Users can select time point (from time point column in Upload data page) and color scheme to visualize.

Time Point:

2011

Color Scheme:

Red

- **Map Distribution Section:**

- User can hover over the area to display the value of that area.
- Users can zoom in or zoom out by press 
- Users can view fullscreen map by press 
- Users can change theme map by press 

- Users can **take screenshot of map** by press button  .  
The captured image is downloaded as a PNG image.

when user views the map distribution finished, press the [Go to analysis page](#) button. then user will go to "spatiotemporal epidemiological analysis" page.

## Application Pages

# 4 Spatiotemporal Epidemiological Analysis Page

The screenshot shows the 'Spatiotemporal Epidemiological Analysis' page. At the top, there's a navigation bar with a logo, 'STEHealth', and a 'Sidebar Menu' button. Below the navigation, the main content area has a title 'Spatiotemporal Epidemiological Analysis' and two tabs: 'Cluster Detection' (selected) and 'Association with Risk Factors'. The 'Cluster Detection' tab contains several sections: 'Cluster Detection' (with a description of what it does), 'Filter' (with dropdown menus for 'Time Point' and 'Color Scheme' set to 'Red and Green'), 'Download Result' (with a 'Download (.csv)' button), 'Capture screenshot' (with a 'Screenshot Map' button), and 'Examples of interpretation (from sample data)'. On the left, a sidebar menu lists various options like 'Home', 'Upload Data', 'Map Distribution', 'Spatiotemporal Epidemiology Analysis' (which is highlighted in purple), 'About Application', 'Manual', 'Help', and 'Releases'. At the bottom of the sidebar is another 'Sidebar Menu' button. There are also two callout boxes: one green box labeled 'Web Application Logo and Name' pointing to the STEHealth logo, and one orange box labeled 'Expand Sidebar Menu' pointing to the sidebar menu button. A callout text on the right side of the page says 'Please upload data in "Upload Data" page to display cluster detection.'

The "spatiotemporal epidemiological analysis" page is the page that occurs result after the user has successfully uploaded the data and press [Go to analysis page](#) button on the "Map Distribution" page.

This page includes two tabs:

**01 – Cluster Detection**

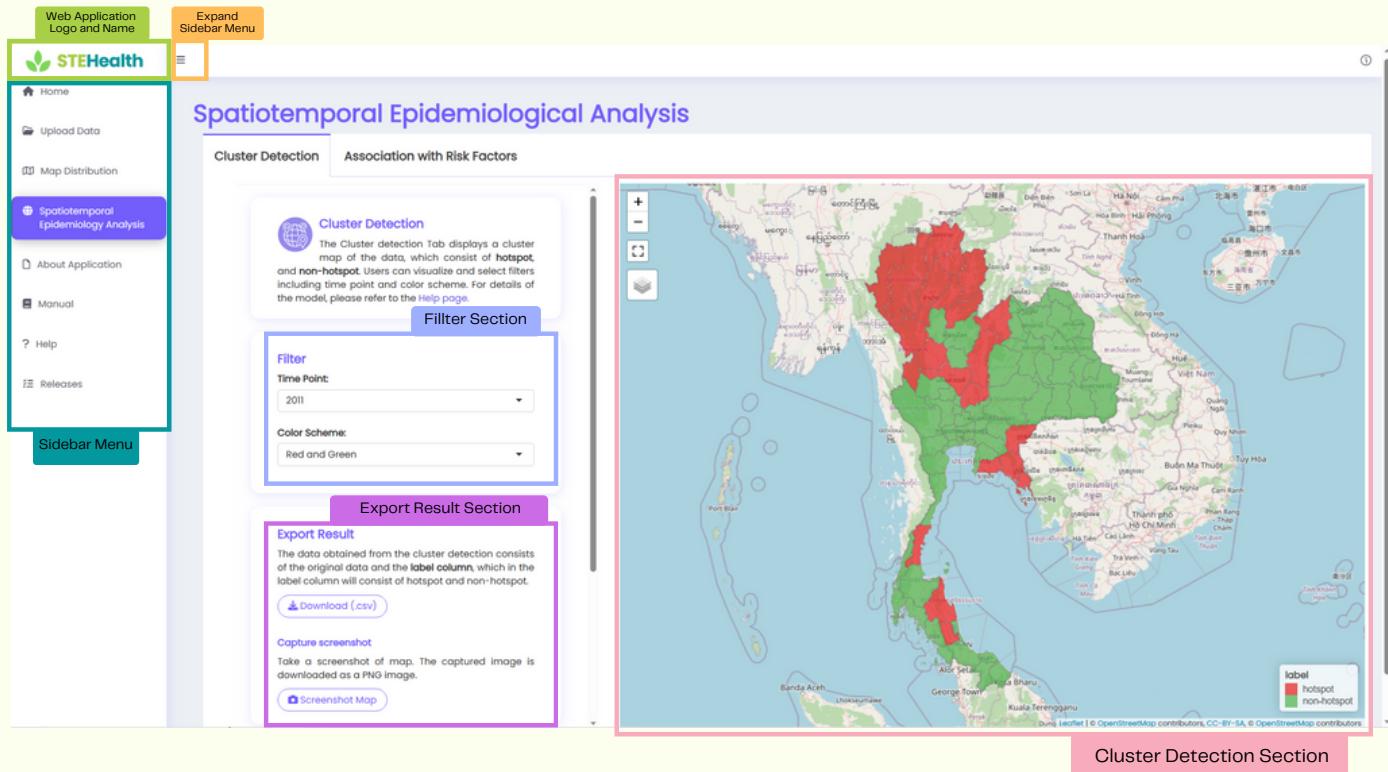
**02 – Association with Risk Factors**

# Application Pages

4.1

Spatiotemporal Epidemiological Analysis Result Page:

## Cluster Detection



Cluster detection is an important tool for identifying areas of high risk and developing hypotheses about health outcomes [1]. Cluster detection used to compute probabilities that the risk in an area exceeds certain thresholds can be done using the posterior probability distributions [2]. This probability of exceedance can then be used to decide whether an area should be hot-spot [3].

The cluster detection tab displays a **hotspot area map** of the data.

- **Details of the model**

This application perform cluster detection in spatiotemporal epidemiological analysis section using Bayesian spatiotemporal model. Let  $y_{it}$  be raw death counts for location  $i$  and time  $t$  which are a more common outcome of Bayesian disease mapping is modeled as a combination of intercept, and random effects.

$$y_{it} \sim Poisson(E_{it}\rho_{it}), \\ \log(\rho_{it}) = \alpha + \eta_{it}$$

The space-time random effects in the model describe variation due to location and time. The spatial effect is spatially structured effect called BYM. It is spatial effects combined unstructured spatial effect and spatially structured effect which can be expressed as;

$$u_i | u_{-i} \sim Normal\left(\mu_i + \frac{1}{N_i} \sum_{j=1}^n a_{ij}(u_j - \mu_j), s_j^2\right) + u_i \sim iid Normal(0, \sigma^2)$$

The temporal effect is structured effect called random walk prior of order 1 which can be written as;

$$\gamma_t | \gamma_{t-1} \sim Normal(\gamma_{t-1}, \sigma^2)$$

The prior distribution of space-time interaction depends on the spatial and temporal main effects which are assumed to interact. The model is interaction type I which unstructured spatial and temporal effects interact to each other.

- **Filter Section** Users can select time point (from time point column in Upload data page) and color scheme to visualize.

Time Point:

Color Scheme:

- **Cluster Detection Section:**

- User can hover over the area to display the label of that area.
- Users can zoom in or zoom out by press
- Users can view fullscreen map by press
- Users can change theme map by press

- **Export Result Section**

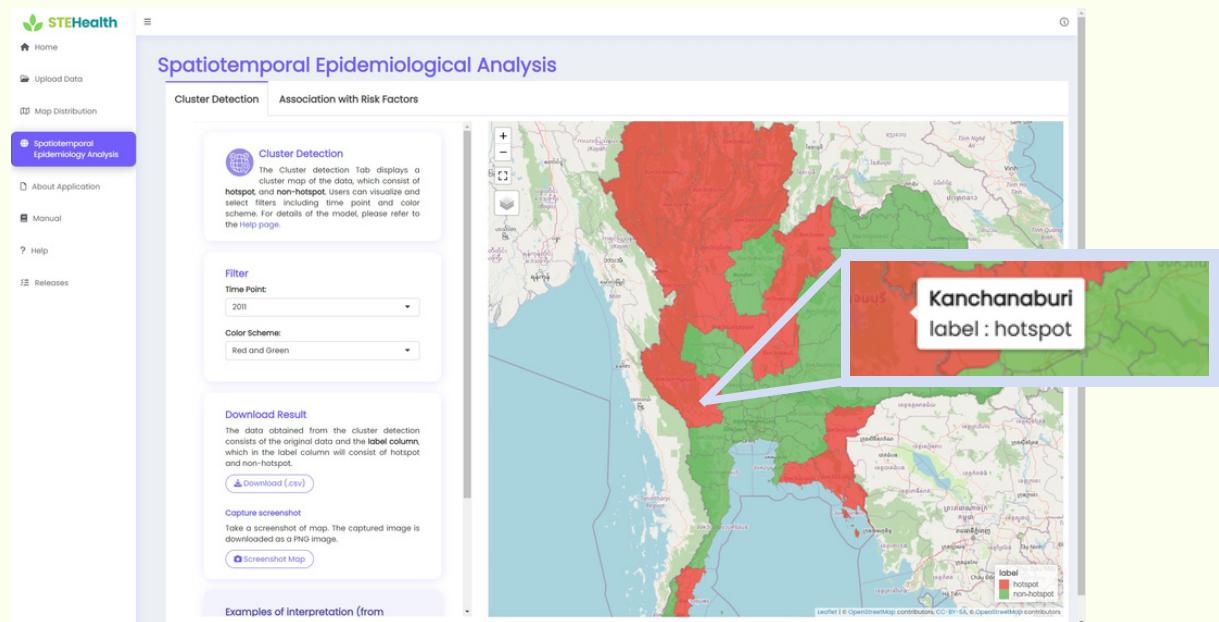
- Users can **export csv result** by press button . The result data from cluster detection consists of the original data and the **label column**, which in the label column will consist of hotspot and non-hotspot.
- Users can **take screenshot of map** by press button . The captured image is downloaded as a PNG image.

### Screenshot of sample result data from cluster detection

	province	province_id	year	y	E	debt	income	poverty	expenditure	homicide.crime	property.crime	shocking.crime	label
0	Amnat Charoen	1	1	15	22.499667	15816.29521	15619.29521	19.465428	14093.59122	93.803267	103.259996	11.132917	non-hotspot
1	Ang Thong	2	1	15	17.169731	23426.86803	23229.86803	11.370984	19134.75280	132.802670	249.675410	21.027569	non-hotspot
2	Bangkok Metropolis	3	1	136	343.009171	49759.27425	49562.27425	3.971482	31896.10984	3478.753667	9877.476599	493.980976	non-hotspot
3	Bueeng Kan	4	1	16	24.638955	17420.63623	17223.63623	4.419098	15850.78284	97.173624	103.904513	18.819348	non-hotspot
4	Buri Ram	5	1	82	94.237048	16775.13139	16578.13139	34.641094	13042.21393	370.039319	279.426377	28.979629	non-hotspot
...	...	...	...	...	...	...	...	...	...	...	...	...	...
842	Udon Thani	73	11	164	93.573496	25454.97746	25257.97746	6.712360	30506.27100	171.799921	371.360346	34.148120	hotspot
843	Uthai Thani	74	11	19	19.827627	23302.91004	23105.91004	3.962674	23866.78137	77.163457	71.663962	6.758570	non-hotspot
844	Uttaradit	75	11	36	27.867017	23139.96822	22942.96822	7.977242	21975.76472	84.386137	134.992120	13.473962	hotspot
845	Yala	76	11	11	29.845162	10747.17634	10550.17634	18.491871	10899.73612	248.055302	1115.498036	116.100956	non-hotspot
846	Yasothon	77	11	27	32.570332	23520.83817	23323.83817	9.359222	20389.94348	98.303706	193.468316	13.071078	non-hotspot

847 rows × 13 columns

## Example interprets of sample data from cluster detection



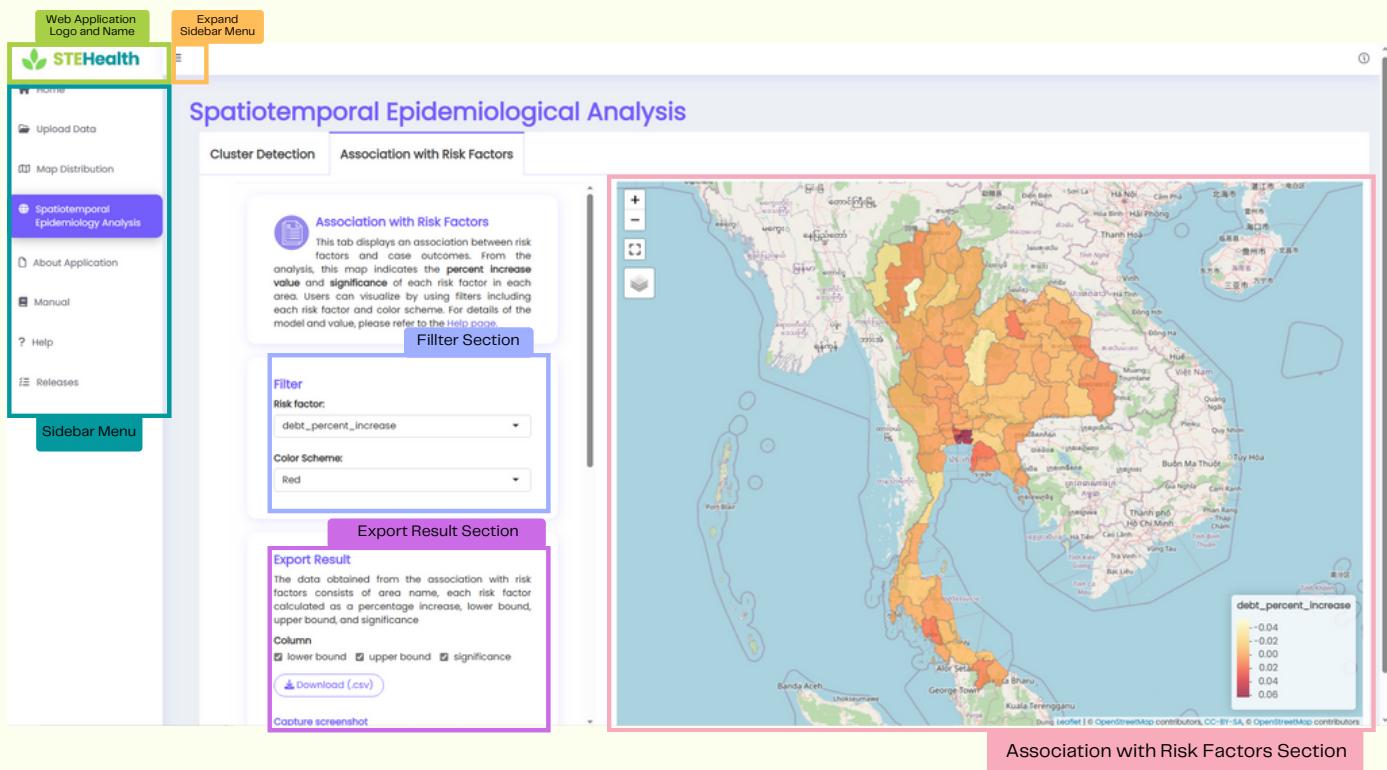
In Kanchanaburi, has a hotspot, meaning that Kanchanaburi has a higher number of suicides than the specified threshold (the base line of our work is defined as the average number of suicides).

# Application Pages

4.2

Spatiotemporal Epidemiological Analysis Result Page:

## Association with Risk Factors



The percentage of a health outcome expected to change as a risk factor increases one unit. When the probability is positive, it means that as the risk factor rises, so will the outcome, whereas when the probability is negative, it means that if the risk factor increases, the outcome decreases. The data are assumed to be unrelated when the probability is zero.

This tab displays an **association between risk factors** and case outcomes. From the analysis, the coefficient of the risk factors obtained from the fit model, which is in the log scale, must be exponentiated and minus 1 and multiplied by 100. Therefore, the value is obtained as a **percent increase**. In addition, the map also indicates the **significance** of each risk factor in each area.

- **Details of the model**

Association with risk factors is performed in spatiotemporal epidemiological analysis section using Bayesian spatiotemporal model. Let  $y_{it}$  be raw death counts for location  $i$  and time  $t$  which are a more common outcome of Bayesian disease mapping is modeled as a combination of intercept, fixed effects (risk factors), and random effects.

$$y_{it} \sim Poisson(E_{it}\rho_{it}),$$
$$\log(\rho_{it}) = \alpha + \sum_m^M \beta_m x_{mit} + \eta_{it}$$

The risk factor association is modeled on the multiplicative scale. Conditioned on the random effect terms and other fixed effects constant.

The space-time random effects in the model describe variation due to location and time. The details of spatial effect, temporal effect and space-time interaction in this model can be found on [page 18](#)

- **Filter Section** Users can select risk factor (from 7 covariates) and color scheme to visualize.

Risk factor:

debt\_percent\_increase

Color Scheme:

Red

- **Association with Risk Factors Section:**

- User can hover over the area to display the mean of that area.
- Users can zoom in or zoom out by press
- Users can view fullscreen map by press
- Users can change theme map by press

- **Export Result Section**

- Users can **export csv result** by press button . The result data from association with risk factors consists of the area name and each risk factor calculated as a **percentage increase**, lower bound, upper bound, and significance. Users can select the desired column by clicking on the checkbox.
- Users can **take screenshot of map** by press button . The captured image is downloaded as a PNG image.

### Screenshot of sample result data from association with risk factors

NAME_1	percent_increase_debt	debt_lowerbound	debt_upperbound	debt_significance	...	percent_increase_shocking.crime	shocking.crime_lowerbound	shocking.crime_upperbound	shocking.crime_significance
0 Annat Charoen	0.003541	-0.002228	0.002299	not significant	...	-0.010432	-0.014509	0.014193	not significant
1 Ang Thong	0.000837	-0.002241	0.002258	not significant	...	-0.003207	-0.014455	0.014358	not significant
2 Bangkok Metropolis	0.061935	-0.001694	0.002934	not significant	...	0.059457	-0.013251	0.015030	not significant
3 Bueng Kan	-0.018724	-0.002391	0.002003	not significant	...	-0.127153	-0.016257	0.012428	not significant
4 Buri Ram	-0.003422	-0.002266	0.002199	not significant	...	0.002679	-0.014371	0.014453	not significant
...	...	...	...	...	...	...	...	...	...
72 Udon Thani	-0.005361	-0.002292	0.002185	not significant	...	0.020211	-0.013871	0.014474	not significant
73 Uthai Thani	0.003036	-0.002202	0.002262	not significant	...	-0.025650	-0.014624	0.013852	not significant
74 Uttaradit	0.002325	-0.002207	0.002258	not significant	...	0.081126	-0.013178	0.015638	not significant
75 Yala	0.012414	-0.002128	0.002377	not significant	...	-0.012394	-0.014568	0.014190	not significant
76 Yasothon	-0.006113	-0.002262	0.002140	not significant	...	-0.011269	-0.014583	0.014239	not significant

77 rows × 29 columns

1. debt

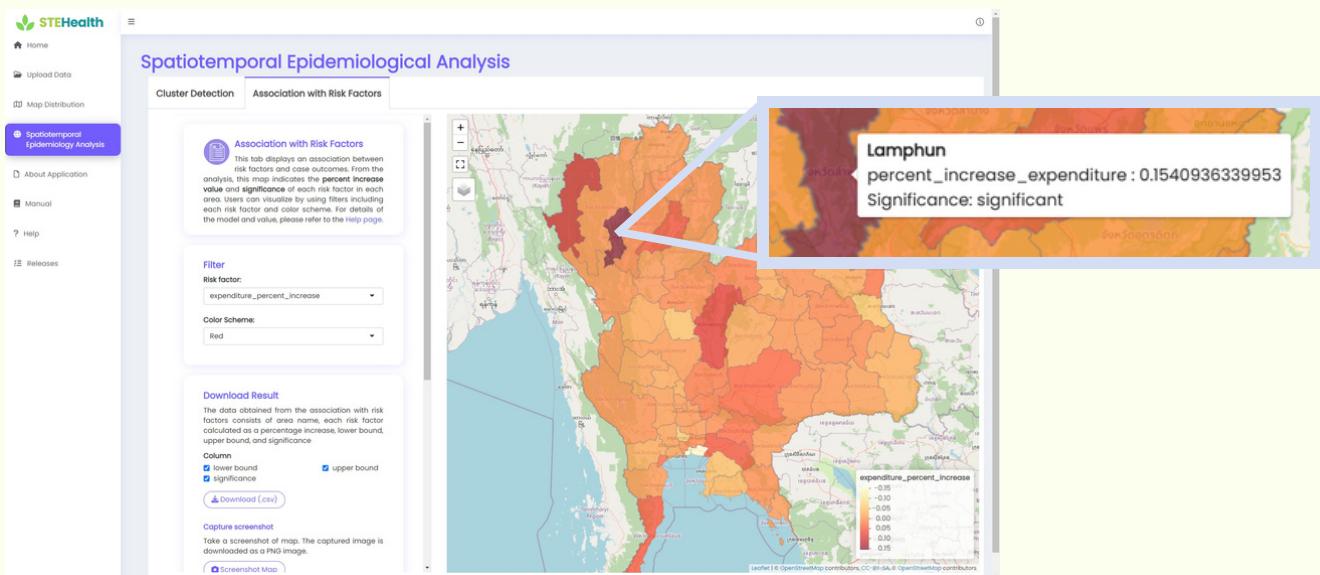
...

7. shocking crime

## Example interprets of sample data from association with 7 risk factors (Multivariate Analysis)

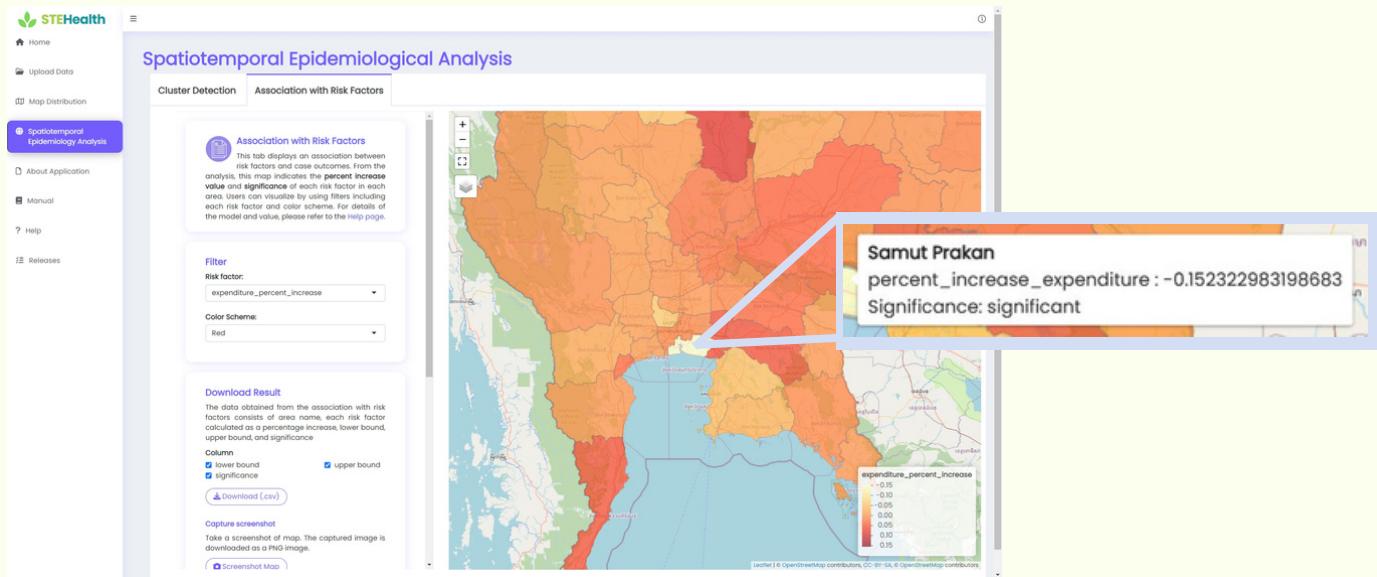
This example is an interpretation of a multivariable analysis of Thai suicide and risk factors. The model used 7 risk factors for multivariable analysis. However, the results are displayed one by one.

- If the significance is **significant**
  - If the value is **positive (+)**



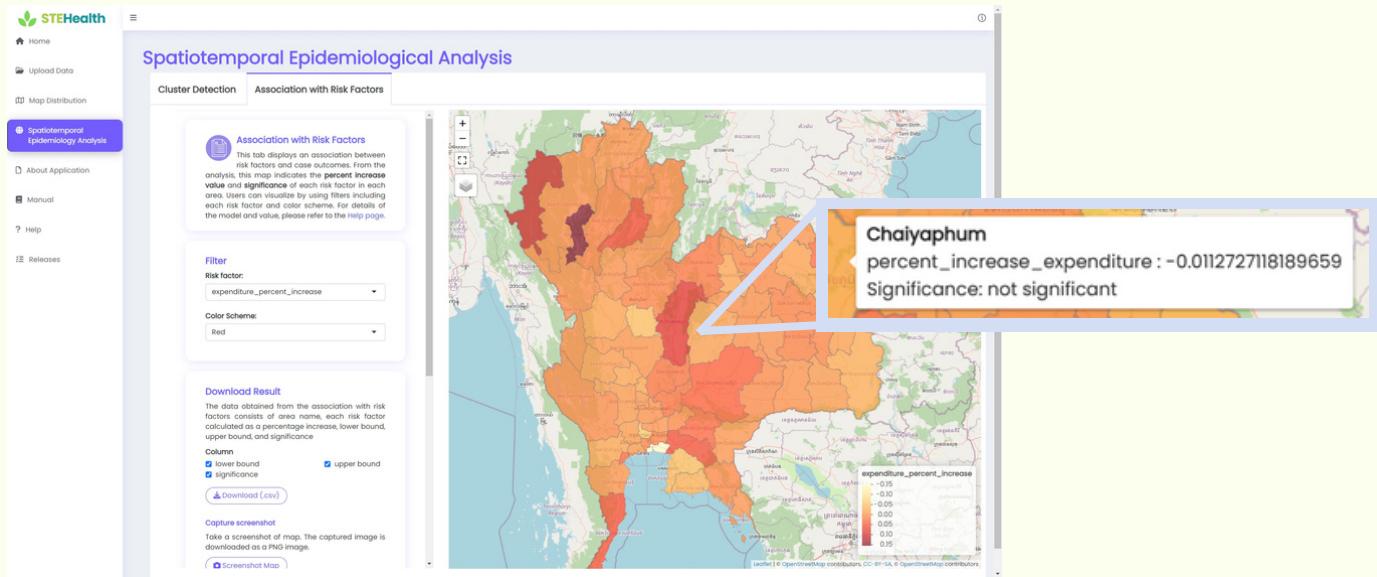
In Lamphun, the percent increase in expenditure is 0.15, which means if expenditure increases by 1 baht (THB), the suicide risk will increase by 0.15%, or every 100 baht (THB) increase in expenditure increases the suicide risk by 15%.

- If the value is **negative (-)**



In Samuut Prakan, the percent increase in expenditure is -0.15, which means if expenditure increases by 1 baht (THB), the suicide risk will decrease by 0.15%; in other words, if the expenditure increases by 100 baht (THB), it will decrease the suicide rate by 15%.

- If the significance is **not significant**



When the value of significance is not significant, it means that the expenditure variable and the suicide rate do not have significant relationships in Chaiyaphum.

# Application Pages

5

## About Application Page

Web Application Logo and Name

Expand Sidebar Menu

STEHealth

- Home
- Upload Data
- Map Distribution
- Spatiotemporal Epidemiology Analysis
- About Application
- Manual
- Help
- Releases

Sidebar Menu

### About Application

#### Background

The accessibility to spatiotemporal analytical tools is currently limited for public health workers and researchers, a user interface using RShiny will also be developed to increase accessibility and facilitate visualization and analysis for future spatiotemporal epidemiological studies. In addition, RShiny is effectively compatible with R-INLA which is the package we used to perform the analysis. To better communicate the results to stakeholders and public health researchers, we will develop user interfaces in the form of web applications with interactive features. However, the spatiotemporal analysis methods have limited availability, particularly for non-technical users. Moreover, the previously developed user interfaces do not provide specific features, such as proper cluster detection and space-time association with risk factors. We will then investigate and integrate these features into our project. Therefore, a web application using RShiny will be developed to increase accessibility and facilitate visualization and analysis for future spatiotemporal epidemiological studies. In addition, though this interface will be built in the context of mental health as a case study, this web application can be applied to the space-time analysis of other diseases.



#### Purpose

To develop a application to facilitate visualization and analysis for spatial and spatiotemporal epidemiological studies.

#### Developer

1. Papin Thanutchapat; Space-time pattern detection model and association with risk factors for suicide.
2. Chiraphat Phoncharoenwirate; Insights information of spatiotemporal epidemiology of suicide mortality and association with risk factors analysis.
3. Omrakorn Mekchalaporn; Application design and development.

#### Advisor

1. Dr. Unchalisai Taetragool
2. Asst. Prof. Dr. Chawarat Rotejanaprasert
3. Asst. Prof. Dr. Peerut Chienwichai

#### Code

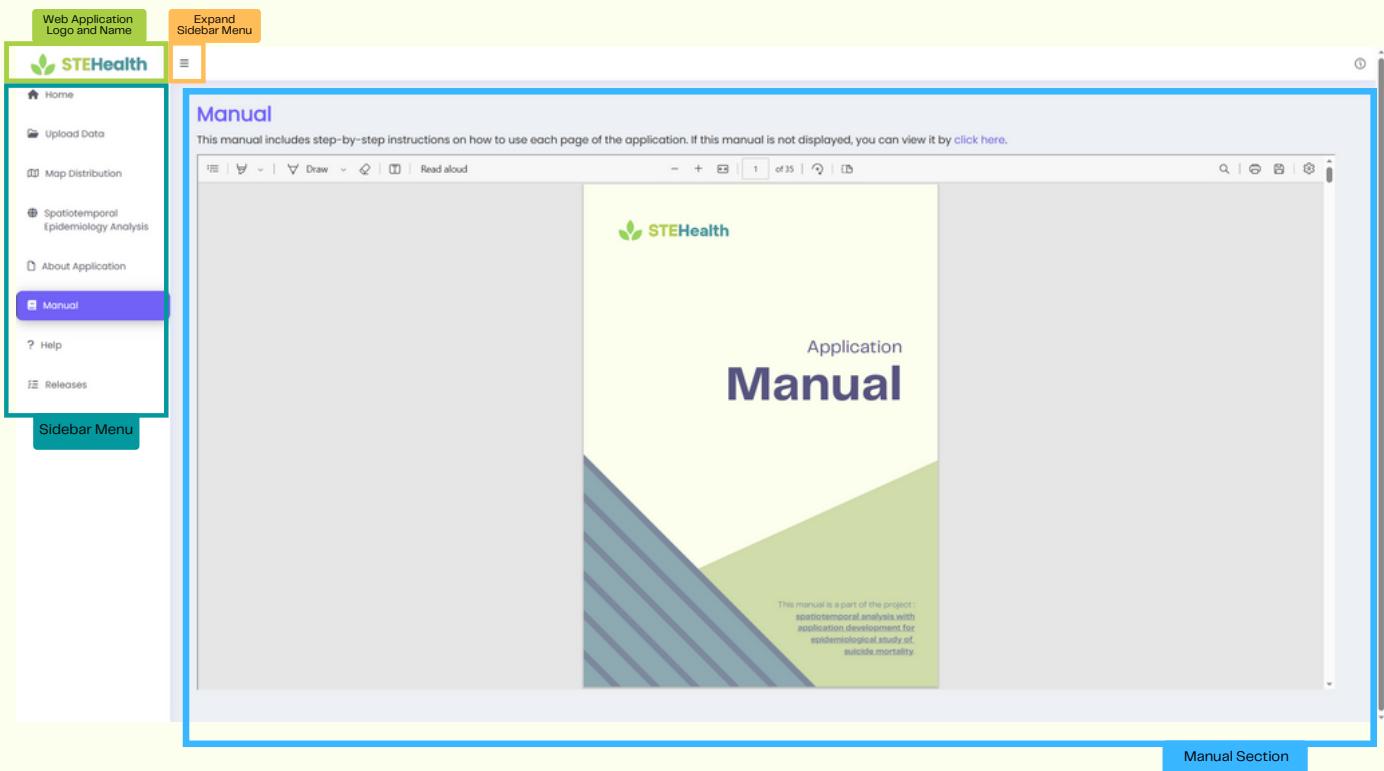
Code and data used for case study are available on [Github](#).

About Web Application Section

The "About Application" page provides information about the background, purpose, developer, advisor, references, and credits of the application.

## Application Pages

# 6 Manual Page



The "Manual" page explains how to use the application as a pdf book. This manual includes step-by-step instructions on how to use each page of the application

# Application Pages

## 7 Help Page

The "help" page is a page that describes structure of each page, contact, data used for case study of the application and **example error** (next page).

## Application Pages

Help Page:

7.1

# When Error Occurred ?

If an error occurs in usage, for example:

Error Message	Description
Map display gray color	It is caused by the user changing pages or changing taps while the application is plotting the map. The solution is to try displaying the map by filters adjusting.
Application crashes or analysis not working	It may be because the user uploaded data that is not as specified making it unable to analyze the data.
Application crashes display “ERROR: out of memory”	Depending on the performance of the device used, it may be because the user is using the application too quickly, for example, plotting a map too often without completing the previous plot.

# Application Pages

## 8 Releases Page

The screenshot shows the 'Releases' page of the STEHealth application. At the top, there are two buttons: 'Web Application Logo and Name' (green) and 'Expand Sidebar Menu' (orange). The sidebar menu on the left includes links for Home, Upload Data, Map Distribution, Spatiotemporal Epidemiology Analysis, About Application, Manual, Help, and Releases (which is highlighted with a purple background). Below the sidebar is a 'Sidebar Menu' button. The main content area has a title 'Releases' and a section titled 'Version History'. It lists two entries:

- version 1.1 (1 May 2023)  
This version according to the **usability test**:
  - Added calculate expected value
  - Added 'fullscreen' button in all map.
  - Added select column to download option in 'Association with Risk Factors' tap.
  - Added download map option by pressing 'Screenshot map' button.
  - Added 'Releases' page.
  - Added details about analysis in 'Upload Data' page.
  - Added details about in 'Manual' page.
  - Added examples of interpretation on 'Spatiotemporal Epidemiological Analysis' page.
  - Added approach link to internal pages.
  - Fixed manual is not displayed.
  - Changed UI style.
  - Changed the 'time period' filter from slider to dropdown.
  - Changed button and title color on these pages: Map Distribution and Spatiotemporal Epidemiological Analysis.
  - Edited application manual.
  - Edited the variable name on 'Association with Risk Factors' tap from 'percent\_increase\_riskfactor' is 'riskfactor\_percent\_increase'. According to the usability test, some users are unable to choose their preferred risk factor. Because on the screen of variable names, not all of them are visible, only the word front.
  - Fixed bug of 'Download results' on 'Association with Risk Factors' tap that cannot be downloaded if less than 7 covariates are included.
- version 1.0 (27 March 2023)  
This version is **initial release**.

A 'Help Section' button is located at the bottom right of the main content area.

The “Releases” page is a page that describes version history of application.

# Demonstration of 05 How to use application

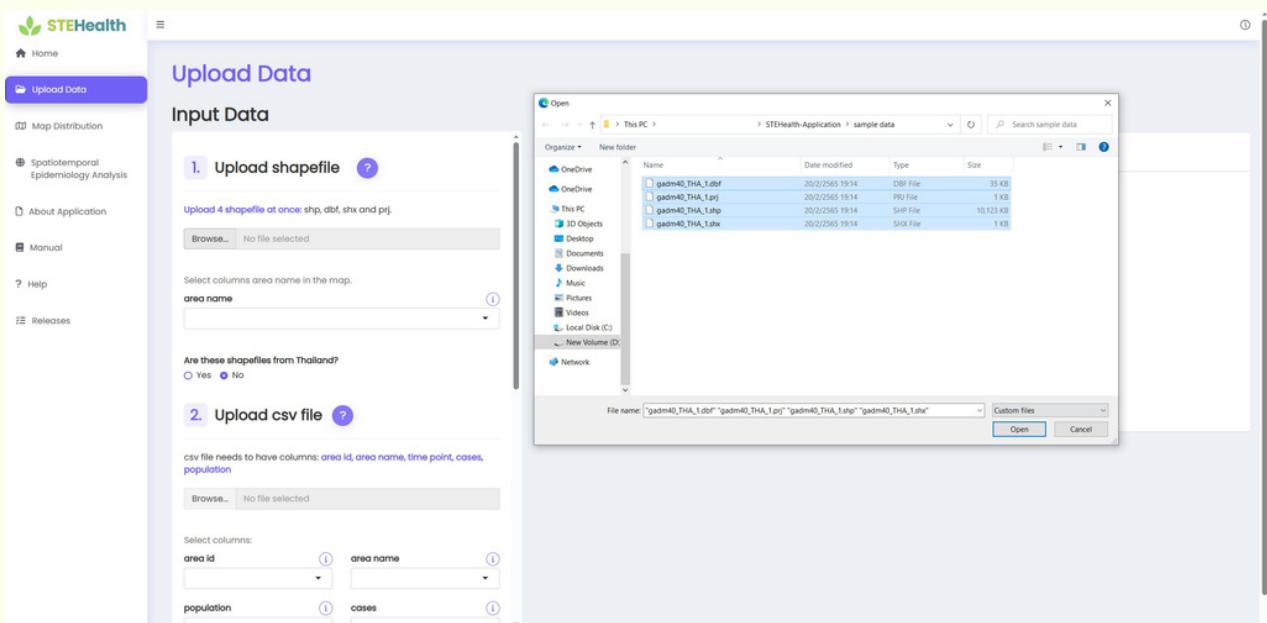
## Step 1

Open application and go to **Upload Data Page**.



## Step 2

**Upload 4 shapefile at once:** shp, dbf, shx and prj.



## Step 3 -Select columns area name.

3

**Note that:** "area name" in the shapefile must be matched to "area name" in the csv file

The screenshot shows the STEHealth application's 'Upload Data' interface. On the left, there's a sidebar with links like Home, Upload Data, Map Distribution, Spatiotemporal Epidemiology Analysis, About Application, Manual, Help, and Releases. The main area has two sections: 'Input Data' and 'Preview Input Data'. In 'Input Data', step 1 highlights the 'area name' dropdown where 'NAME\_1' is selected. Step 2 highlights the 'area name' column in the preview table, which lists various provinces like Amnat Charoen, Ang Thong, Bangkok Metropolis, etc. The preview table also includes columns for ID\_0, COUNTRY, ID\_1, NAME\_1, VARNAME\_1, NL\_NAME\_1, TYPE\_1, ENTYPE\_1, CC\_1, HASC\_1, and ISO\_1.

## Step 4 -Upload csv file

-Select columns: area id, area name, time point, population, cases

This screenshot shows the 'Upload Data' interface again, but with a different CSV file ('suicide\_th\_data\_sample.csv') loaded. Step 4 is indicated by green circles 1 and 2. Circle 1 points to the 'area name' dropdown in the 'Input Data' section. Circle 2 points to the 'area name' column in the 'Preview Input Data' table. The preview table now includes additional columns: province, province\_id, year, suicide, population, debt, income, poverty, expenditure, homicide.crime, and property. The table lists data for provinces like Amnat Charoen, Ang Thong, Bangkok Metropolis, Bueng Kan, and Buri Ram.

## Step

5

### -Select Expected Value (Optional)

1

2.1 Select Expected Value (Optional)  
Does this CSV file have an expected value column?  
Yes  No

Note that: If the CSV file lacks an expected value column, the calculation will use the 'cases' and 'population' columns to derive an expected value.

2.2 Select Covariates (Optional)  
Put covariate in order from 1 to 7, with no-blanks.  
Select column(s):

covariate 1	covariate 2
covariate 3	covariate 4
covariate 5	covariate 6
covariate 7	

Note that:  
• If the user select 1 covariate, the analysis is univariate.  
• If the user selects covariates more than 1, all covariates will be calculated at the same time, which is a multivariate analysis. However, the results will be displayed one by one on the Spatiotemporal Epidemiological Analysis' page ('Association with Risk Factors' top).

Preview Map Distribution

province	province_id	year	suicide	population	debt	income	poverty	expenditure	homicide_crime	property_crime	shocking_crime
Length:847	Min. : 1	Min. : 2011	Min. : 1.00	Min. : 175121							
Class : character	1st Qu.:20	1st Qu.:2013	1st Qu.: 26.00	1st Qu.: 478692							
Mode : character	Median :39	Median :2016	Median : 46.00	Median : 639863							
Mean : 39	Mean : 2016	Mean : 54.55	Mean : 843875								
3rd Qu.:58	3rd Qu.:2019	3rd Qu.: 70.00	3rd Qu.: 1063832								
Max. :177	Max. :2021	Max. : 124.00	Max. : 15689268								
debt	income	poverty	expenditure								
Min. : 8311	Min. : 8114	Min. : 0.3953	Min. : 6713								
1st Qu.: 19739	1st Qu.: 4.6662	1st Qu.: 15591	1st Qu.: 15591								
Median : 23524	Median : 9.9088	Median : 19139	Median : 20350								
Mean : 25569	Mean : 10.4220	Mean : 15.4220	Mean : 20250								
3rd Qu.: 30519	3rd Qu.: 28822	3rd Qu.: 153.50	3rd Qu.: 23459								
Max. : 106606	Max. : 106499	Max. : 162.3837	Max. : 15689268								
homicide_crime	property_crime	shocking_crime									
Min. : 123.14	Min. : 50.83	Min. : 3.31									
1st Qu.: 202.04	1st Qu.: 191.98	1st Qu.: 16.04									
Median : 237.04	Median : 197.37	Median : 30.38									
Mean : 294.45	Mean : 232.17	Mean : 49.09									
3rd Qu.: 344.38	3rd Qu.: 632.59	3rd Qu.: 53.67									
Max. : 3819.17	Max. : 9877.48	Max. : 542.08									

Show	entries	Search:									
province	province_id	year	suicide	population	debt	income	poverty	expenditure	homicide_crime	property_crime	shocking_crime
Amnat	1	2011	15	372241	15816.30	15619.30	19.485428	14093.59	93.80327	103.2600	
Chaiyaphum											
Ang Thong	2	2011	15	284061	23426.87	23229.87	11.370984	19134.75	132.80267	249.6754	
Bangkok Metropolis	3	2011	136	5674843	49759.27	49562.27	3.971482	31896.11	34787.5367	9877.476	
Bueng Kan	4	2011	16	407634	17420.64	17223.64	4.419098	15850.78	97.77362	103.9045	
Buri Ram	5	2011	82	1559085	16775.13	16578.13	34.641094	13042.21	370.03932	279.4264	

## Step 6 -Select Covariates (Optional)

6

**Note that:** putting covariates with no blanks.

1

2.2 Select Covariates (Optional)  
Put covariate in order from 1 to 7, with no-blanks.  
Select column(s):

covariate 1	covariate 2
debt	income
covariate 3	covariate 4
poverty	expenditure
covariate 5	covariate 6
homicide_crime	property_crime
covariate 7	shocking_crime

Note that:  
• If the user select 1 covariate, the analysis is univariate.  
• If the user selects covariates more than 1, all covariates will be calculated at the same time, which is a multivariate analysis. However, the results will be displayed one by one on the Spatiotemporal Epidemiological Analysis' page ('Association with Risk Factors' top).

Preview Map Distribution

province	province_id	year	suicide	population	expected.value	debt	income	poverty	expenditure	homicide_crime	property_crime	shocking_crime
Length:847	Min. : 1	Min. : 2011	Min. : 1.00	Min. : 175121								
Class : character	1st Qu.:20	1st Qu.:2013	1st Qu.: 26.00	1st Qu.: 478692								
Mode : character	Median :39	Median :2016	Median : 46.00	Median : 639863								
Mean : 39	Mean : 2016	Mean : 54.55	Mean : 843875									
3rd Qu.:58	3rd Qu.:2019	3rd Qu.: 70.00	3rd Qu.: 1063832									
Max. :177	Max. :2021	Max. : 124.00	Max. : 15689268									
expected.value	debt	income	poverty									
Min. : 11.78	Min. : 8114	Min. : 0.3953	Min. : 6713									
1st Qu.: 31.67	1st Qu.: 19936	1st Qu.: 4.6662	1st Qu.: 15591									
Median : 41.50	Median : 25068	Median : 9.9088	Median : 19139									
Mean : 56.78	Mean : 28822	Mean : 10.4220	Mean : 20250									
3rd Qu.: 71.58	3rd Qu.: 30519	3rd Qu.: 153.50	3rd Qu.: 23459									
Max. : 182.88	Max. : 106499	Max. : 162.3837	Max. : 15689268									
homicide_crime	property_crime	shocking_crime										
Min. : 123.14	Min. : 50.83	Min. : 3.31										
1st Qu.: 202.04	1st Qu.: 191.98	1st Qu.: 16.04										
Median : 237.04	Median : 232.17	Median : 49.09										
Mean : 294.45	Mean : 232.31	Mean : 49.09										
3rd Qu.: 344.38	3rd Qu.: 632.59	3rd Qu.: 53.67										
Max. : 65609	Max. : 104.9017	Max. : 542.08										

Show	entries	Search:										
province	province_id	year	suicide	population	expected.value	debt	income	poverty	expenditure	homicide_crime	property_crime	shocking_crime
Amnat	1	2011	15	372241	25.04579	15816.30	15619.30	19.485428	14093.59	93.80327	103.2600	
Chaiyaphum												
Ang Thong	2	2011	15	284061	19.11271	23426.87	23229.87	11.370984	19134.75	132.80267	249.6754	
Bangkok Metropolis	3	2011	136	5674843	381.82503	49759.27	49562.27	3.971482	31896.11	34787.5367	9877.476	
Bueng Kan	4	2011	16	407634	27.42717	17420.64	17223.64	4.419098	15850.78	97.77362	103.9045	
Buri Ram	5	2011	82	1559085	104.9017	16775.13	16578.13	34.641094	13042.21	370.03932	279.4264	

## Step

7

Press **Preview Map Distribution** button.

The screenshot shows the STEHealth application interface. On the left, a sidebar includes links for Home, Upload Data (highlighted in blue), Map Distribution, Spatiotemporal Epidemiology Analysis, About Application, Manual, Help, and Releases. The main area has two tabs: 'Upload Data' (active) and 'Preview Input Data'. The 'Upload Data' tab contains sections for 'Input Data' (with '2.1 Select Expected Value (Optional)' and '2.2 Select Covariates (Optional)') and a note about univariate/multivariate analysis. The 'Preview Input Data' tab shows a table of input data with columns: province, province\_id, year, suicide, population, expected.value, debt, income, poverty, expenditure, and homicide. The data is presented in two formats: a detailed table above and a summary table below.

## Step

7

- Users can visualize **Map Distribution** by using filters including time point and color scheme.
- Users can also take a screenshot of map.
- Press **Go to analysis page** button.

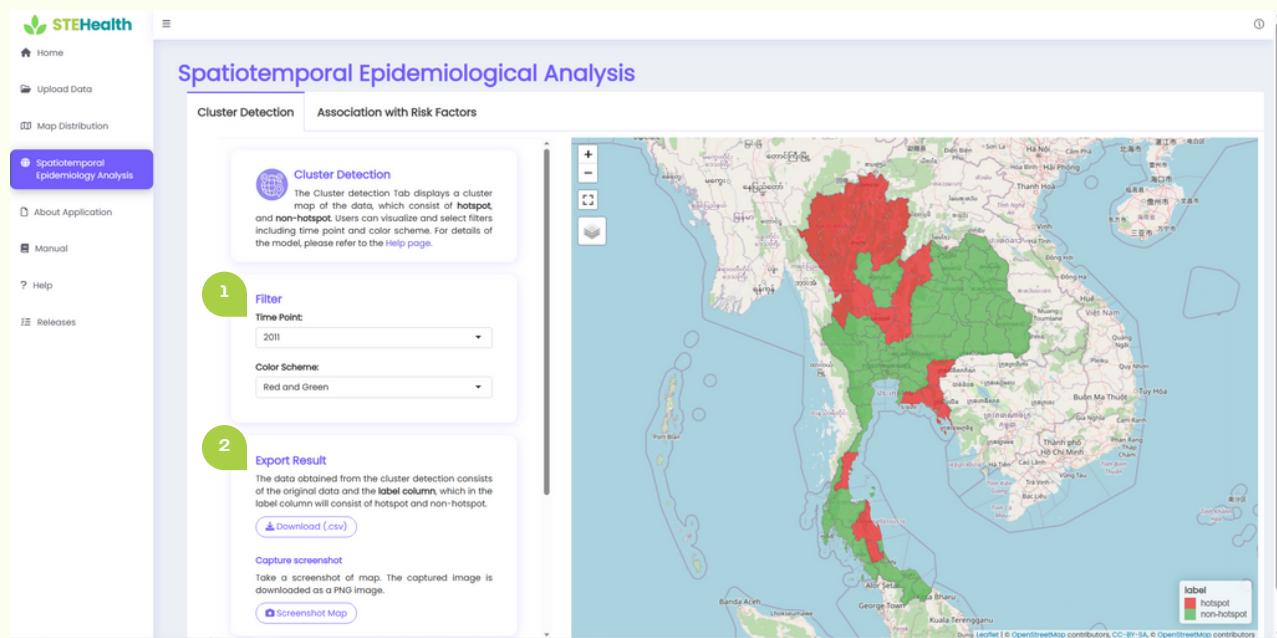
The screenshot shows the STEHealth application interface. The sidebar and tabs are identical to the previous step. The main area is titled 'Map Distribution'. It features a 'Map Distribution' section with a circular icon and a brief description. Below it are three numbered steps: 1. Filter (Time Point: 2011, Color Scheme: Red), 2. Capture screenshot (with a 'Screenshot Map' button), and 3. Go to analysis page. To the right is a choropleth map of Vietnam showing county-level suicide rates. A legend on the right indicates rates from 50 to 200. The map includes labels for provinces and districts.

**Note that:** The Spatiotemporal Epidemiological Analysis page may take 1-3 minutes to calculate depending on computer performance.

## Step 8

### In Cluster Detection Tab:

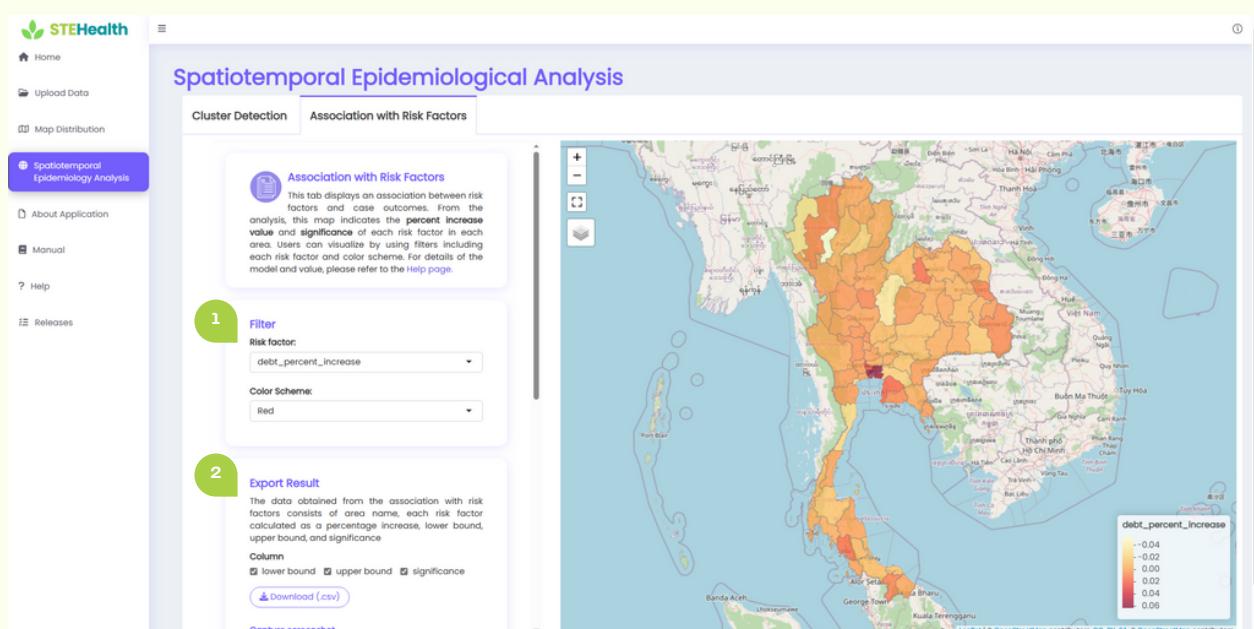
- Users can visualize results of **Cluster Detection** by using filters including time point and color scheme.
- Users can also download data obtained from cluster detection and take a screenshot of map.



## Step 9

### In Association with Risk Factors Tab:

- Users can visualize **Association with Risk Factors** by using filters including each risk factor and color scheme.
- Users can also download data obtained from cluster detection and take a screenshot of map.



# 06 Source code, Dependencies, References, Credits, and Contact us

## Source code

Source code in application are available on [GitHub](#).

## Dependencies

- **Softwares**

Software	Description
R	Language and environment for statistical computing and graphics
RStudio	Integrated development environment (IDE) for R
R-Portable	R portable configures R to work with the PortableApps framework, so that R can be ran from a thumb drive or portable hard drive without leaving artifacts on the computer.

## • R packages

R packages	Description
shiny	Makes it easy to build interactive web apps from R
shinydashboard	Use with shiny to create dashboards
shinyjs	Perform common useful JavaScript operations in Shiny apps that will greatly improve the apps without having to know any JavaScript
shinyBS	Adds additional Twitter Bootstrap components to Shiny
shinyWidgets	Collection of custom input controls and user interface components for 'Shiny' applications. Give your applications a unique and colorful style!
shinydashboardPlus	Extend 'shinydashboard' with 'AdminLTE2' components. 'AdminLTE2' is a free 'Bootstrap 3' dashboard template
dplyr	A fast, consistent tool for working with data frame like objects, both in memory and out of memory
ggplot2	Creates elegant data visualisations using the grammar of graphics
leaflet	Create Interactive Web Maps with the JavaScript 'Leaflet' Library
leaflet.extras	This package serves as an add-on to the 'leaflet' package by providing extra functionality via 'leaflet' plugins.
RColorBrewer	Provides color schemes for maps and other graphics
rgdal	Provides bindings to Frank Warmerdam's Geospatial Data Abstraction Library (GDAL)
R-INLA	Performs full Bayesian analysis on generalised additive mixed models using Integrated Nested Laplace Approximations
spdep	Spatial Dependence: Weighting Schemes, Statistics
capture	Add a button in Shiny application or R Markdown document to take a screenshot (PNG or PDF) of a specified element.
bsplus	The Bootstrap framework lets you add some JavaScript functionality to your web site by adding attributes to your HTML tags.

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## Contact us

If you have any trouble with this application or have any further questions or feedback, then please contact us at: [ornrakorn.mek@outlook.com](mailto:ornrakorn.mek@outlook.com) and we will be happy to help.

