Spatial Optimization based on integrated impact of climate change

Supported by MOTIVE project

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Introduction

Motive project

The Title of project is:

Model Of InTegrated Impact and Vulnerability Evaluation of Climate Change

Motive project

- **Sponsor**: Ministry of Environment
- **Project Period**: 2014.5.1~2021.4.30(7 Years)
- 100+Experts from the Interdisciplinary Research groups

- **Ultimate Goal**: Development of integrated evaluation model reflecting Korean circumstance to be utilized for designing 'science-based adaptation strategies'

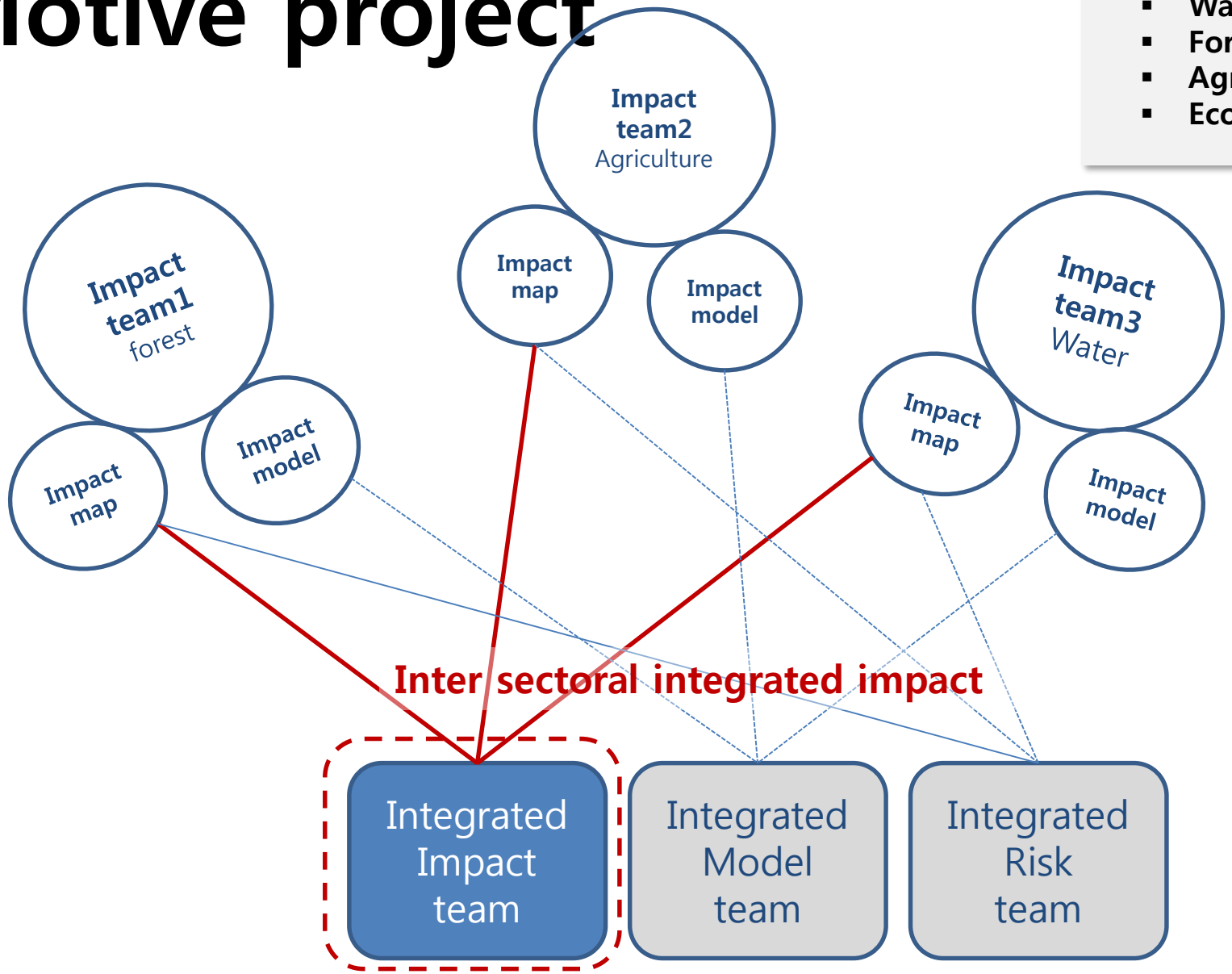
Scopes

- **Time period**: 2030s, 2050s, 2080s
- **Spatial** : S. Korea 1kmx1km

Motive project

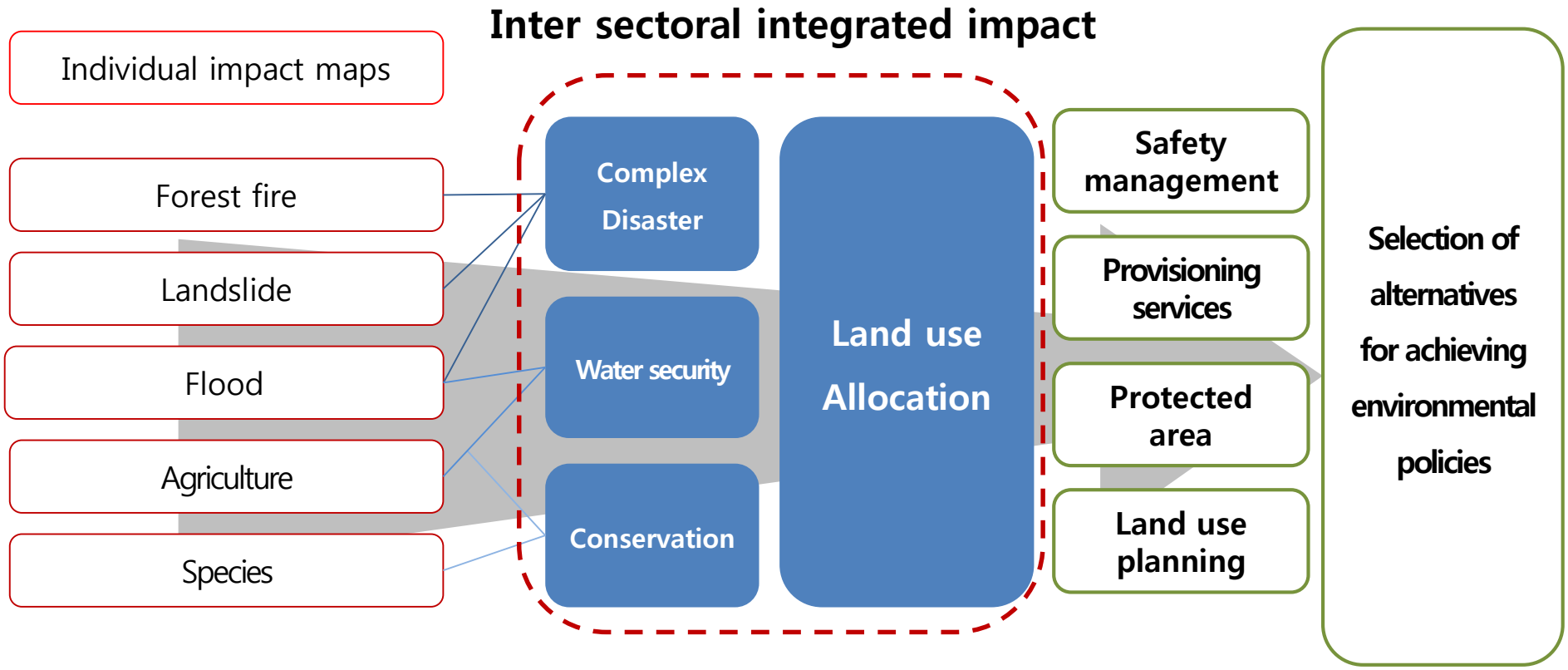
sectoral impact

- Ocean/Fishery
- Health
- Water
- Forest
- Agriculture
- Ecosystem

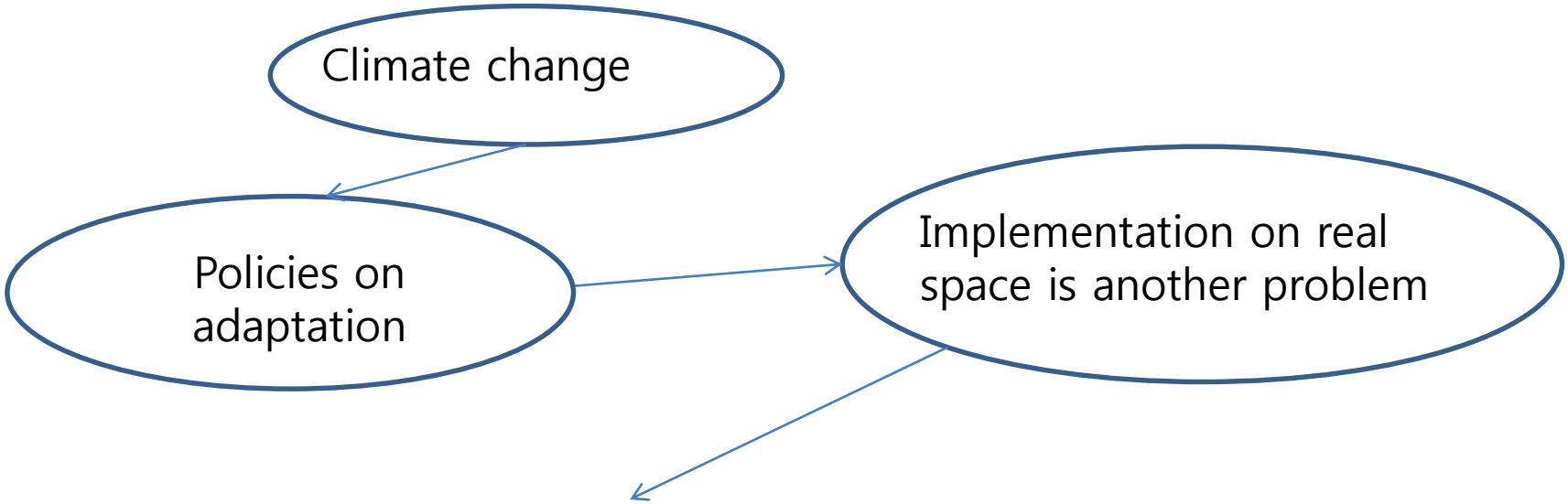


Integrated team

Impact by C.C. | Integrated impact | Environmental policy



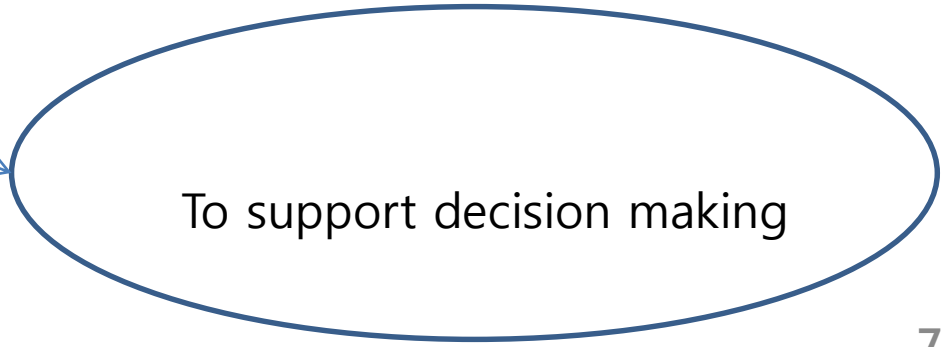
Objective of land use allocation



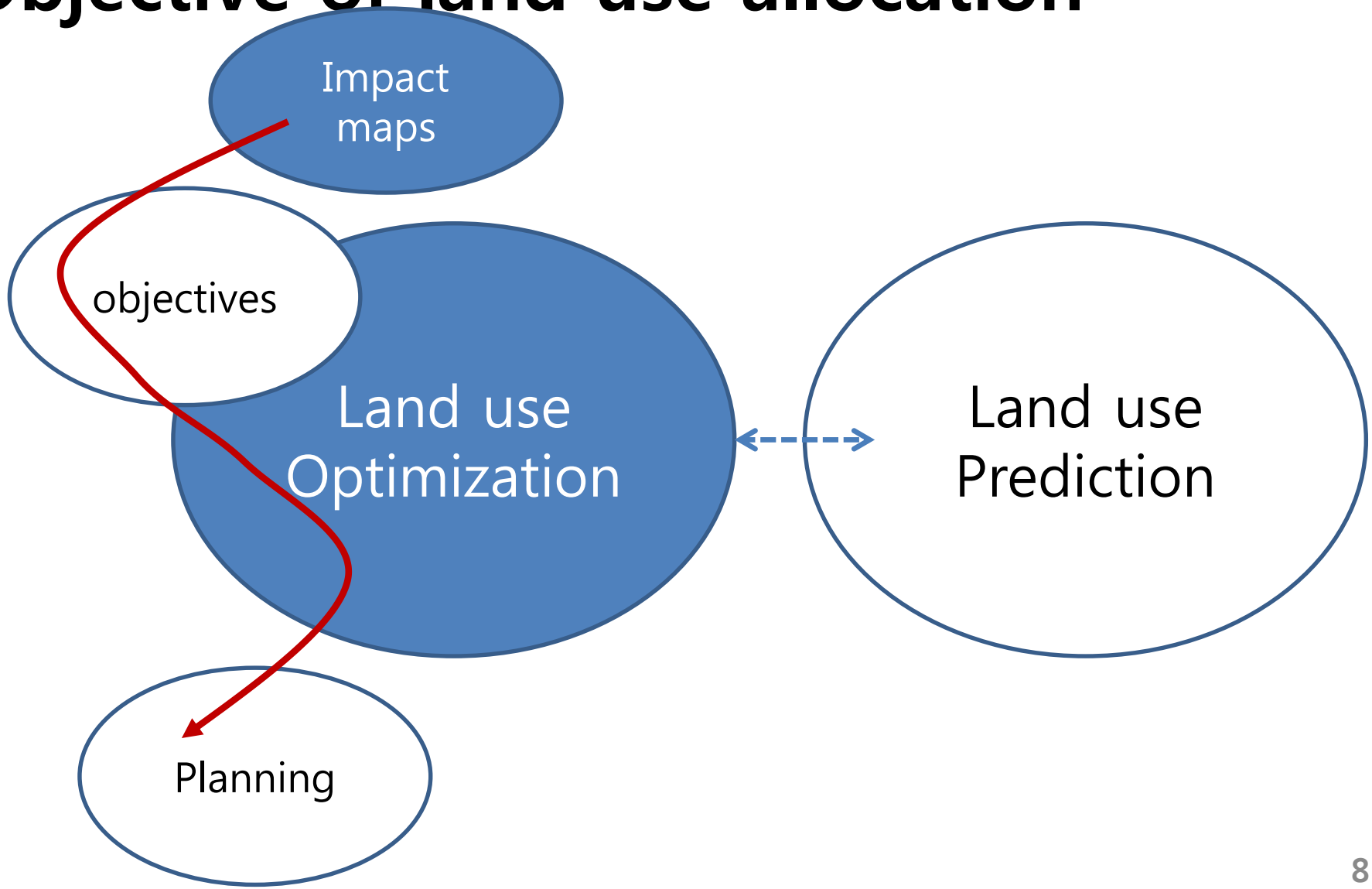
How should we change our space?

"To suggest optimized land use allocation

Considering integrated impacts"

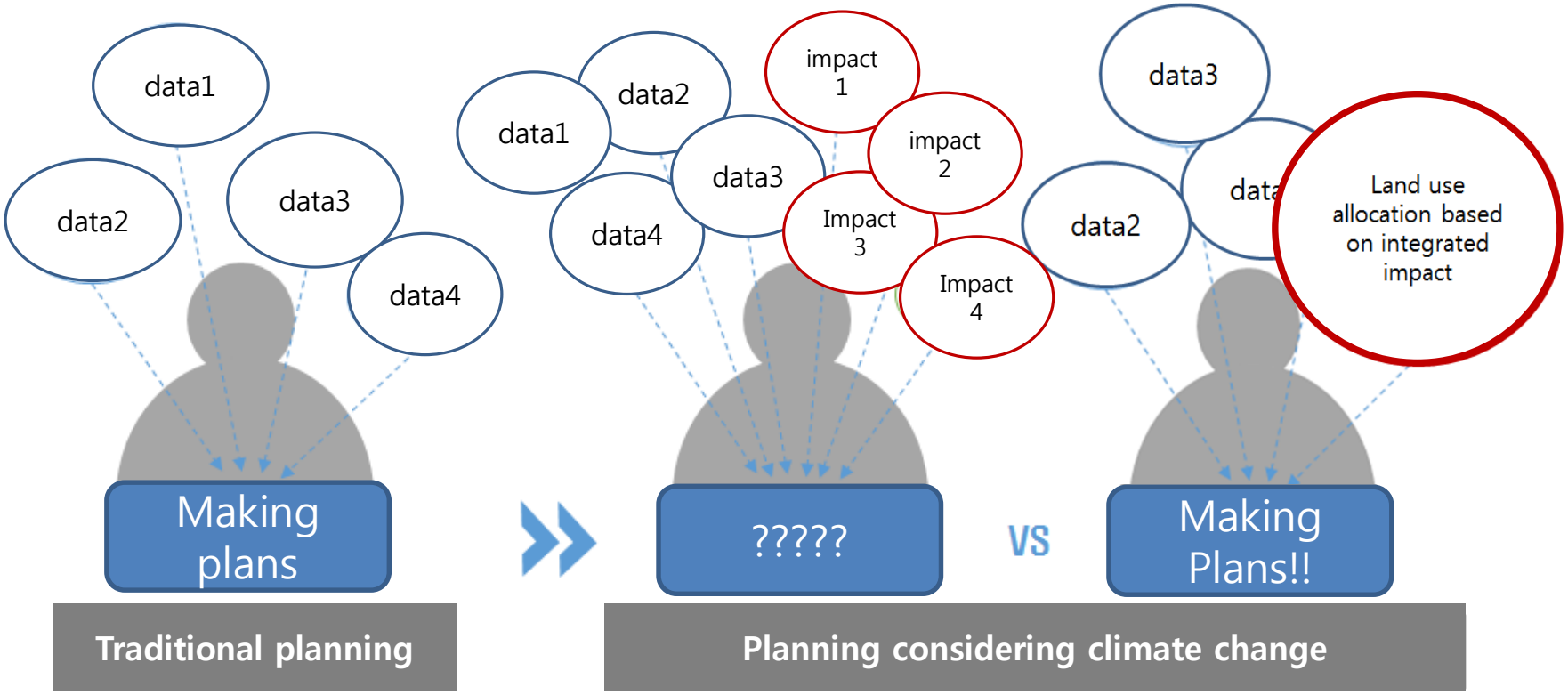


Objective of land use allocation



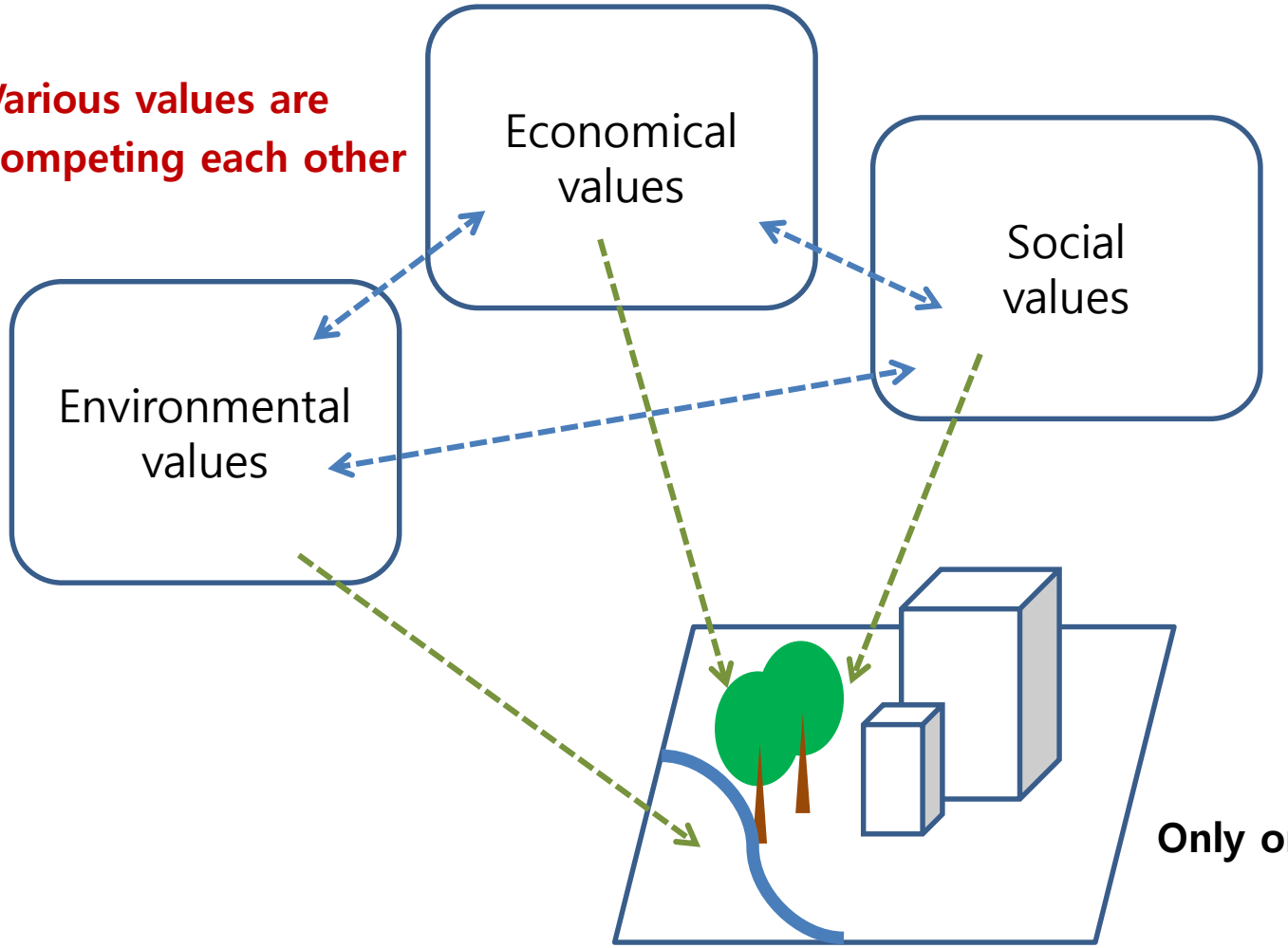
Method

Why we use optimization



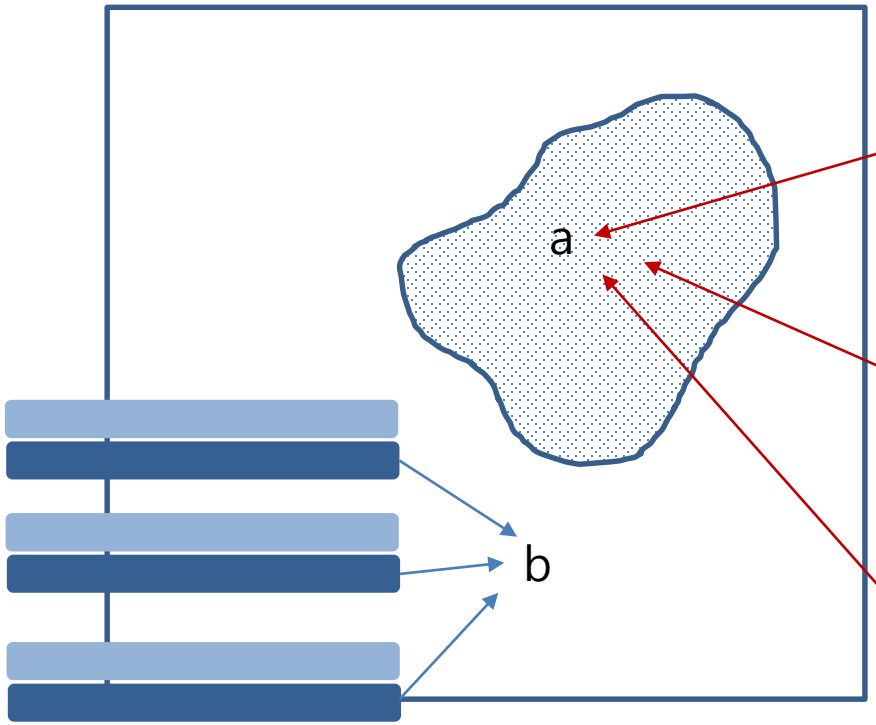
Why we use optimization

Various values are competing each other



Only one real space

Why we use optimization



Impact 1: high water security

Suitable for agriculture

Impact 2: high conservation value

Suitable for forest

impact 3: low disaster possibility

Suitable for development

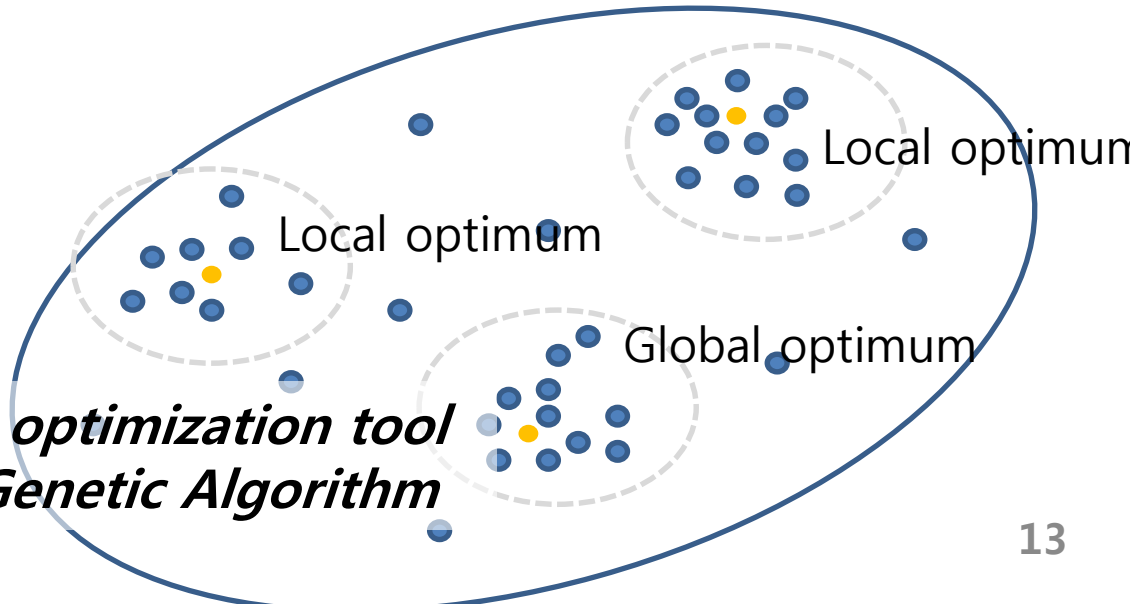
"What impact has priority?

->There is no reasonable basis to decide.

->There is large number of cases.

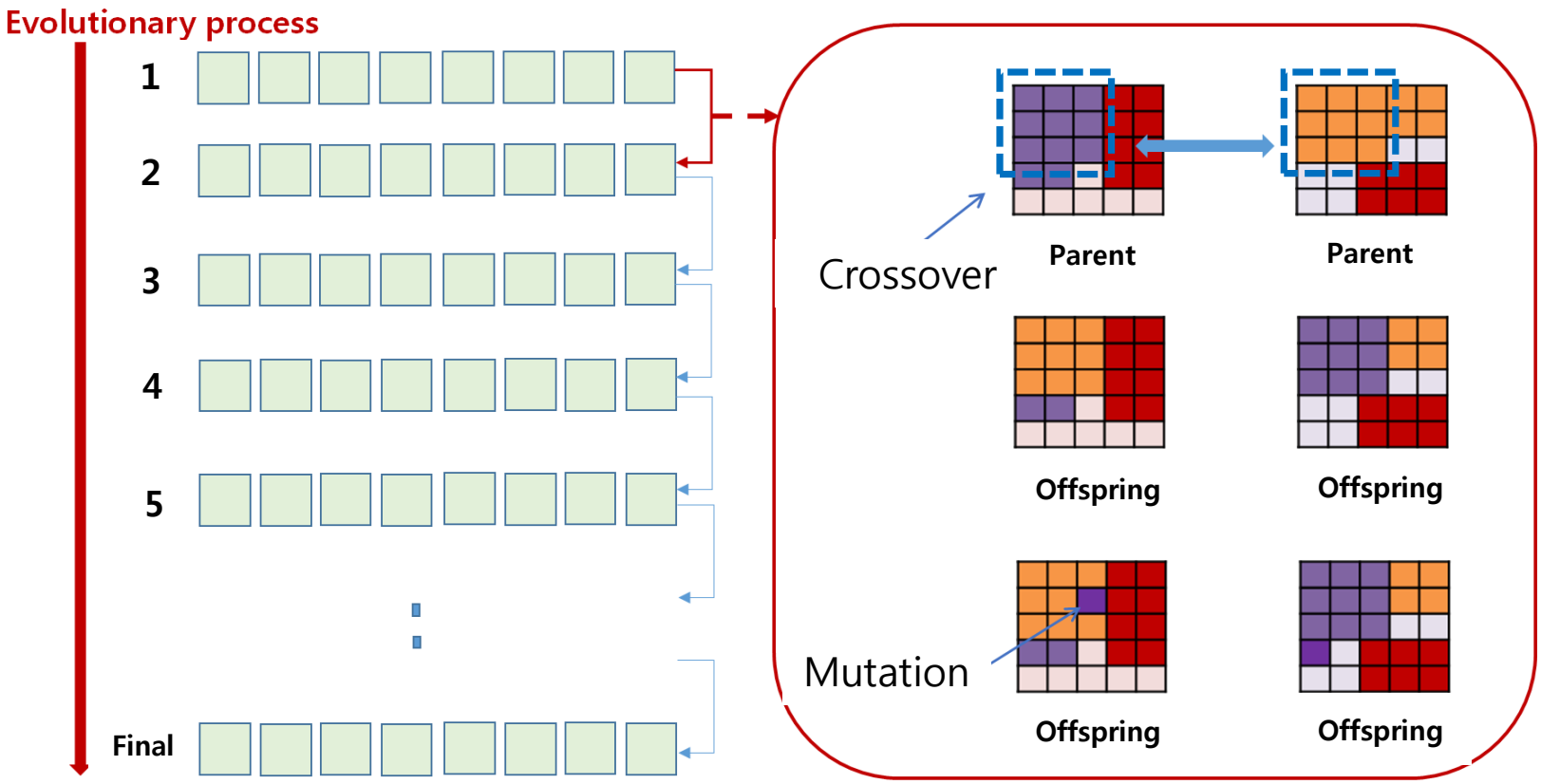
Why we use optimization

We can solve this problem using optimization algorithm!!



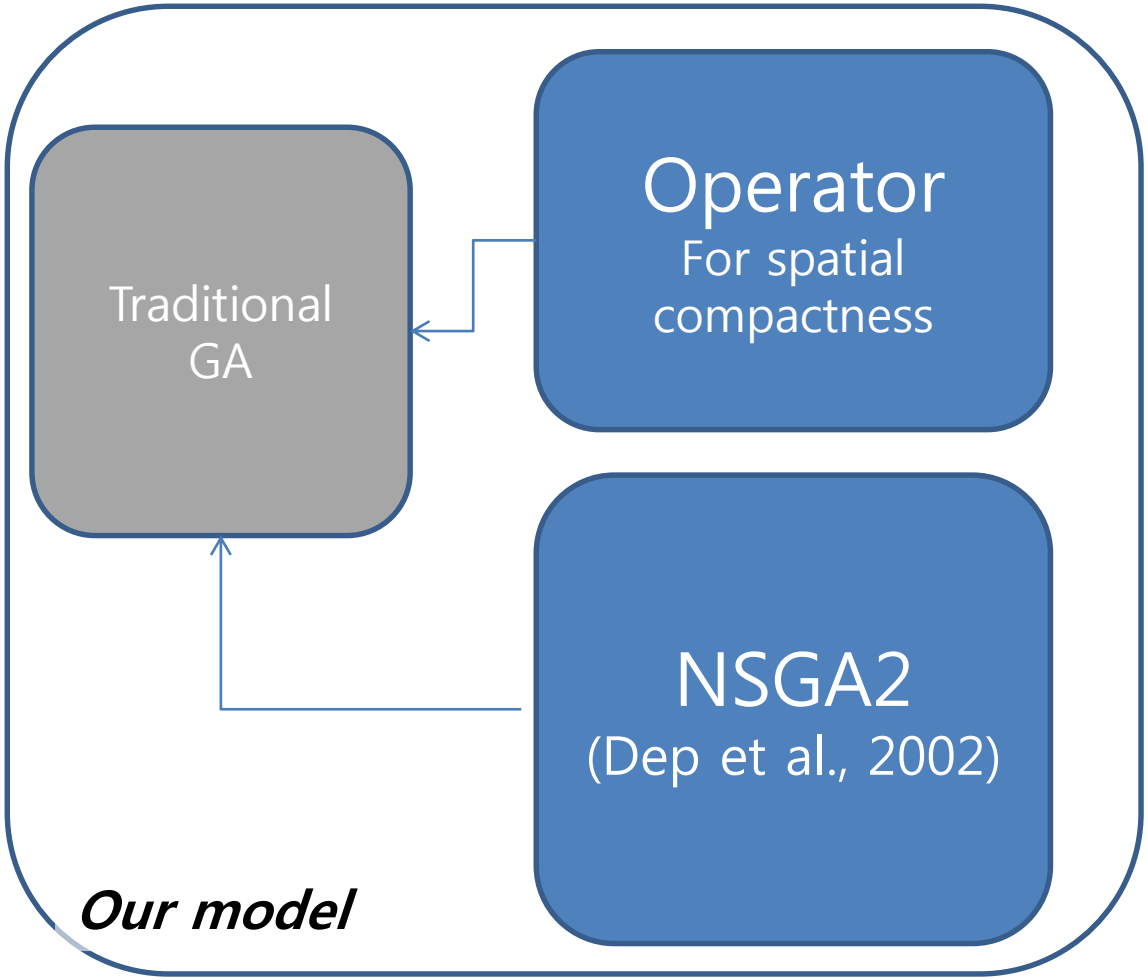
Most popular and effective optimization tool for the spatial planning is Genetic Algorithm

Traditional Genetic Algorithm



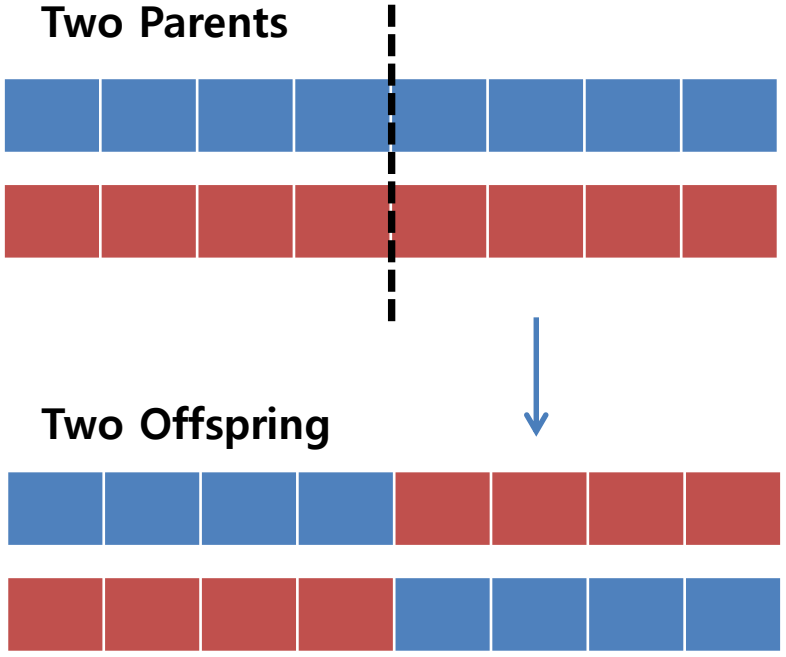
Change some part of parent,
->Select better individuals,
->Go to the next generation.

Our model

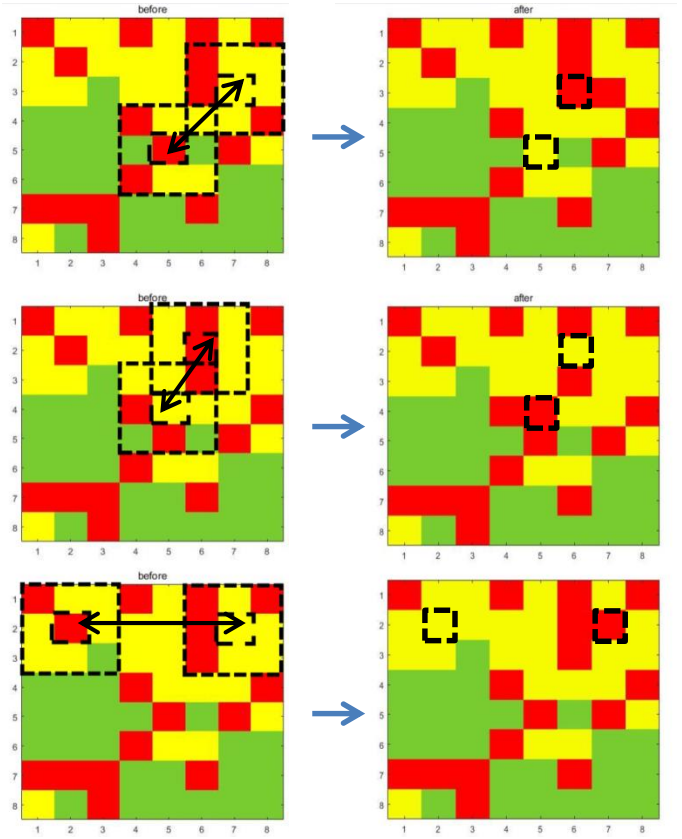

Traditional GA
Operator
For spatial compactness
NSGA2
(Dep et al., 2002)
Our model

Crossover/Mutation operator

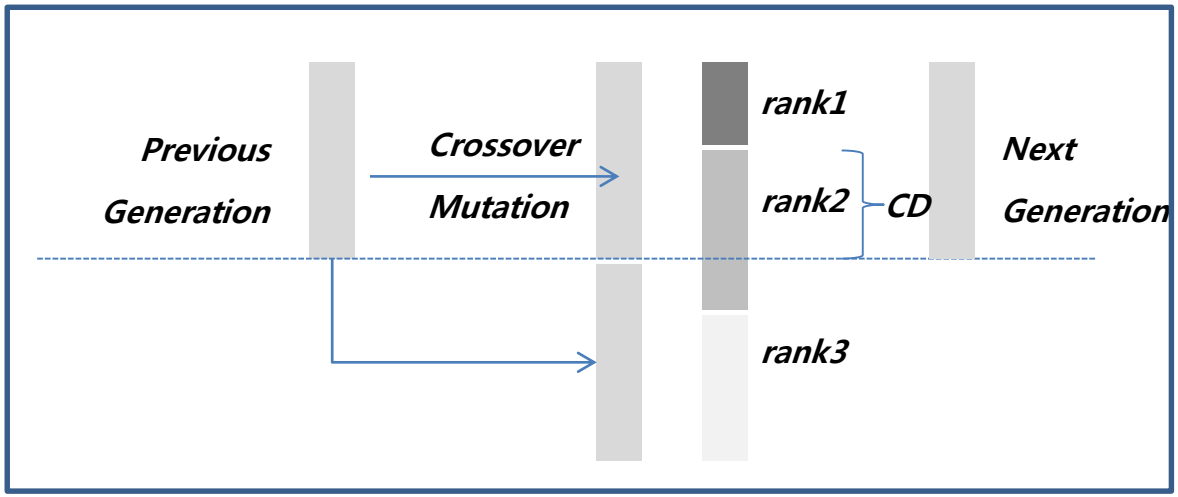
Traditional crossover

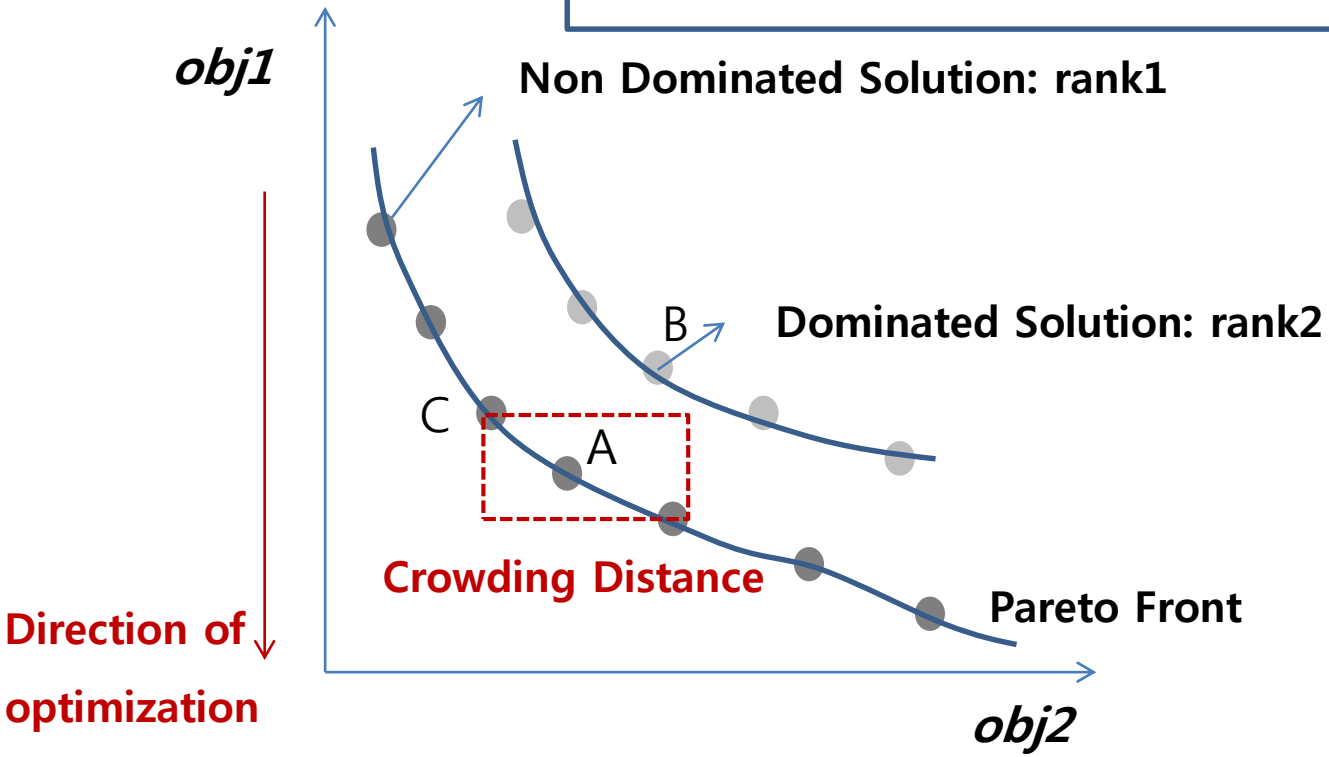


Special operator for spatial optimization



NSGA2

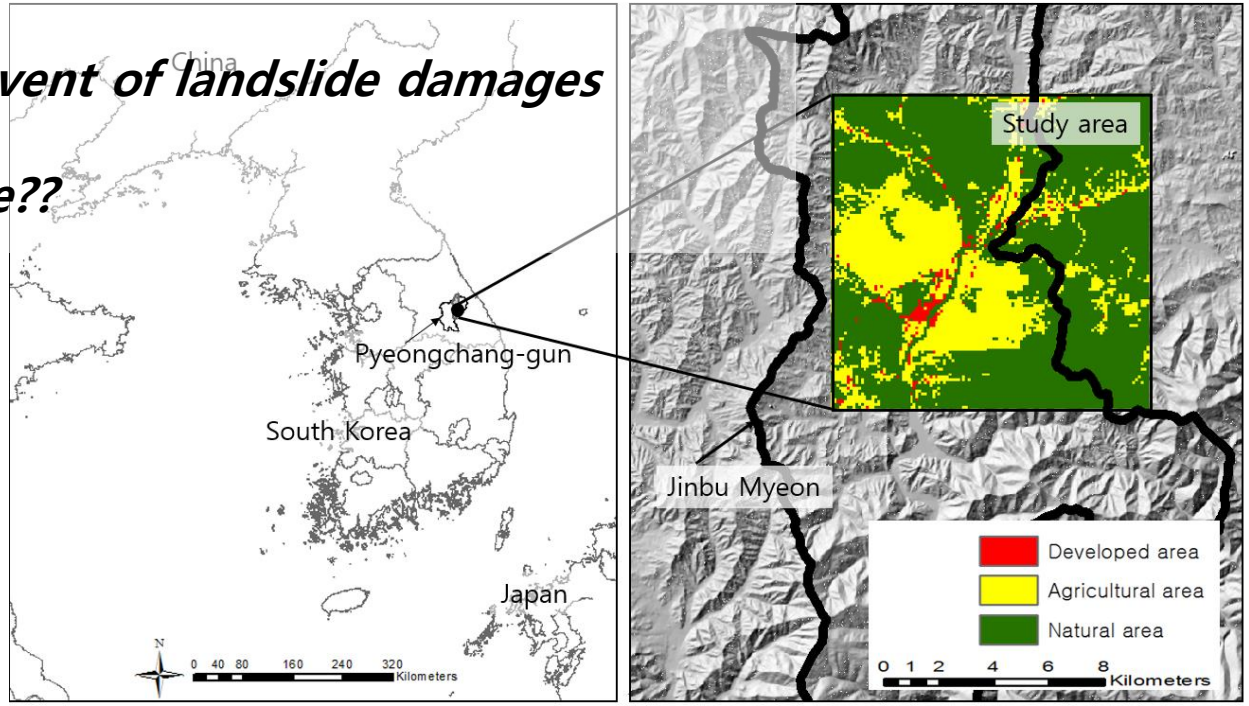

Previous
Generation
Crossover
Mutation
rank1
rank2
rank3
CD
Next
Generation


obj1
Non Dominated Solution: rank1
B
Dominated Solution: rank2
C
A
Crowding Distance
Pareto Front
Direction of
optimization
obj2

Case study

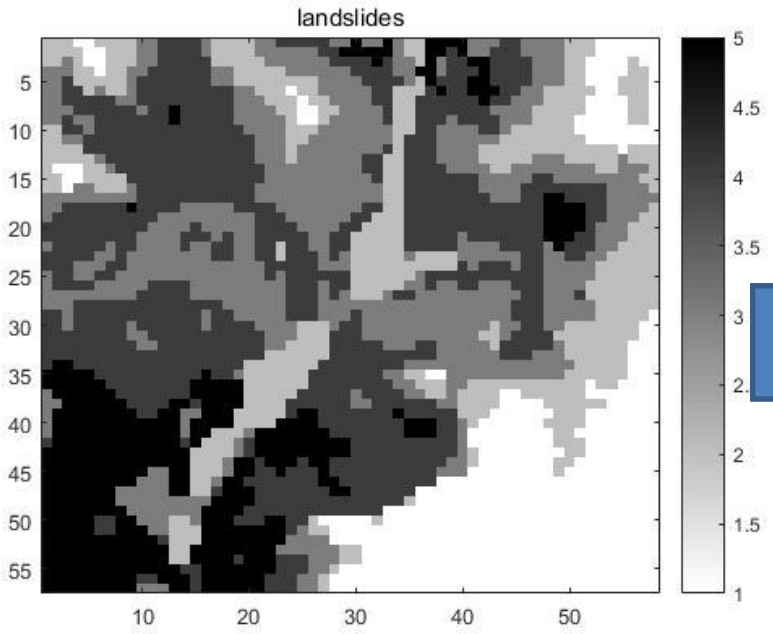
Study area

How can we reduce or prevent of landslide damages considering climate change??

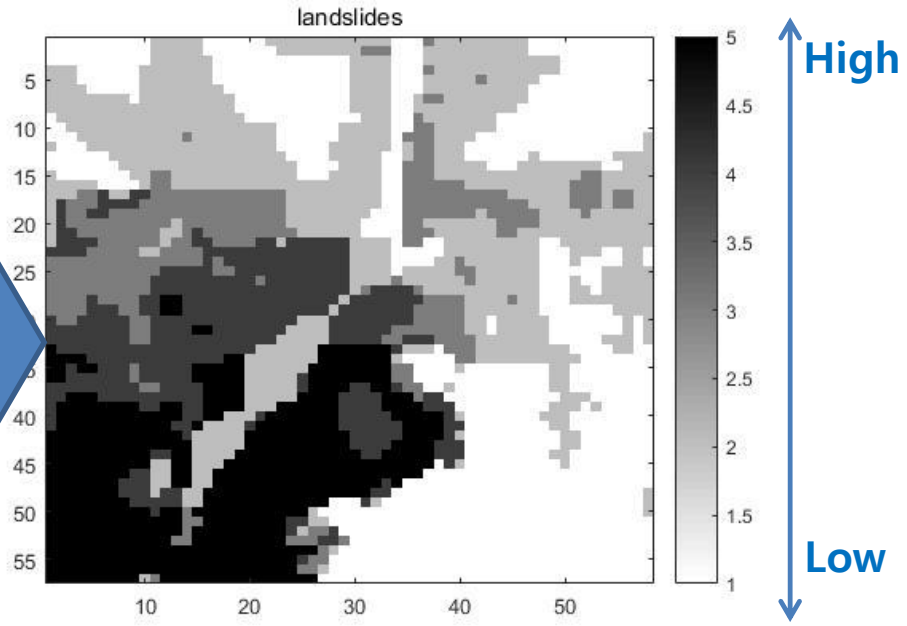


- **<u>Pyeongchang gun, Korea</u>**
- High landslide susceptibility, further increasing is expected (climate change)
- Fast land use change: High development pressure owing to new trail under construction, winter Olympic

Landslides(Current & Future)



Landslide susceptibility 2006



Landslide susceptibility 2071-2099

RCP 8.5 Scenario

Objectives and constraints

Minimization of Landslides damages

(Risk Matrix)

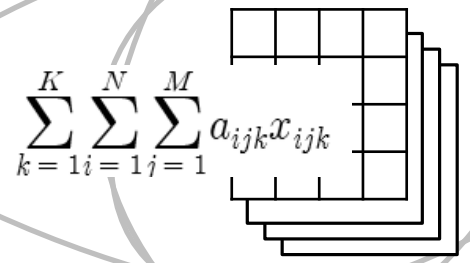
Suscepti bility	devlope ment	Agricult ure	자연
5	High		
4		Medium	
3			Low
2			
1			

Minimization of Change

Relative sore

민감도	개발지	농경지	자연
개발지	0	1	1
농경지	0.6	0	0.2
자연	0.7	0.4	0

$$\sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{j=1}^{M} a_{ijk}x_{ijk}$$



k	k	k	m
k	k	k	m
k	k	k	l
m	l	l	l
m	l	k	m
m	m	m	m

Constraint

Development area increase

No development above than 800m

Maximization of Compactness

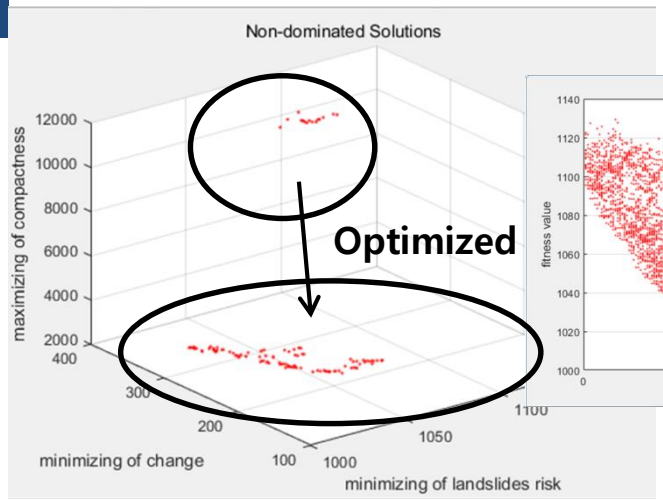
Spatial objective

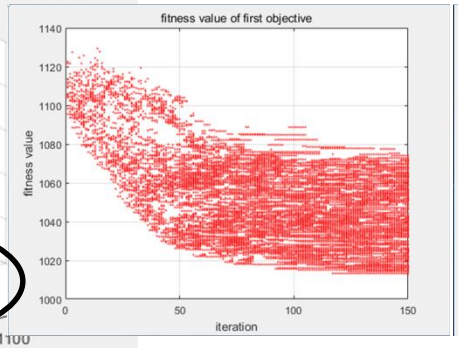
Considering 8 boundary cells

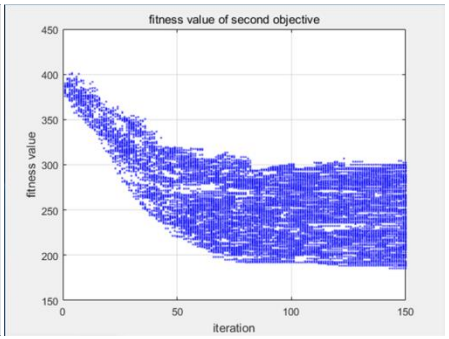
Results

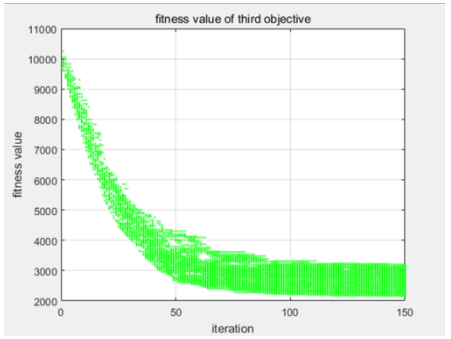
Pareto set

Landslide susceptibility 2006

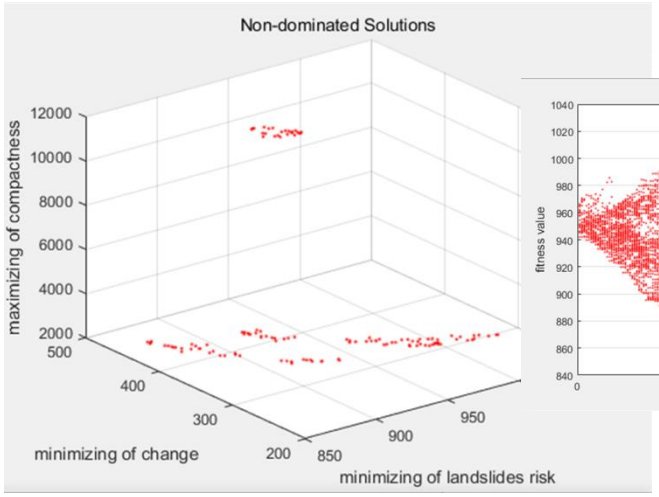




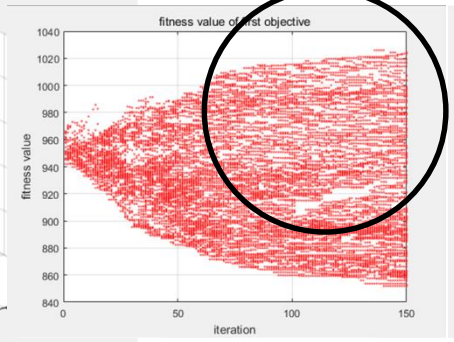


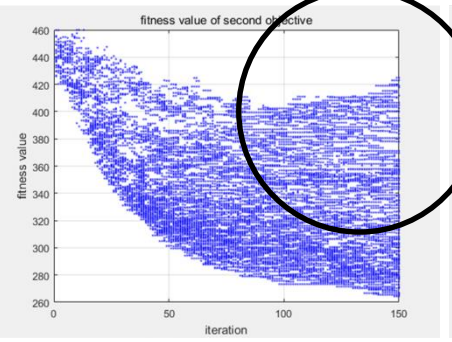


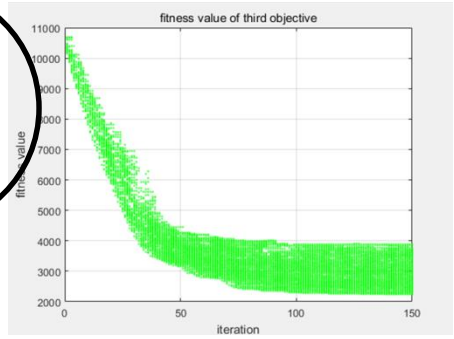
Landslide susceptibility 2071-2099(RCP 8.5)



Competing/trade off

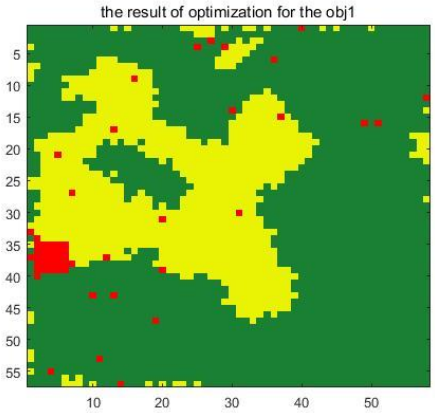




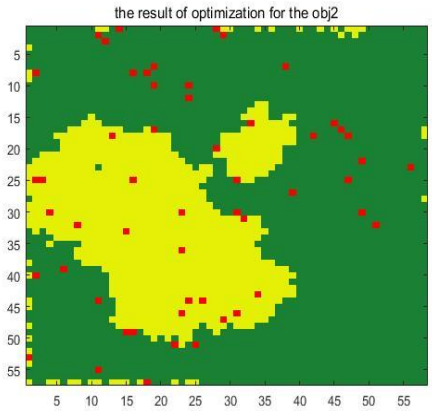


Alternatives(Climate change)

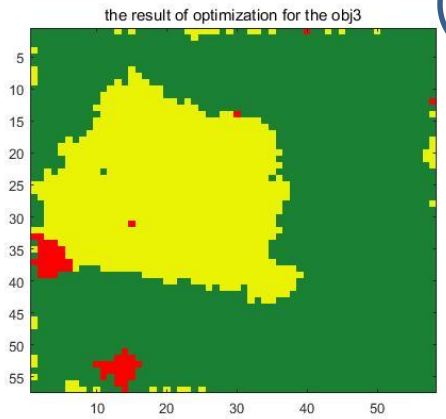
Alternative1



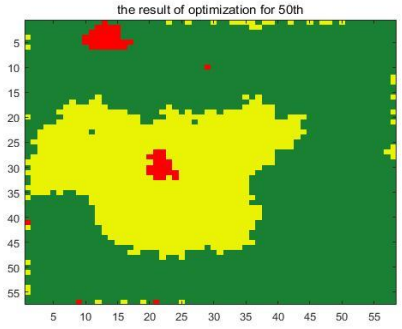
Alternative2



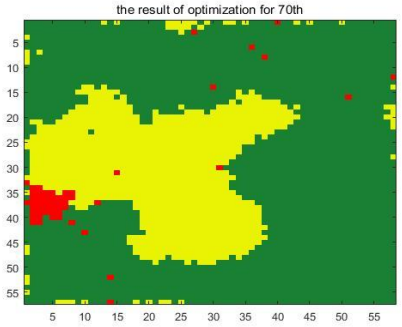
Alternative3



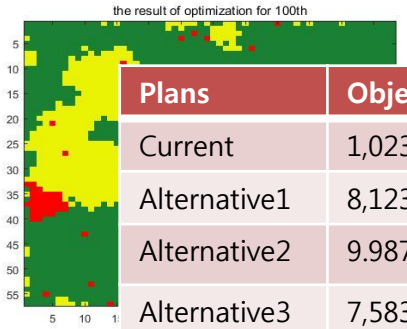
Alternative4



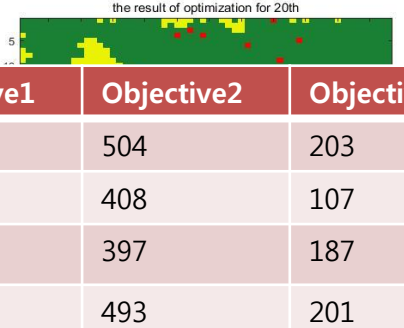
Alternative5



Alternative6

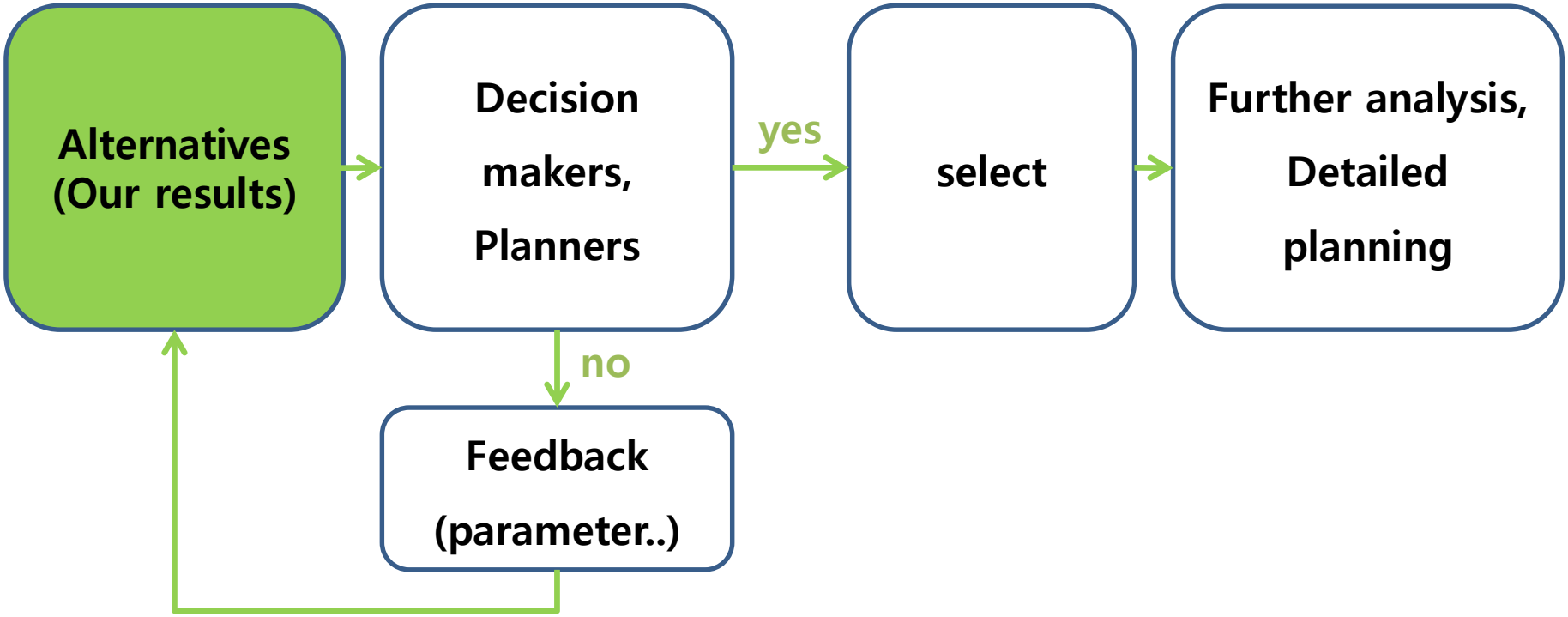


Alternative7



Plans	Objective1	Objective2	Objective3
Current	1,023	504	203
Alternative1	8,123	408	107
Alternative2	9.987	397	187
Alternative3	7,583	493	201
Alternative4	…	…	…
Alternative5	…	…	…
Alternative6	…	…	…
Alternative7	…	…	…

Alternatives



Discussions

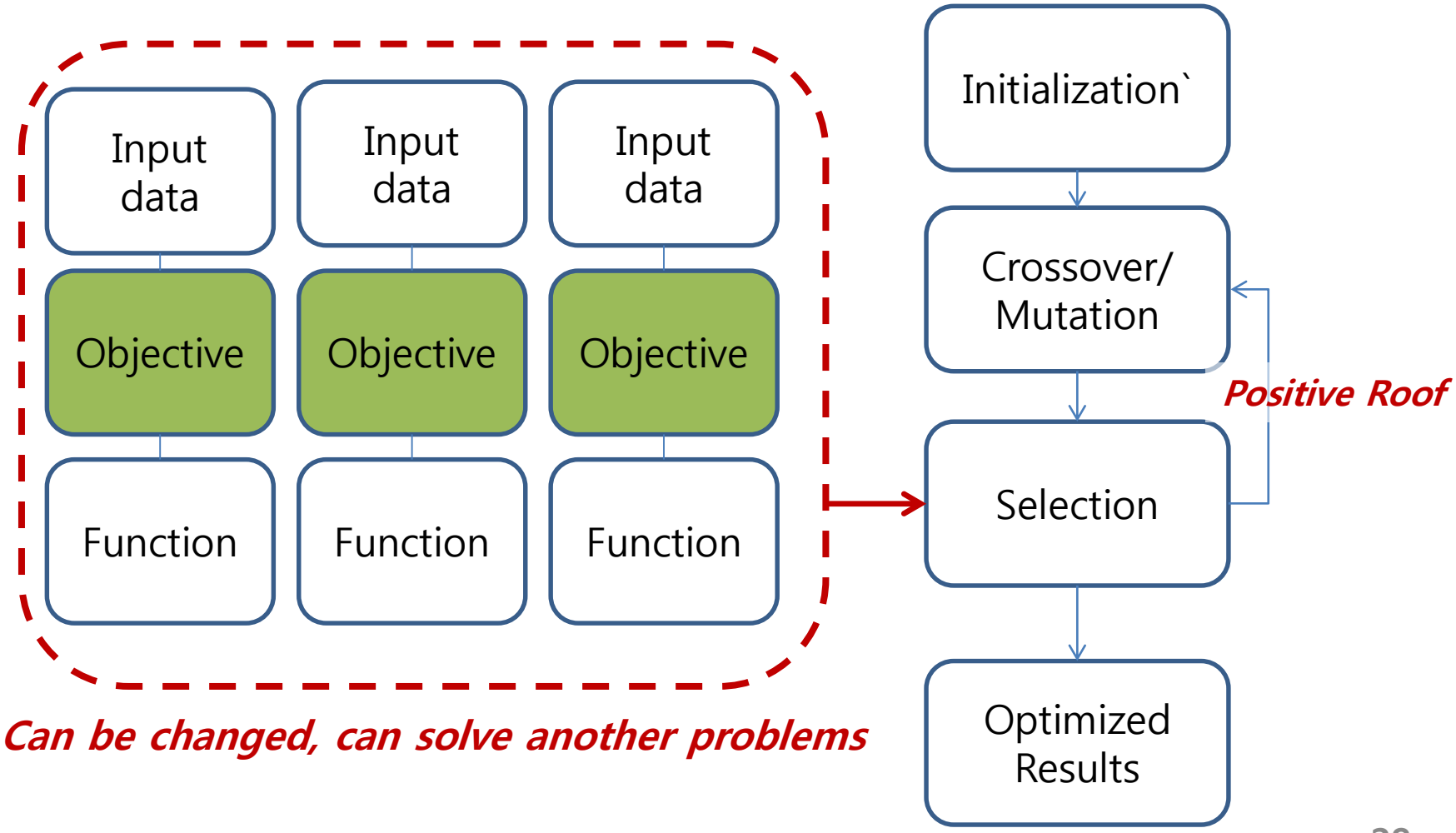
Limitations

We believe this model can support decision making, "action for climate change",

But, we have to improve:

- *Optimization level*
- *Objective functions*
- *Computational time*

Flexible structure



The End, Thank you

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