

# **Potential Analysis of the Population Density Distribution in Southeast Asia**

Michihisa Umekawa

(Kyoto University->

Tokyo University of Foreign Studies)

# Introduction

Purpose: Bring in the “Population density potential” and consider the new analysis:

Investigate the continental Southeast Asian countries from the population density and the potential analysis.

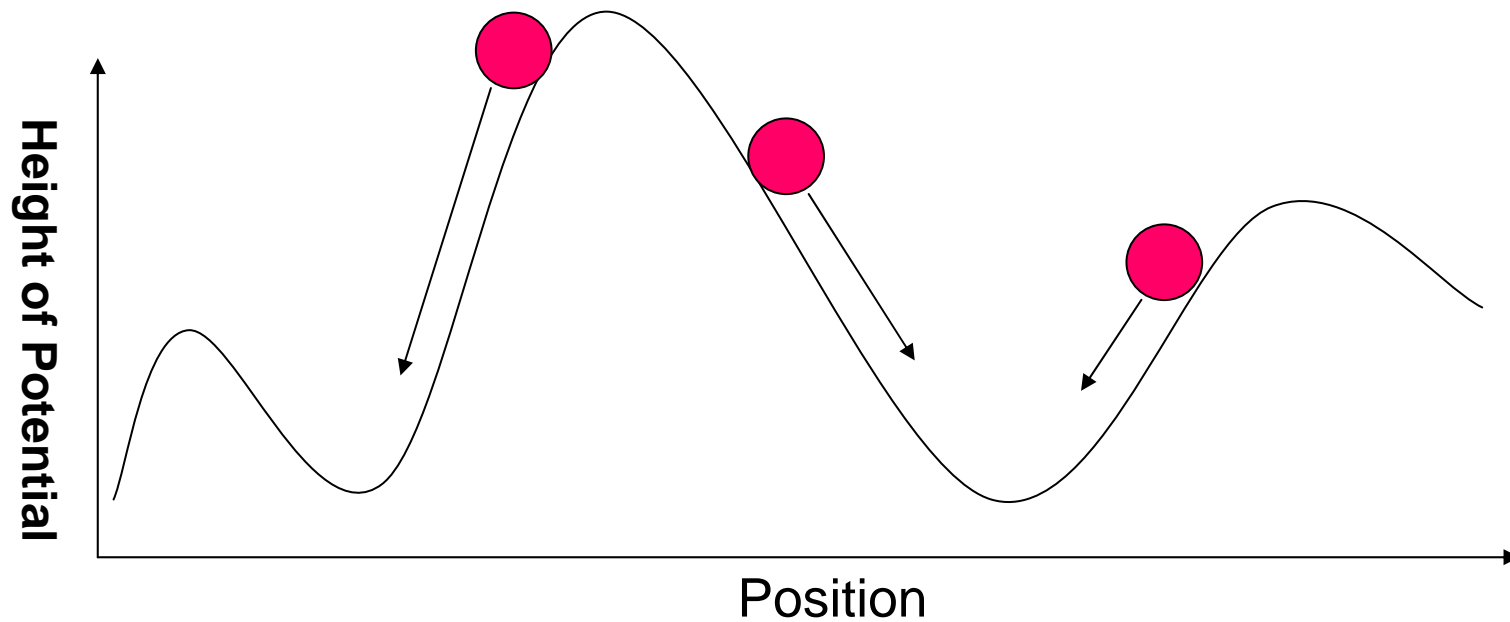
What is potential?

- Comes from mechanics, electromagnetics, etc.
  - Ex. potential energy, electric potential
- conceptual “height”

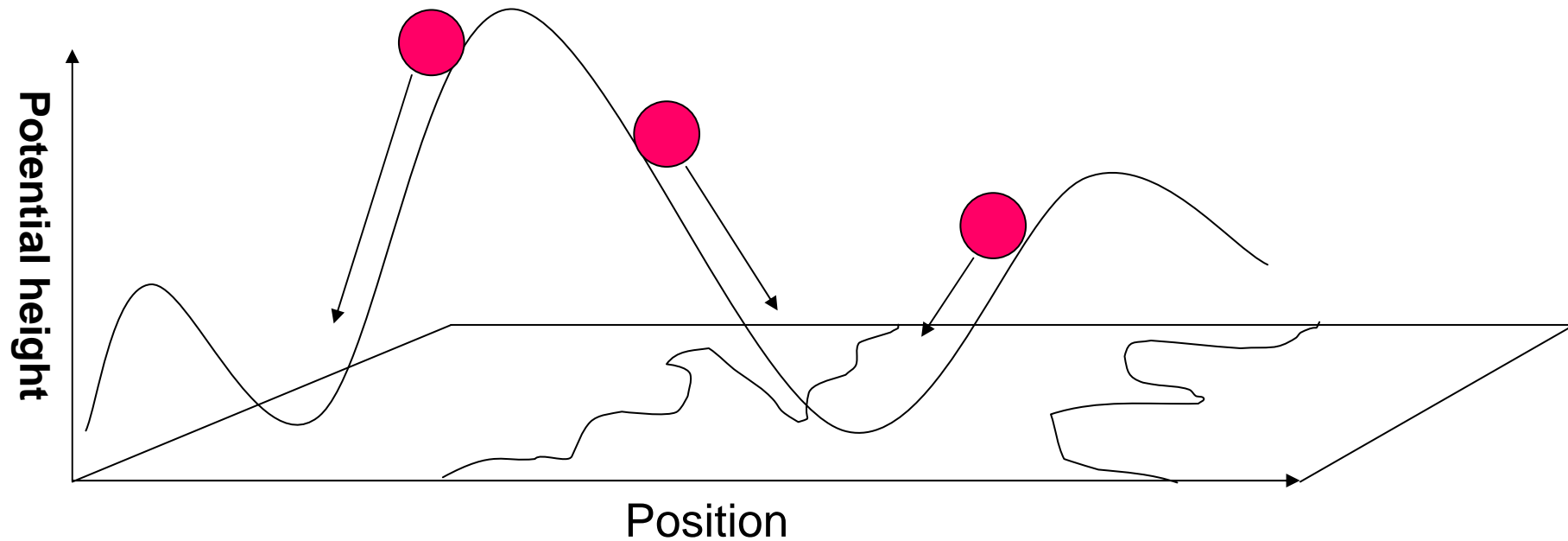
In the concept of physics, “something” moves from potential high position to potential low position in field.

→What is “something” ?

Population density, in this study.



Potential for geographical data on maps, especially population density distribution, accumulates population density to the region whose potential is low.



**Approach for the potential to the population density distribution numerically.**

## Conditions:

- 2D Cartesian coordinate
- 0 fixed boundary values.
- Regions where nobody can live are simply regarded as population density is equal to 0.

Problems are gotten around, however...

→ Qualitative results and discussion are only expected.

# Numerical method

## Numerical Calculations:

- Poisson equation for population density  
→ To calculate from source population density to the potential

$$\Delta\phi = b\rho,$$

where  $b$  is a constant,  $\phi$  is population density potential, and  $\Delta$  Laplacian

$$\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

- Using GNU Fortran90 compiler on Linux  
ICCG Scheme, Poisson solver

# Model

## Models:

- Calculation about six countries: Cambodia, Vietnam, Laos, Thailand, Malaysia (peninsula area), and Myanmar.
- In this presentation, the results of derived population density potential distributions for each model are shown.

## Parameters:

Model	1	2	3	4	5	6
Country	Cambodia	Vietnam	Laos	Thailand	Malaysia	Myanmar
Number of Population (x1,000)	13,104	78,137	5,279	62,806	22,218	47,749
Number of grids	144x144	216x432	240x240	264x432	552x192	264x528
size of 1 grid	2.5'	2.5'	2.5'	2.5'	2.5'	2.5'

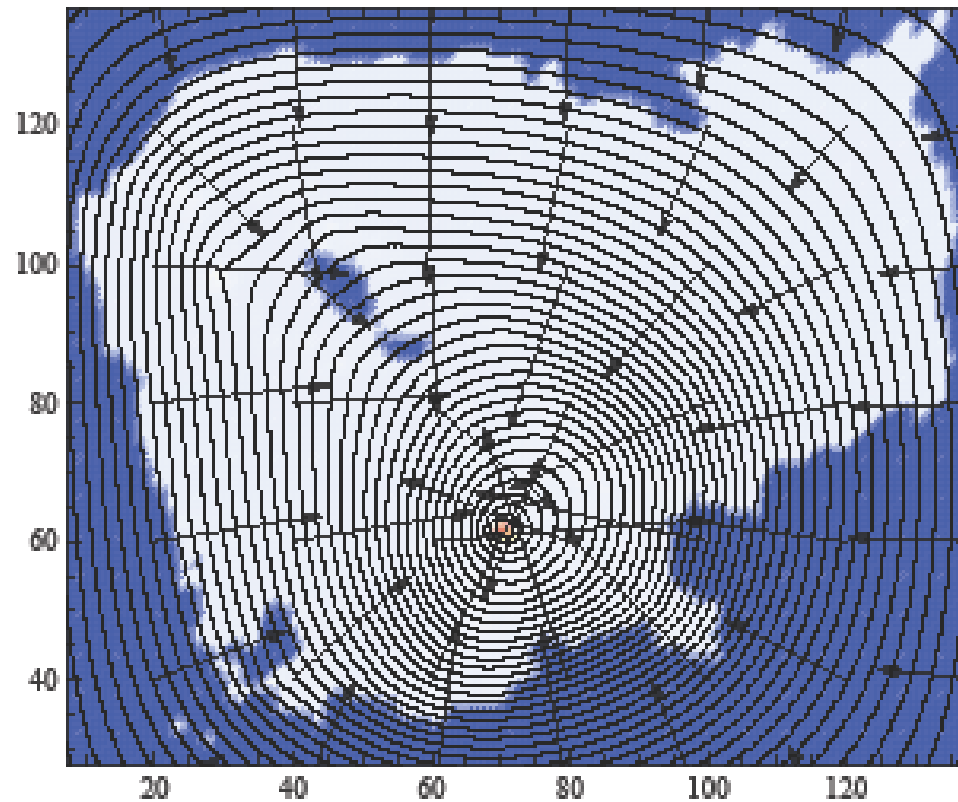
UN 2000, from SEDAC (<http://sedac.ciesin.columbia.edu/>)

Model 5 includes Borneo.



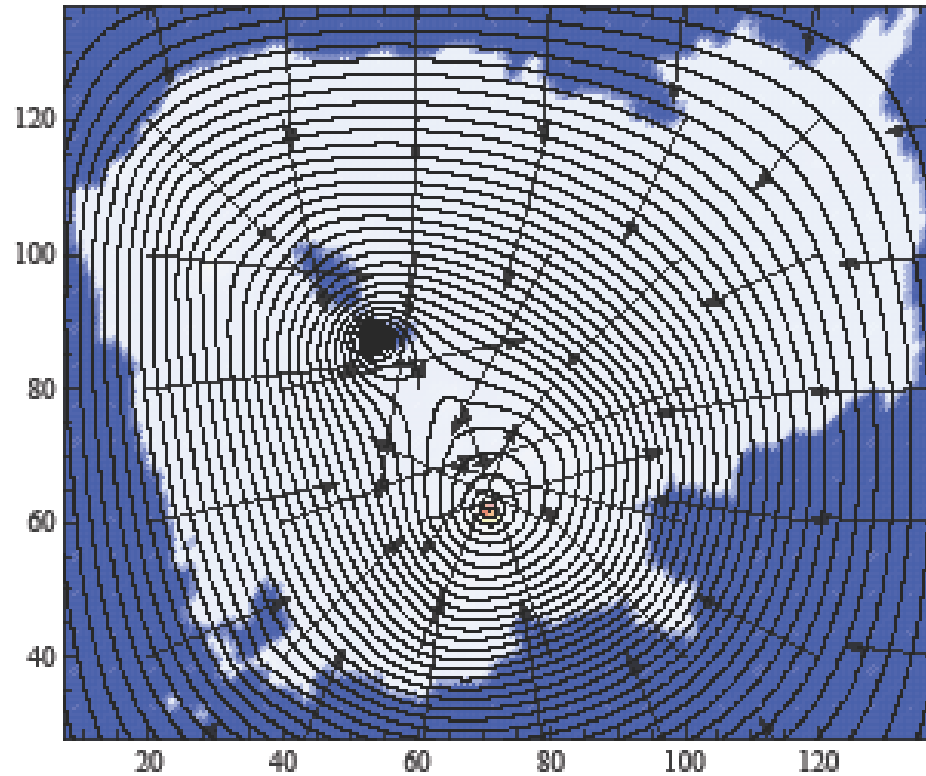
# Result

## Model 1 (Cambodia)



- Mono concentrated structure by Phnom Penh
- Batdamban creates a dent and modify the vector field around it.

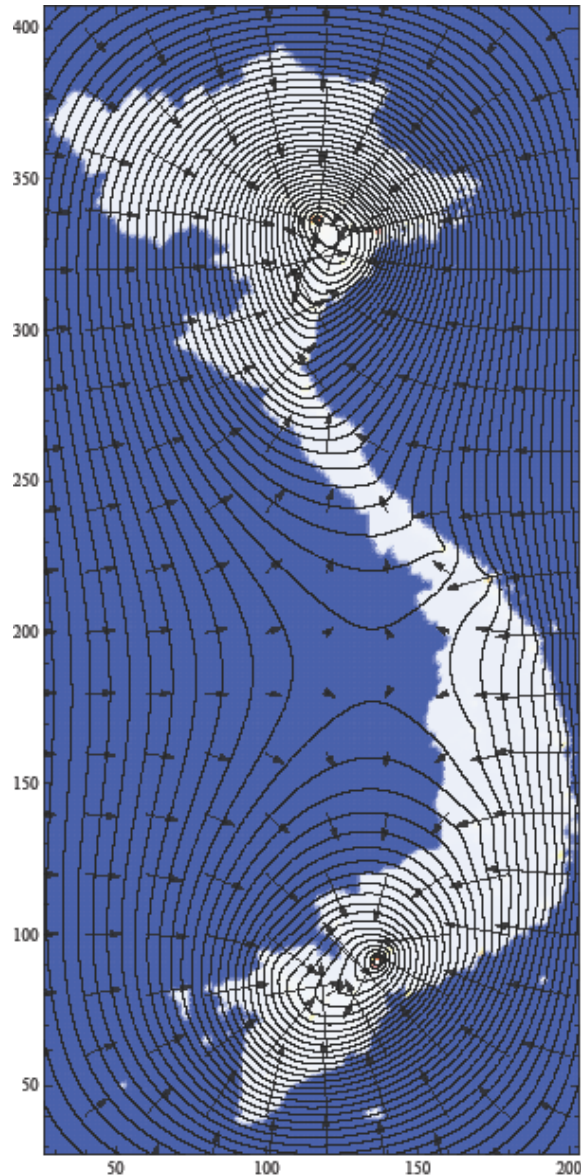
Contour curves are population density potential. Arrows are force field come from the potential.



- The raw data
- What is the deep valley near LakeTonle Sab ?

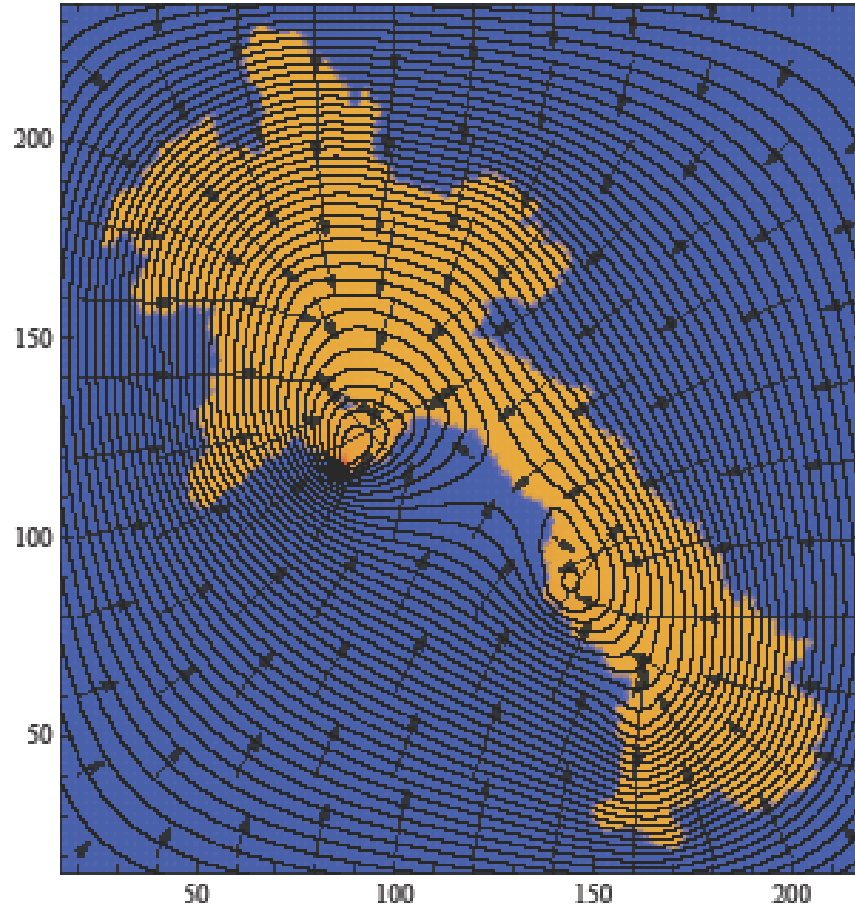
Wrong data?  
only one grid has the value  
“1230853.3” as the population  
density.

## Model 2 (Vietnam)



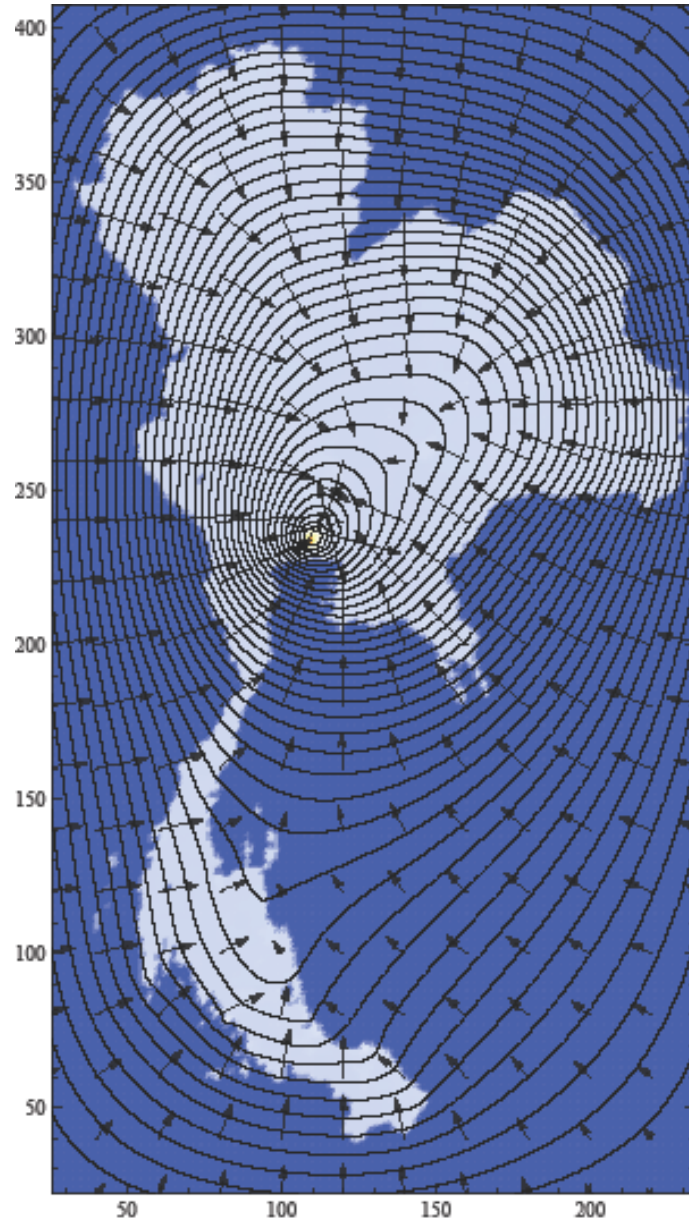
- **Strong bipolar structure of population density potential created by Hanoi and Ho Chi Minh.**
- **Small structure between two large cities.**

## Model 3 (Laos)



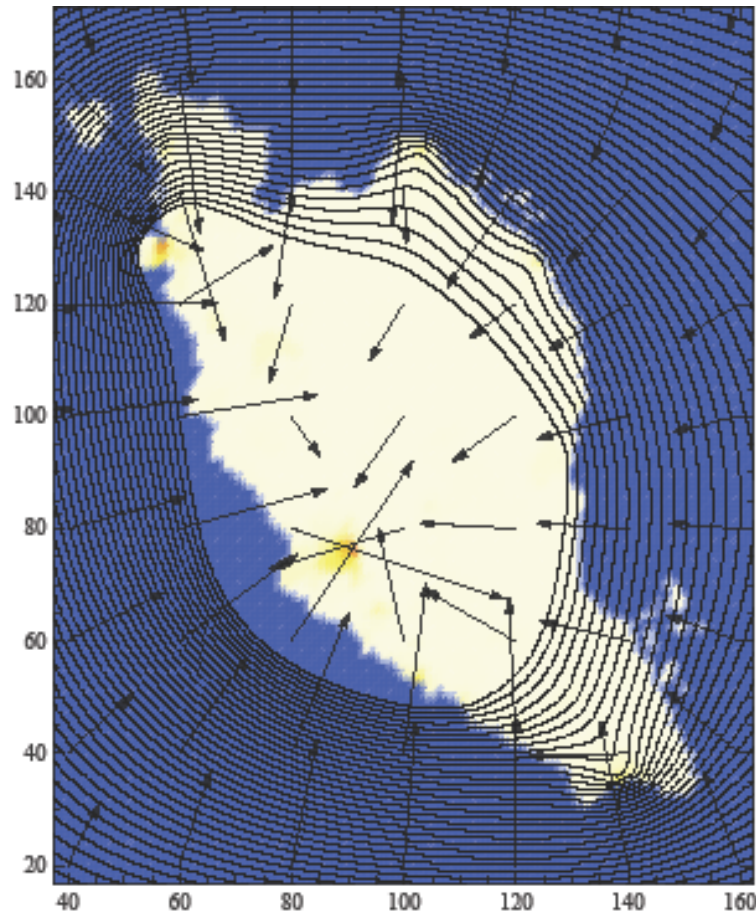
- **Bipolar structure**  
**Deep potential valley by Vientiane**  
**and the dent without population**  
**concentration.**

## Model 4 (Thailand)



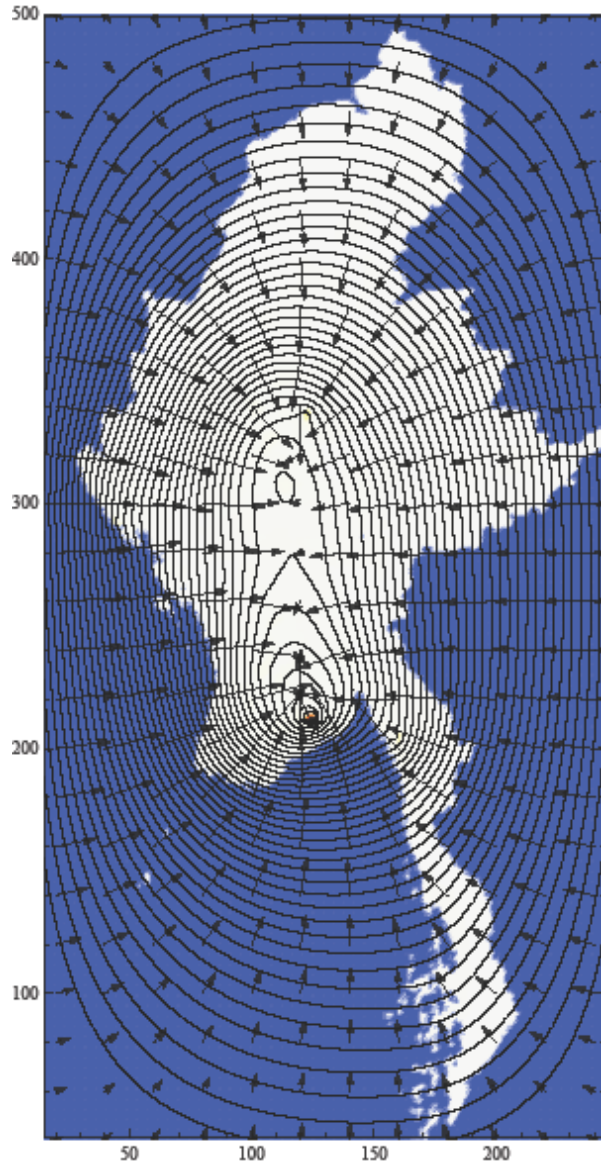
- Mono concentrated by Bangkok
- Stream lines at north west and north east region
- How about effect from Laos?

# Model 5 (Malaysia; Malay Peninsula)



- Bipolar structure created by Kuala Lumpur and Penang.
- Force field totally points Kuala Lumpur.

# Model 6 (Myanmar)



- **Bipolar structure by Yangon and unknown population distribution. The dent is made by the same reason to the Laos model?**

# Discussion

What is population density potential? :

- The direction and stream which citizen watches can find
- Potential structure determines stream of population?
- Potential and force field structures mean digitization of city appeals.
- (Future work) Analysis for more details, small and large scale map  
Urban structure and whole continental Southeast Asia is important.

Category: 1 Mono concentrated potential structure

2 Bipolar structure

+Fully Bipolar (Vietnam)

+Large city and dent (Laos, Myanmar)

This structure is newly discovered phenomenon??

Field works other analysis are effective to determine.



Application to other analyses:

Can it be applied to other geographical quantities?

- For distribution of dialect: digitalization by using the ratio of number of users
- For biological data, distribution of creature
- Multiple analysis with air temperature, elevation, etc.

# Conclusion

- Population density potential analysis is applied to the continental Southeast six Asian countries.
- The countries can be categorized by the property of the potential structure, mono concentrated and bipolar. Bipolar category has sub category, fully bipolar potential structure and without large city case.
- Discovered potential dents without population concentration should be investigated by direct method such as field works or other analyzing methods.

Thank you