Modeling the Integrated Impacts of Climate Change on the Spatial Planning for the Ecosystem Conservation

Mo, Yongwon
Prof. Lee, Dong Kun

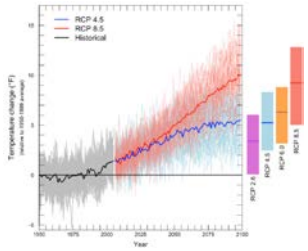
Seoul National University, South Korea

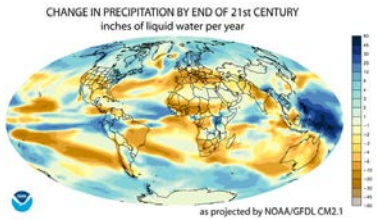
Supported by MOTIVE project

Climate Change Impacts to Ecosystems

Direct impacts

Change of Temp. & Precip.





Species distribution change

(Vos et al., 2008)

Indirect impacts

Agricultural suitability

Landslide

Forest fire

Invasive sp.

Threats to habitats

Connectivity

Spatial Prioritization

Research Questions

How/Where should we…

Connectivity

1. **Connect to assist the migration of species as much as possible by climate change?**

Spatial prioritization

2. **Conserve considering both of direct and indirect impacts by climate change?**

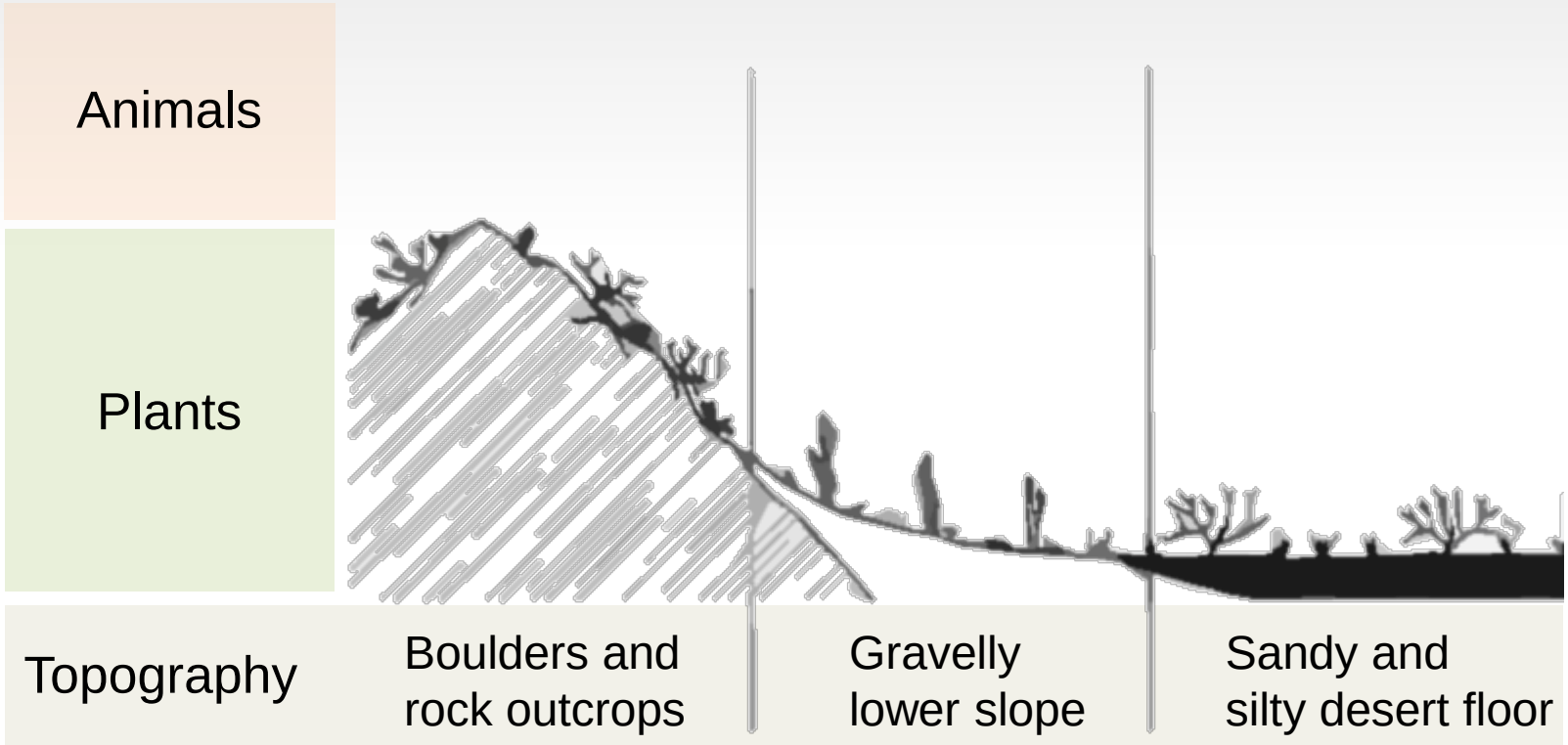
Part 1 :

Connect to assist the migration of species by climate change as much as possible?

- Topographic linkages

(Published) Mo, Y., **Lee, D.K**., Song, K., Kim., H.G., and Park, S.J.,
"Applying topographic classification, based on hydrological process, to design habitat linkages for climate change", **Forests**

Physical environments as “arena” of biological activity (Hunter, 1988)



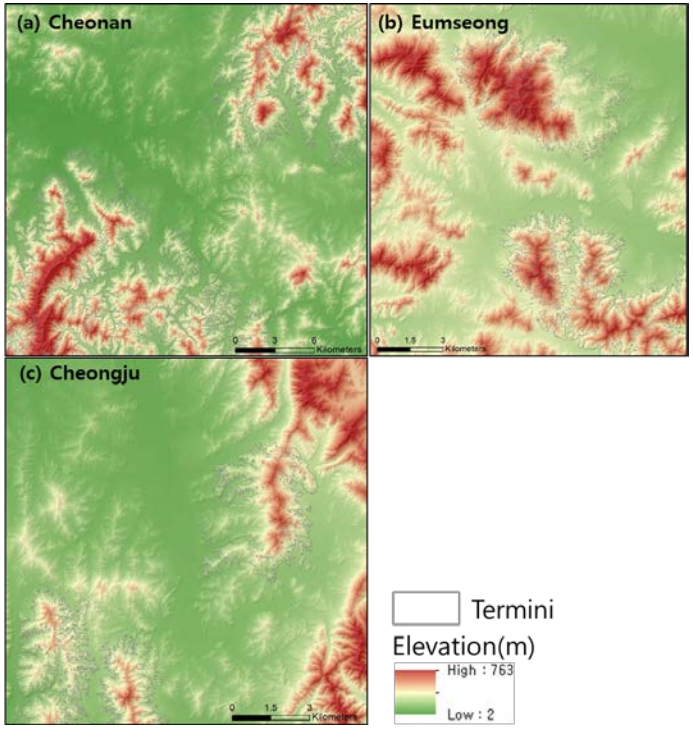
Influence of topography and soils on distribution of plants and animals (revised by Hugget, 2004)

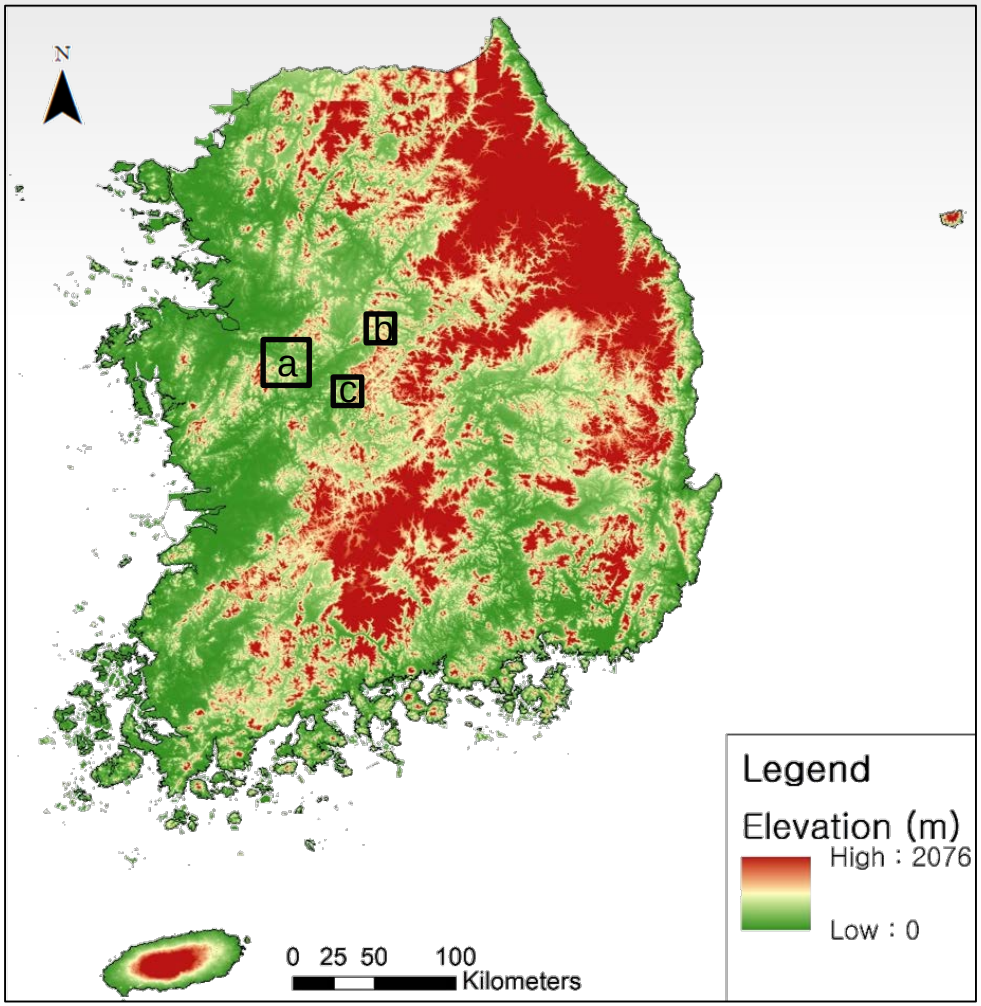
Topographic linkages

“to support movement by species associated with land facet (based on topography), today and in the future.” (Brost and Beier, 2012)

Study sites

- 3 Sample sites
- Large forests needed to connect



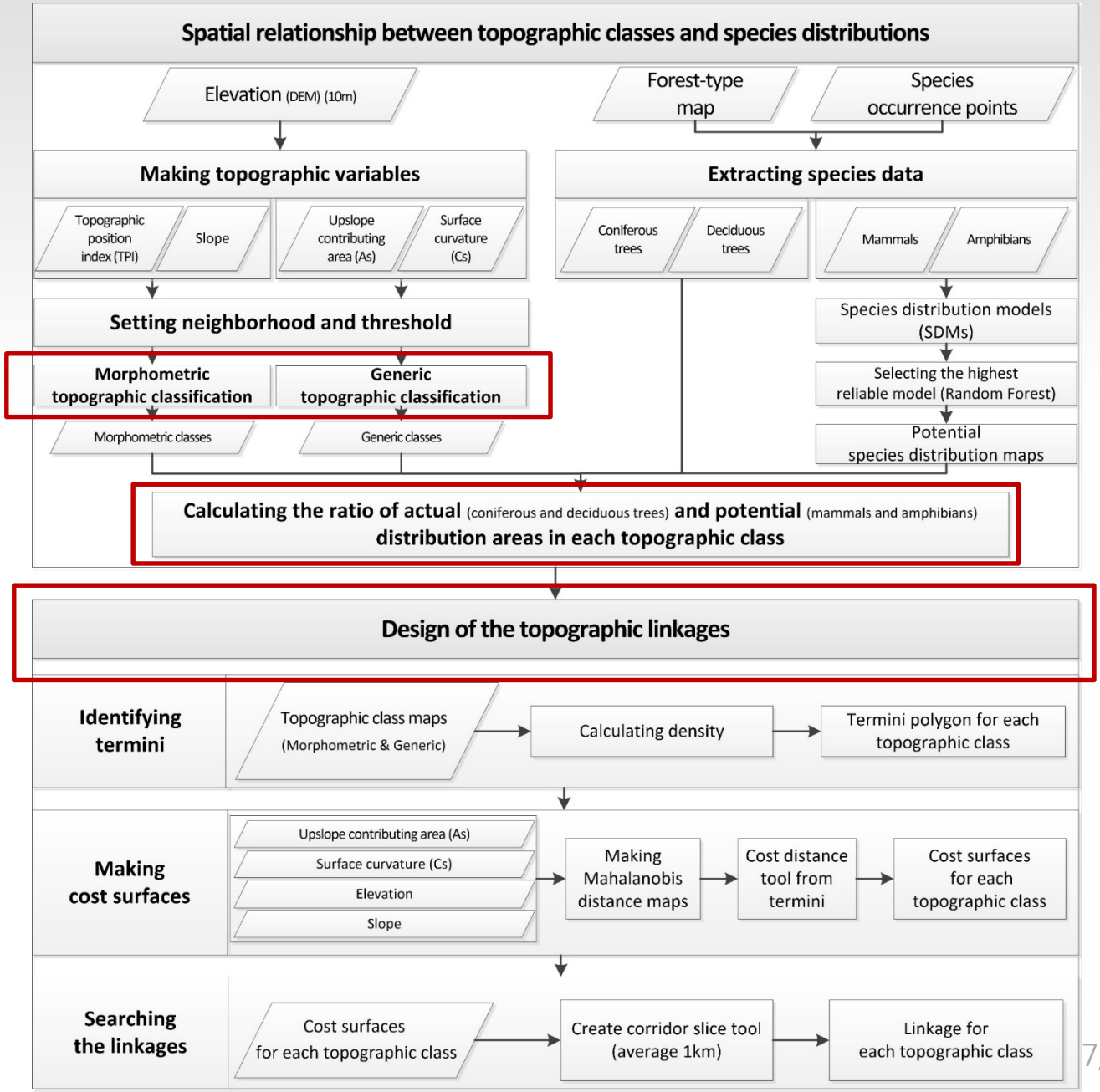


Study flow

Two topographic classification

Represent species distributions

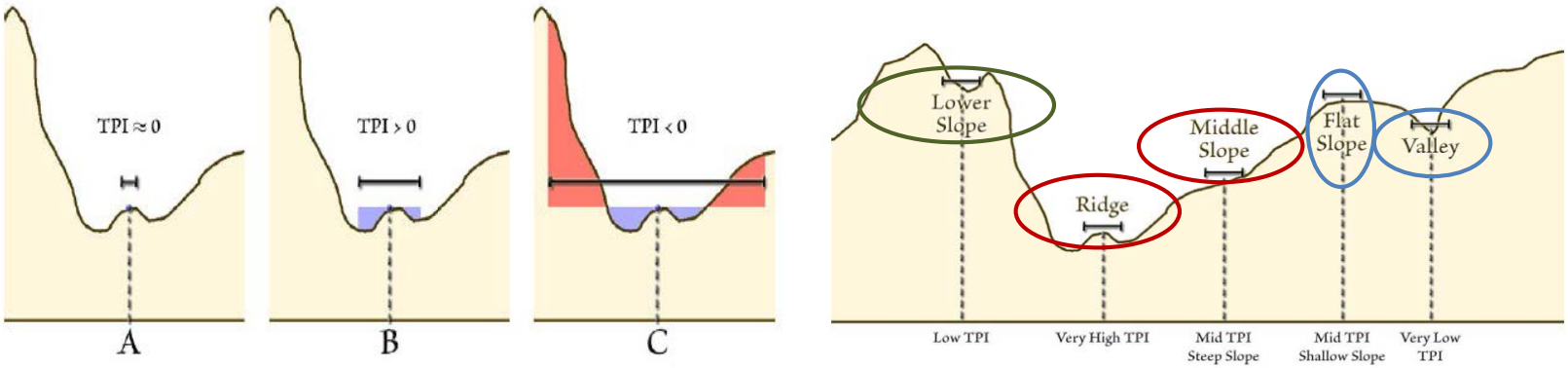
Least Cost Path (LCP)



1. Morphometric Topographic Classification

Concept

- The shape of terrain : relative elevation, slope (Topographic Position Index, TPI)

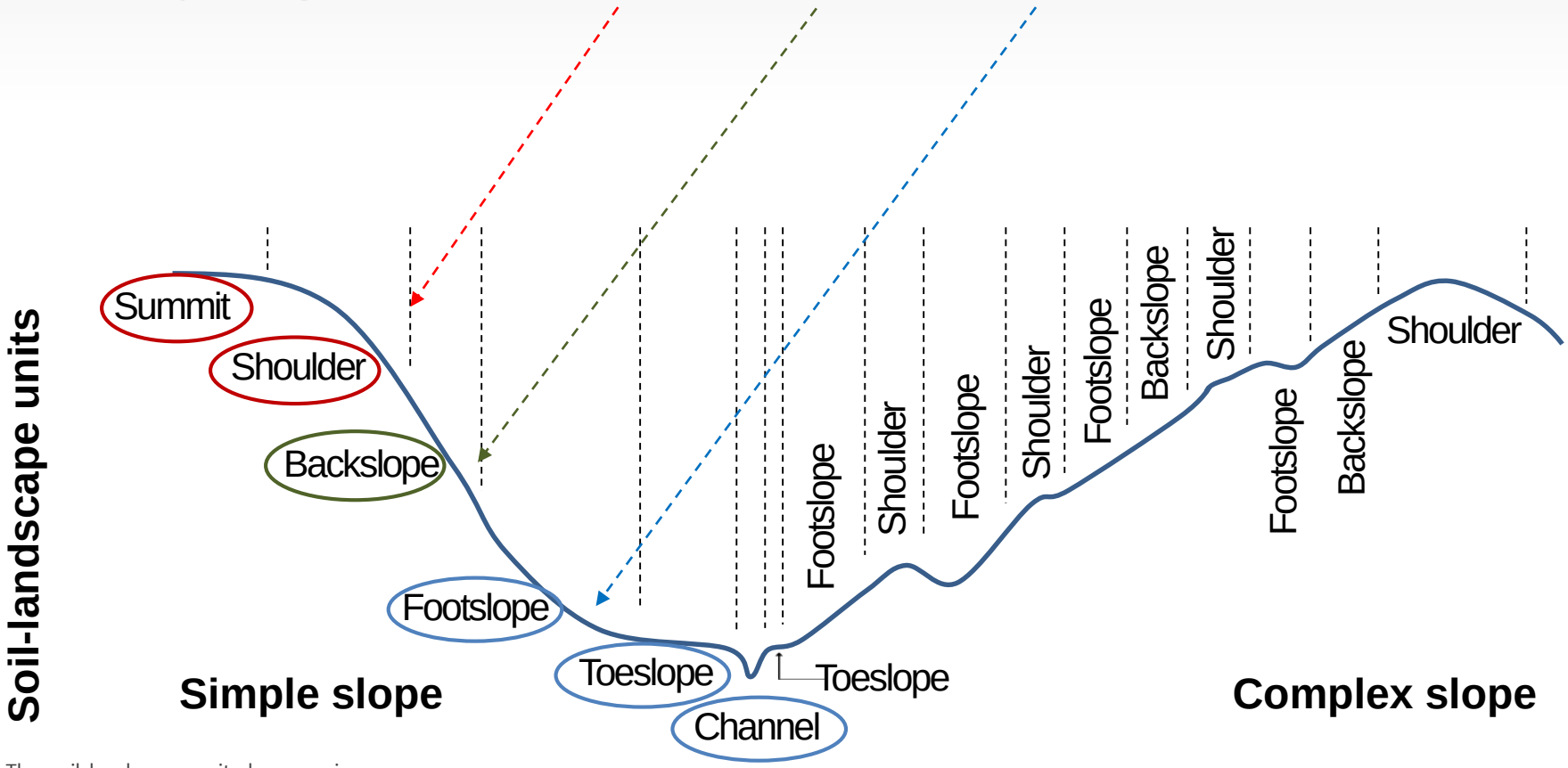


(Jenness et al., 2012)

2. Generic Topographic Classification

Concept

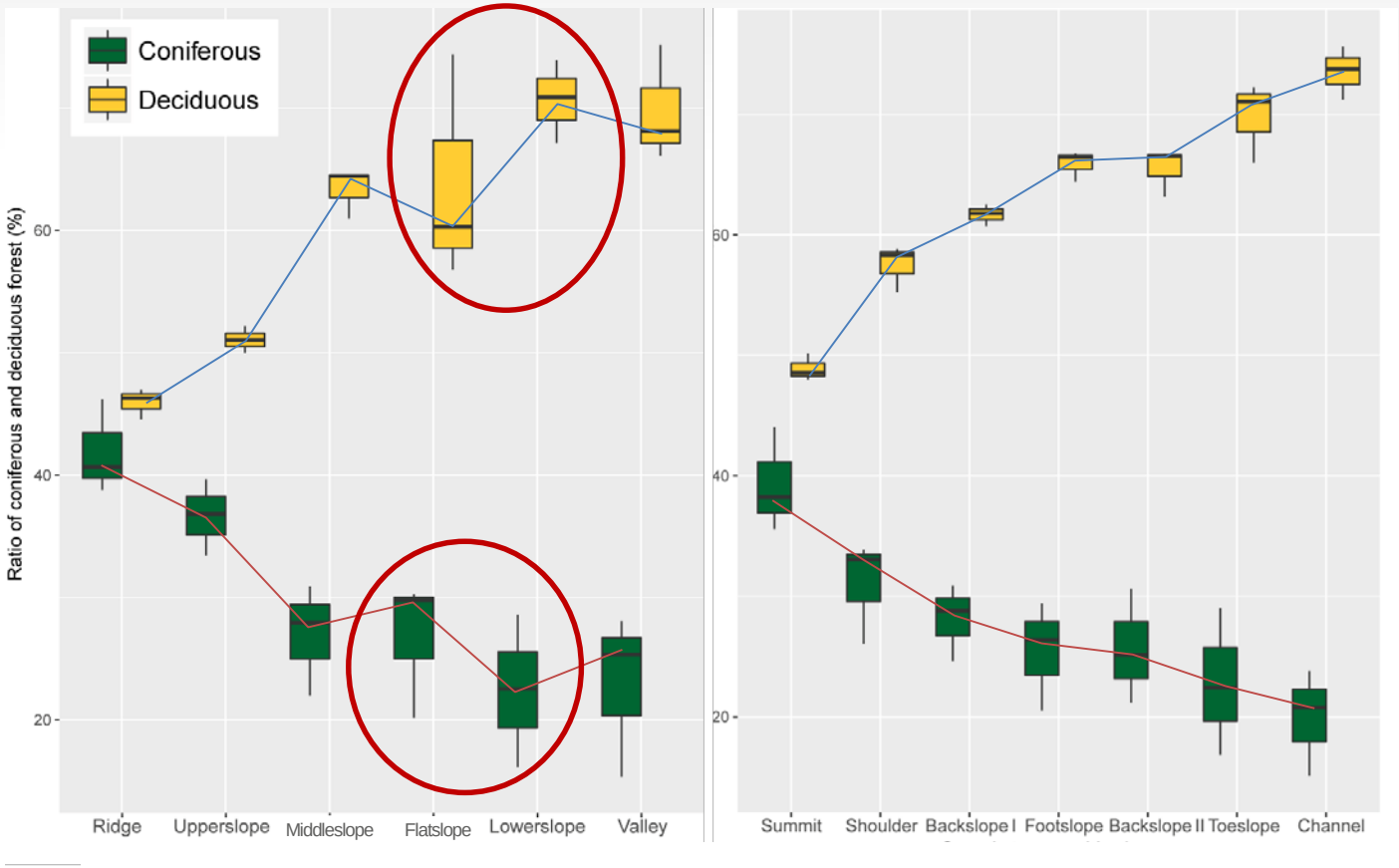
- The hydrological process: erosion, transport and sediment processes



The soil-landscape units by generic classification (revised by Park et al., 2001)

Spatial relationship with coniferous and deciduous forests

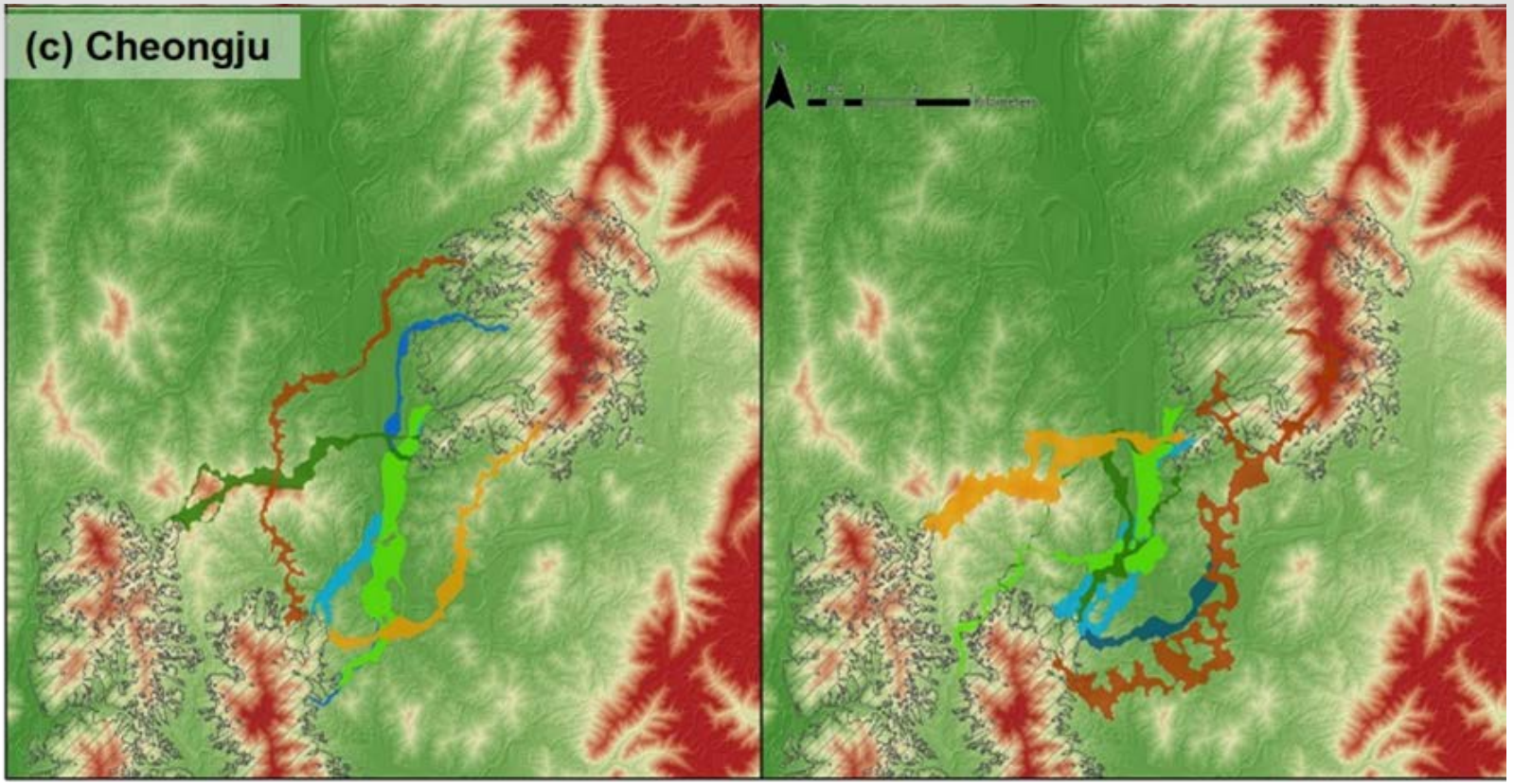
Generic topographic classes represents better



Morphometric

Generic

Results



Morphometric topographic classification

Legend

- Termini
- Ridge
- Upperslope
- Middleslope
- Flatslope
- Lowerslope
- Valley

Morphometric		Generic
↓	Width (Core)	↑
↑	Parameter/ Area	↓
↑	Spatial Difference	↓

Generic topographic classification

- Summit
- Shoulder
- Backslopel
- Backslopell
- Footslope
- Toeslope

Conclusions

- Identified the possibility of using topography
- The generic topographic classification was superior than the morphometric.

- However…not perfect. We need to consider both of biotic and abiotic features in ecosystems.

Further research

- Identify the other abiotic features such as soil, geology, and water.

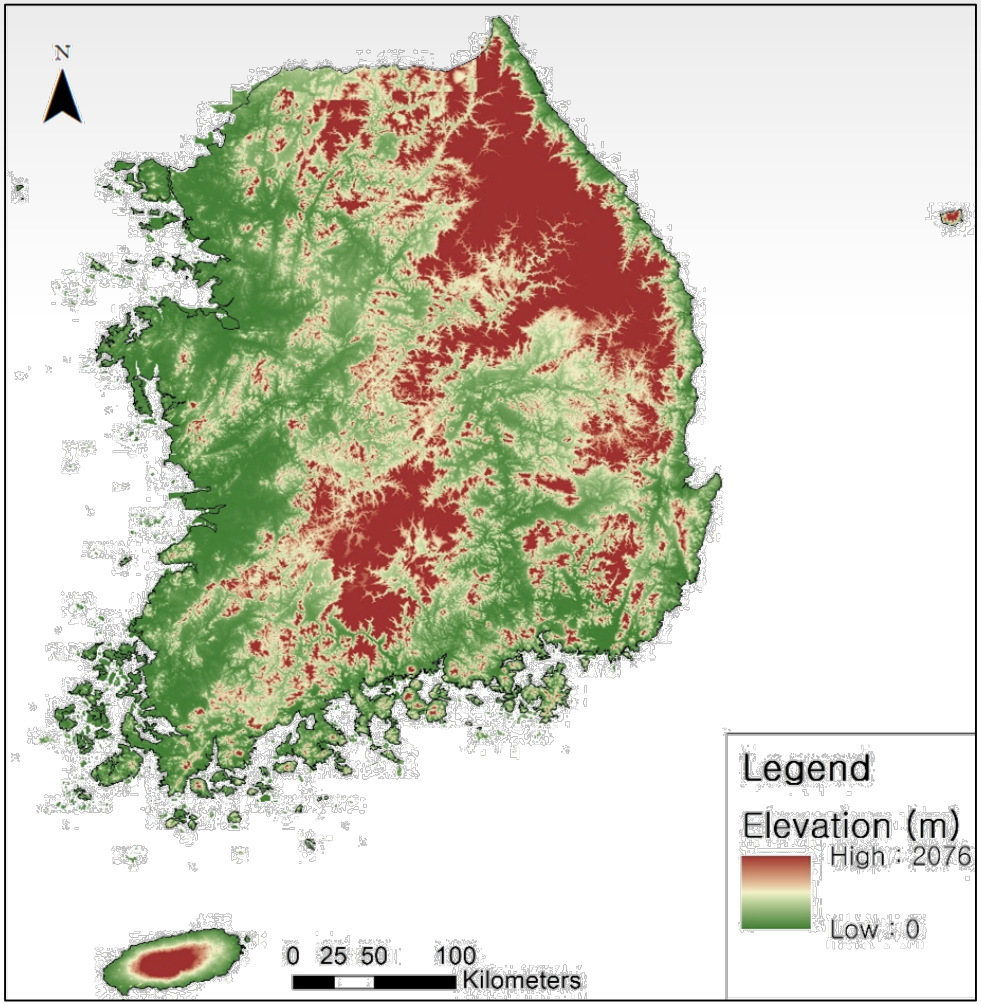
Part 2 :

Conserve to consider both of direct and indirect impacts by climate change?

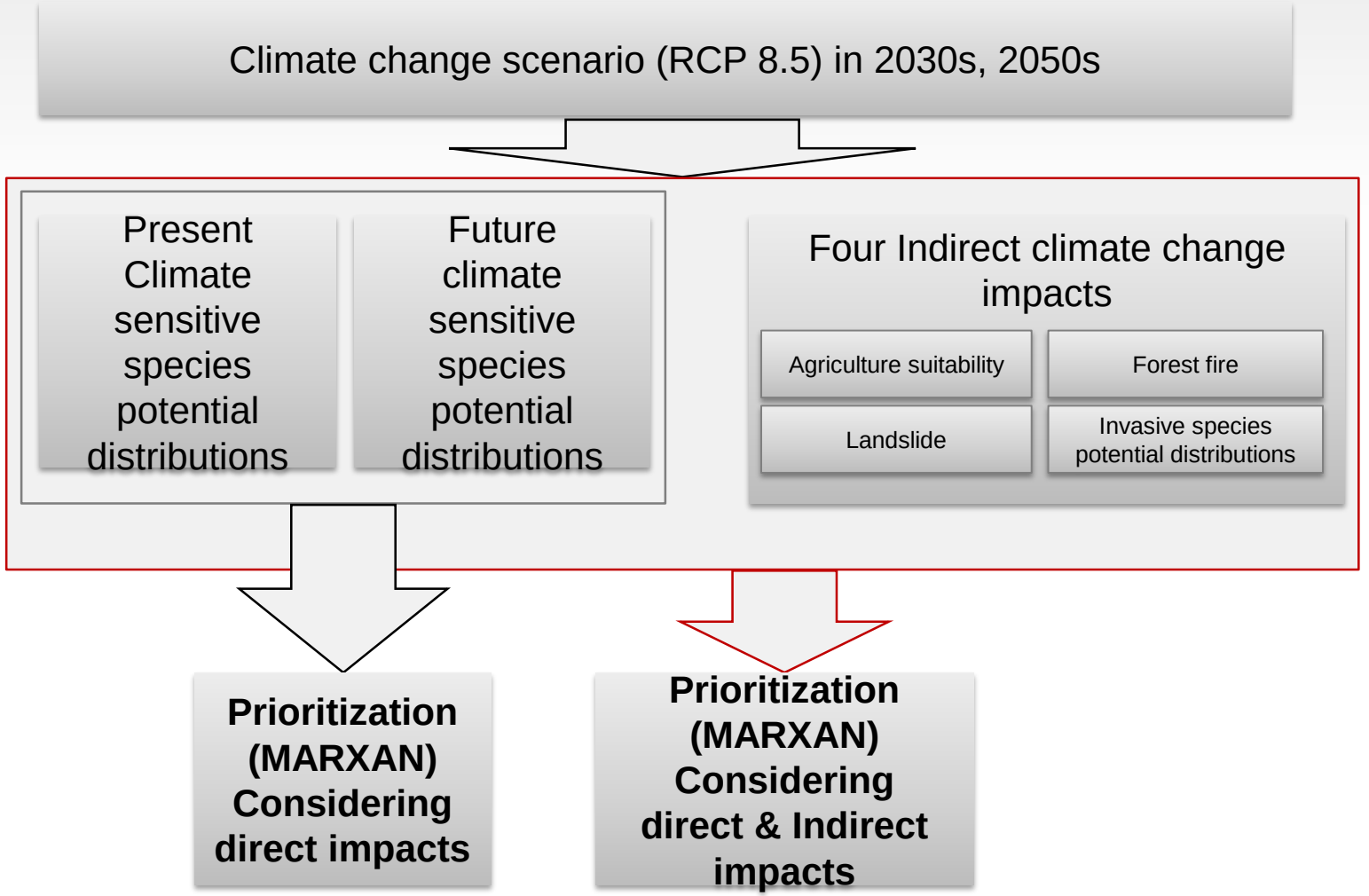
- **direct vs both**
- **stepwise planning**

Study site

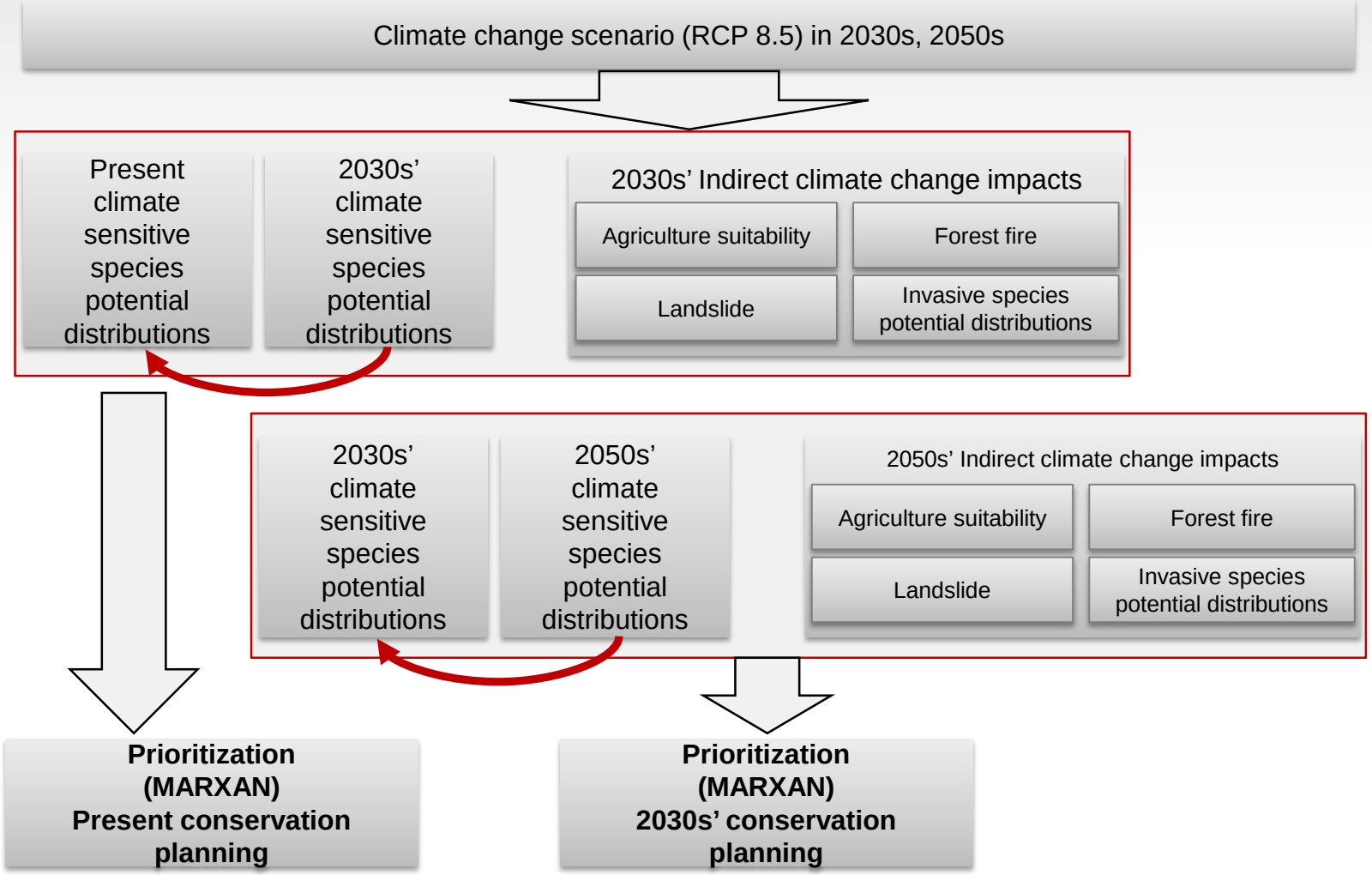
- South Korea
- 1km X 1km Grids
- 96,970 Planning units



Study flow – direct and both



Study flow – stepwise planning



Prioritization - MARXAN (Developed by Queensland Univ. in Australia)

- Design the new protected area network
- Consider threats (cost) and efficiency (minimum total score)
- Applying Simulated Annealing Algorithm (SA)

$$\text{Min(Total Score)} = \underset{①}{\sum_{\text{PUs}} Cost} + \text{BLM} \underset{②}{\sum_{\text{PUs}} Boundary} + \underset{③}{\sum_{\text{PUs}} SPF \times Penalty}$$

① The total cost of the prioritization area

② The total boundary length, multiplied by a modifier(BLM, Boundary Length Modifier)

③ The penalty for not adequately representing conservation targets

***reps. 100 times**

Prioritization - MARXAN (Developed by Queensland Univ. in Australia)

$$\sum_{\text{PUs}} \textcircled{1}\,Cost + \text{BLM} \sum_{\text{PUs}} \textcircled{2}\,Boundary + \sum_{\text{PUs}} \textcircled{3}\,SPF \times Penalty$$

Total Score

= (1+2+1) + (1*12) + 0

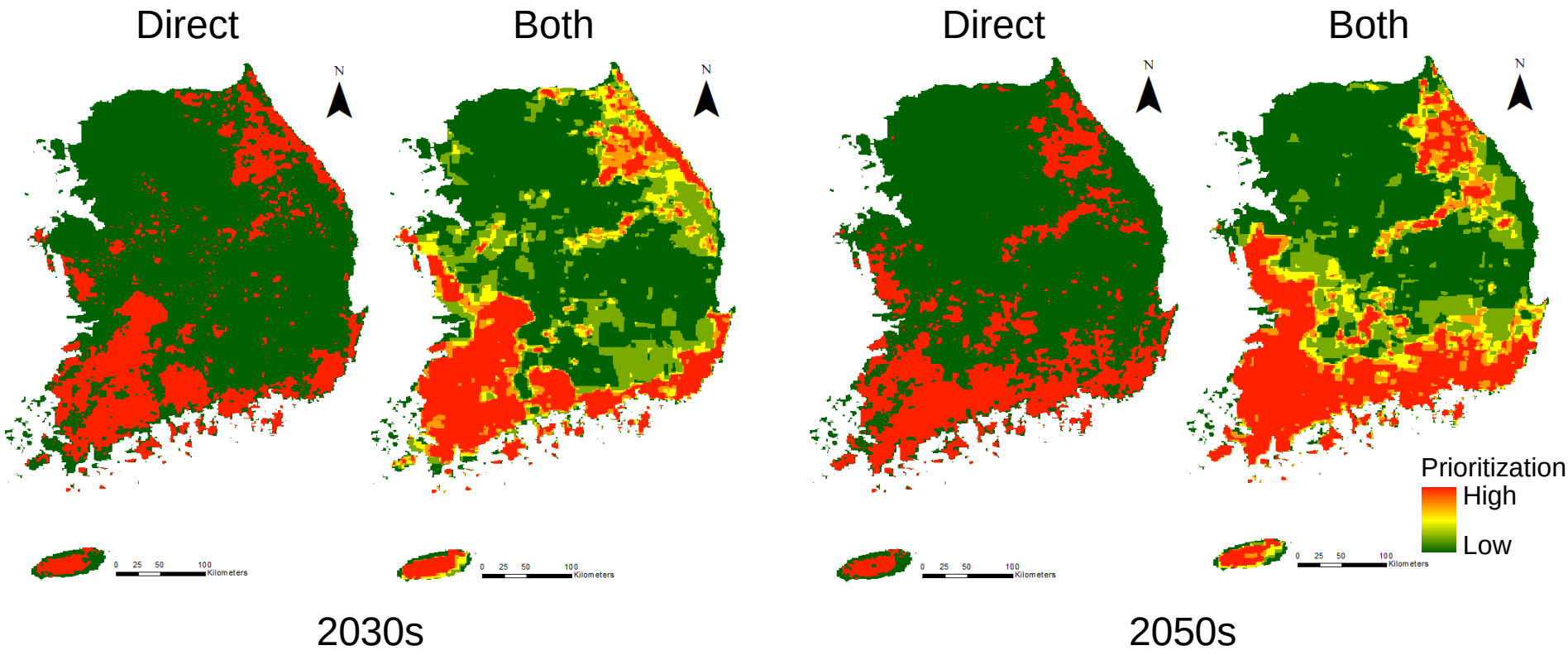
= 4 + 12 + 0

= 16

Cost: number in each box
Boundary: 1
Penalty: 10 by each species

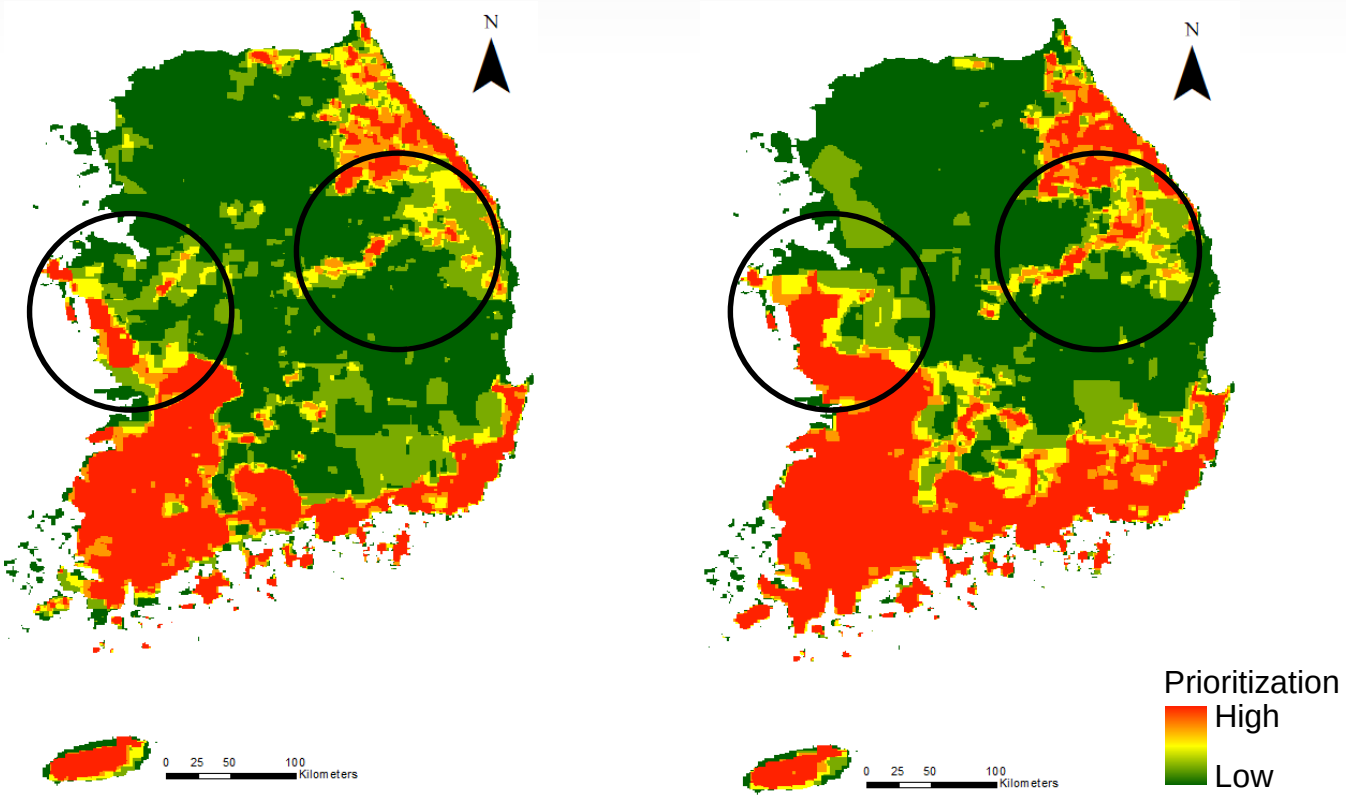
Comparison of Prioritization Between Direct & Both

- Mountain and Alpine area more important
- Fragmentation: Direct > Both



Stepwise Planning

- Identified areas need to be expanded for the future
- Western regions and Alpine areas



Present - 2030s

2030s – 2050s

Conclusions

- Applying both more useful, less fragmented
- Usefulness of stepwise planning

Limitations and further research

- Need to apply the interactions between impacts
- Different type of ecosystems
- Effect of planning-unit

(Under review) Mo, Y., **Lee, D.K**., Kim., H.G., Huber, P.R., and Thorne, J.H., "Different influences of planning-unit characteristics on systematic conservation planning according to the human footprint level", **Biodiversity and Conservation**

- Other impacts by human

- Consider connectivity & spatial prioritization simultaneously

- Consider connectivity & spatial prioritization simultaneously

Thank you for your attention :)

This study was funded by the Korea Ministry of Environment (MOE)
as ‘‘Climate Change Correspondence Program.’’

Indirect climate change impacts (30s, 50s)

Ecosystem

- Climate Sensitive species (30)
- Invasive species (7)

Forest

- Landslide probability
- Forest fire probability

Agriculture

- Agricultural suitability (3)