

Modelling and Mapping Recreational Ecosystem Services Using Multi-Scale Natural and Social Metrics in Japan

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Introduction

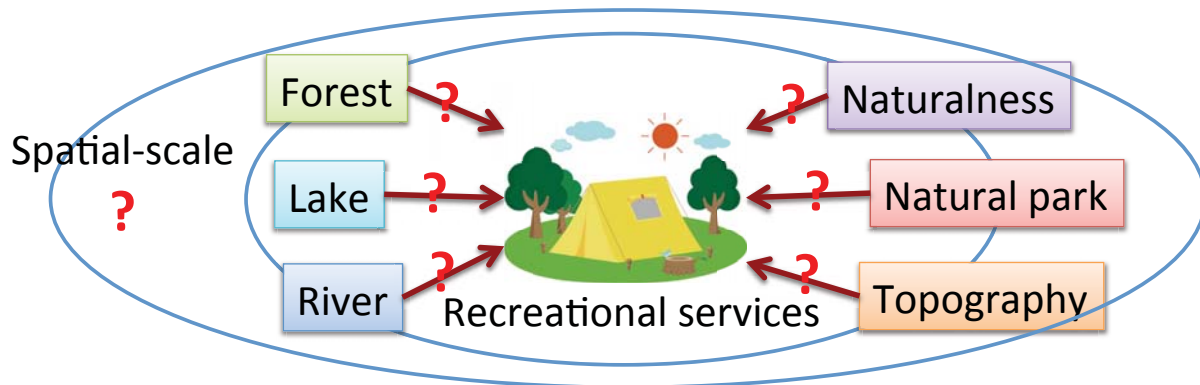
Recreational Ecosystem Services



- Recreation is one of the important cultural ecosystem services
 - **camping**, cycling, hiking, fishing
- Recently growing number of studies have been conducted
- However, there still remain challenges in modelling and mapping recreational services at large spatial scales.
- This study tried to estimate recreational services across Japan using **campground density** as an indicator.



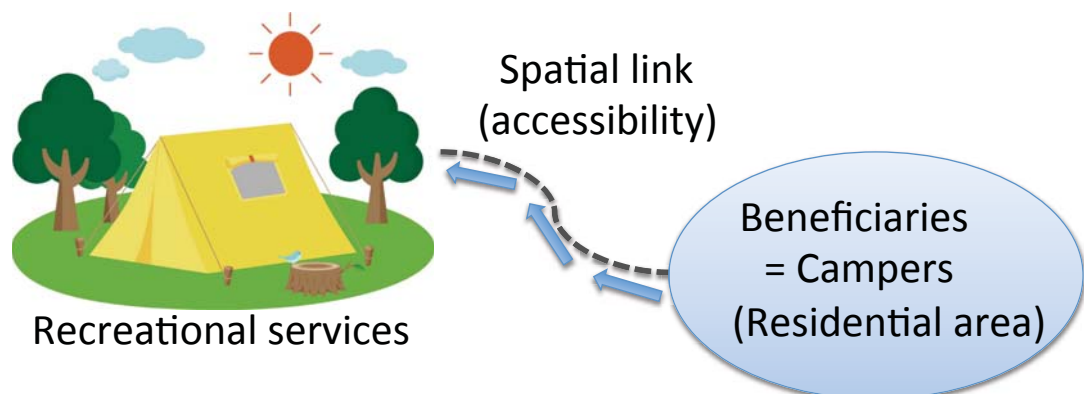
Natural attributes and spatial scales



- Natural attributes are linked to recreational services
- However, these links have not been quantitatively evaluated
 - strong or weak?
 - linear or non-linear?
- Effective spatial scales of natural attributes are also unknown

This study tried to model recreational services by considering multiple spatial-scales of natural attributes.

Social attributes and spatial scales

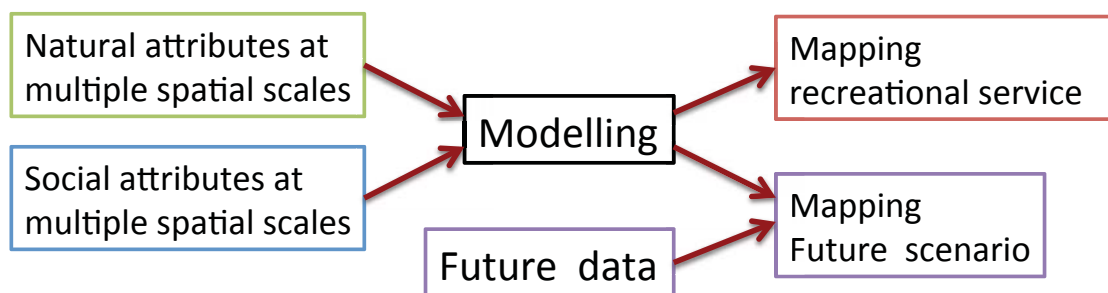


- Social attributes, such as accessibility and number of potential campers, should also affect recreational services.
- Because campers must access to service providing area (i.e., campground) in order to benefit from the ecosystem services.

Not only natural attributes but also social attributes and its effective spatial scales must be considered.

Questions

- (i) How natural attributes affect campground density?
- (ii) Which spatial scale of natural and social attributes affect campground density?
- (iii) Does the most important spatial scale differ between natural and social attributes?



Materials and Methods

Study area: JAPAN



Total area: 378,000km²
Population: 127 million
(340 inhabitants/km²)

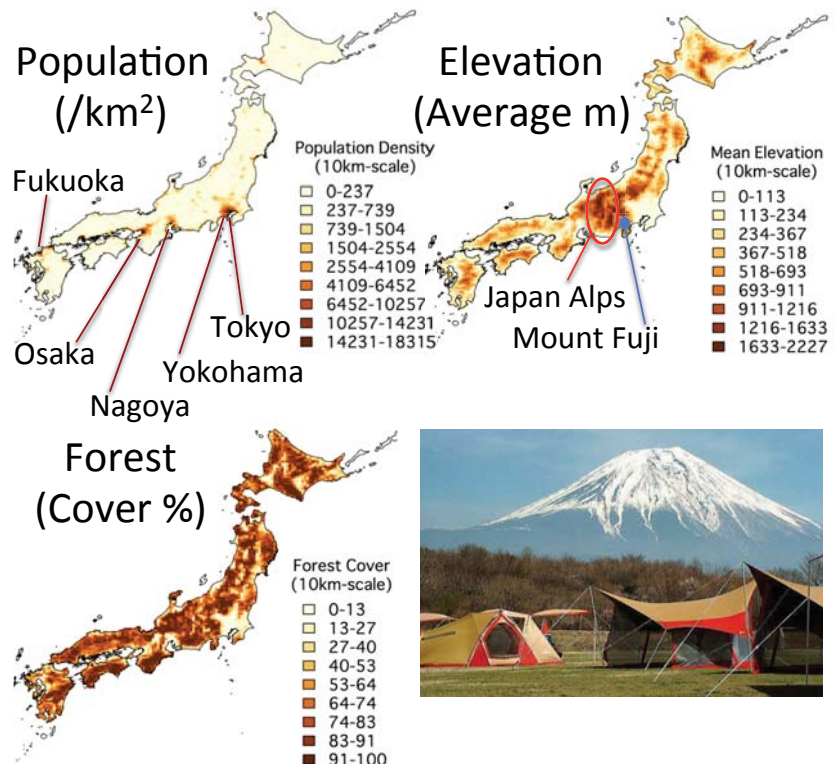
-Population is highly concentrated in large cities

Topography: 70% of Japan is mountainous

The highest mountain: Mount Fuji (3,776 m)

Forest cover: 68%

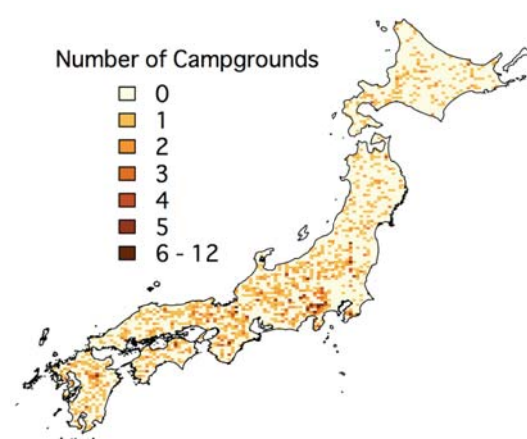
-40% of them are plantations



Data collection: campground density



- We searched campgrounds based on specialized guidebooks
 - We did not include sea coast campgrounds because they are linked to different kinds of natural attributes
- We only used campgrounds that have good facilities and are accessible by car
- In total, 1633 campgrounds were used for modelling
- Campground density was calculated for each 10km grid cell



Data collection: variables

Natural attributes

Forest cover (%)
 Natural forest ratio (%)
 Primary forest ratio (%)
 Agricultural land cover (%)
 Grassland cover (%)
 Lake coast density (m/km²)
 River density (m/km²)
 Natural park cover (%)
 Average elevation (m)
 Highest elevation (m)

Social attributes

Population density (/km²)
 Road density (m/km²)
 Urban area cover (%)
 Distance from the interchange (km)

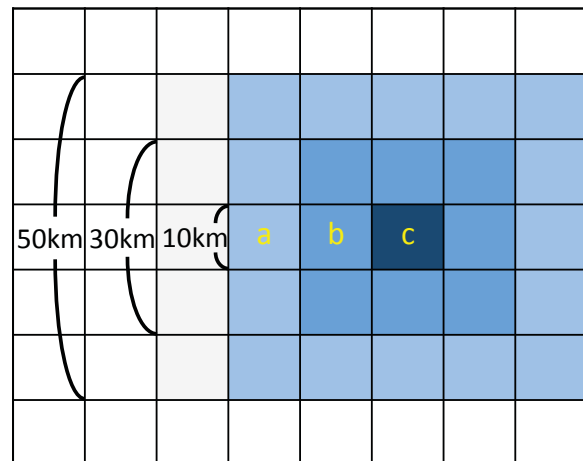
Climatic attributes

Mean annual temperature
 Total annual precipitation
 Annual sunshine
 Annual maximum snow depth

- Natural and social attributes were calculated at 10km, 30km, 50km, 110km, 210km and 410km scale for each 10km grid.
- Climate attributes were calculated for each 10km grid.

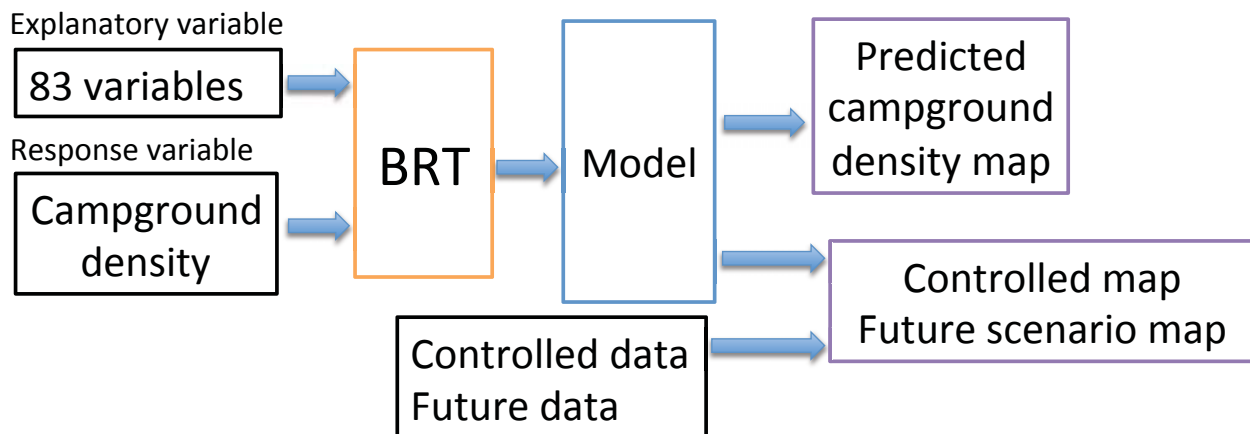
Modelling: variables

- Variables were calculated for 3,395 cells of 10km grid across Japan
- We calculated natural and social attributes at 6 spatial scales (10, 30, 50, 110, 210, 410km) for each 10km grid
- So, each cell has 6 values for each variable
- In total, each cell has 83 variables



Modelling: machine learning

- We used boosted regression trees (BRT) for modelling campground density
 - They can fit complex nonlinear relationships
 - They automatically handle interaction effects between predictors
 - Good predictive performance
- (Elith et al. 2008)

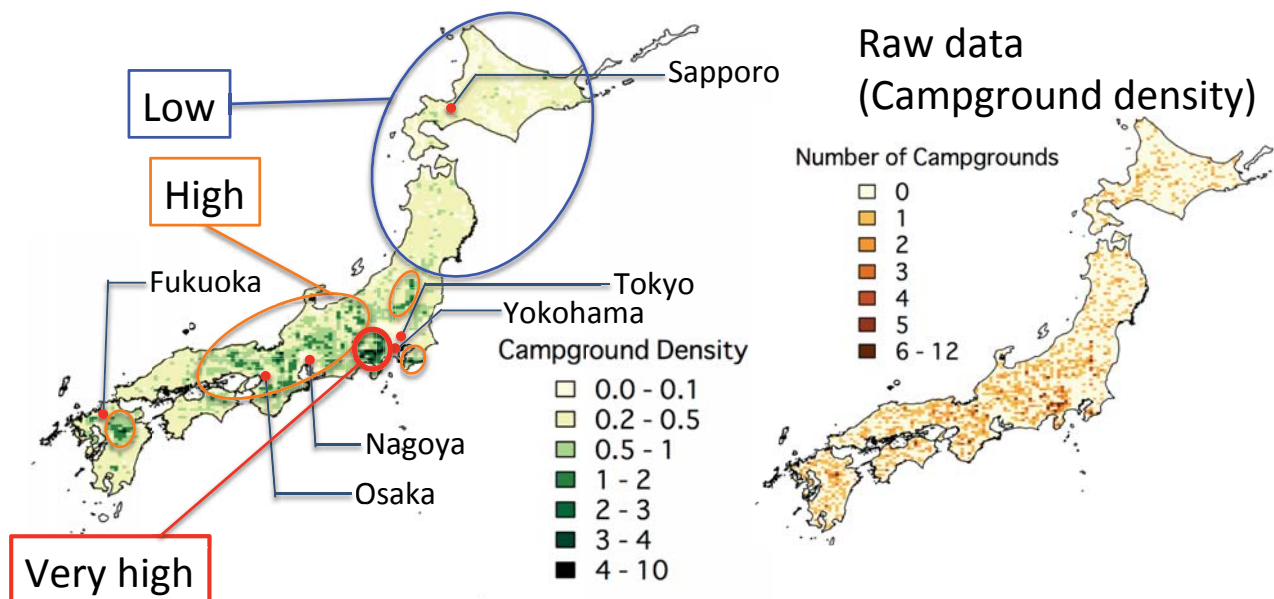


Results and discussion

Predicted recreational service



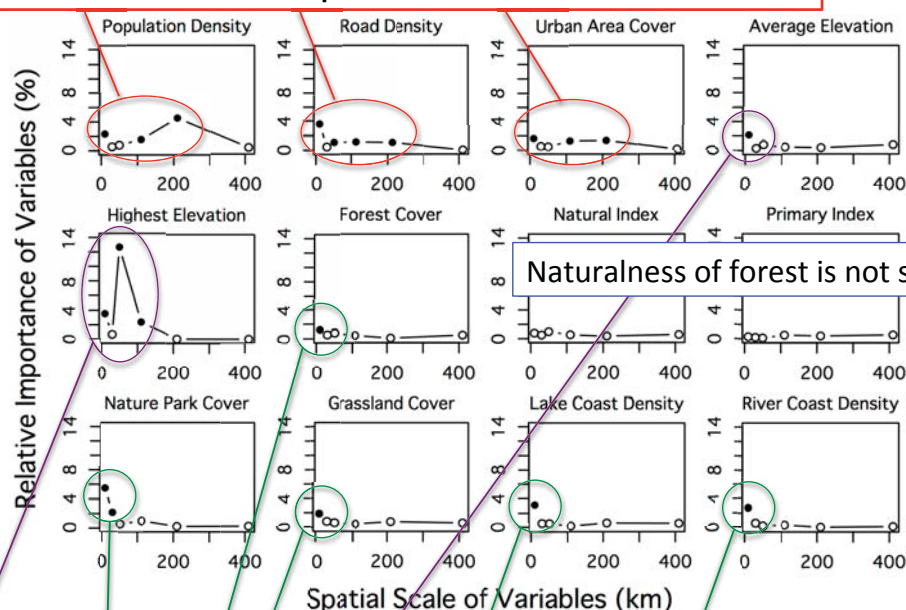
Predicted campground density map



Relative importance of variables



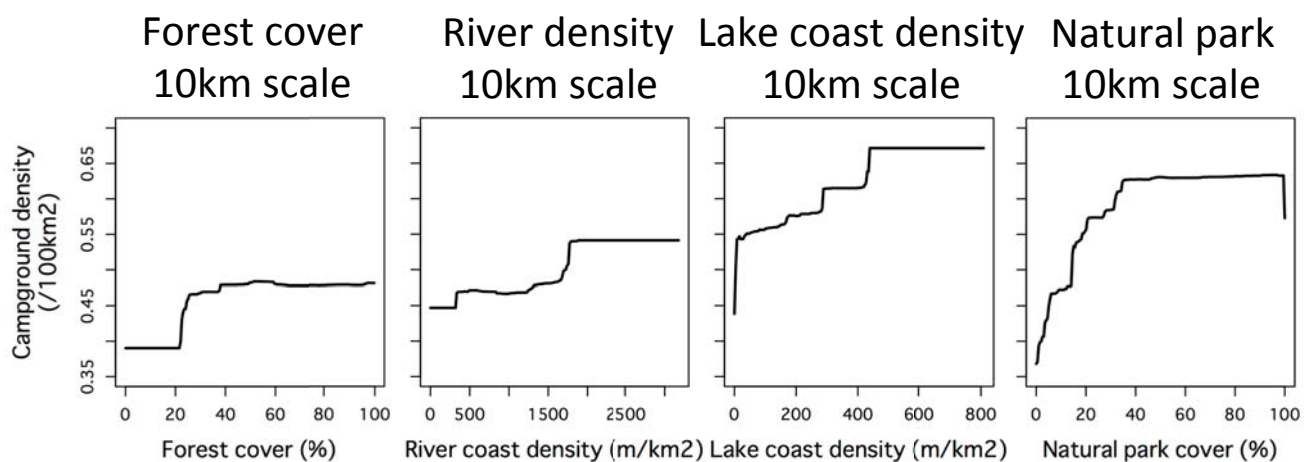
Social attributes are important at 10–210km scale



Natural attributes are important at 10km scale

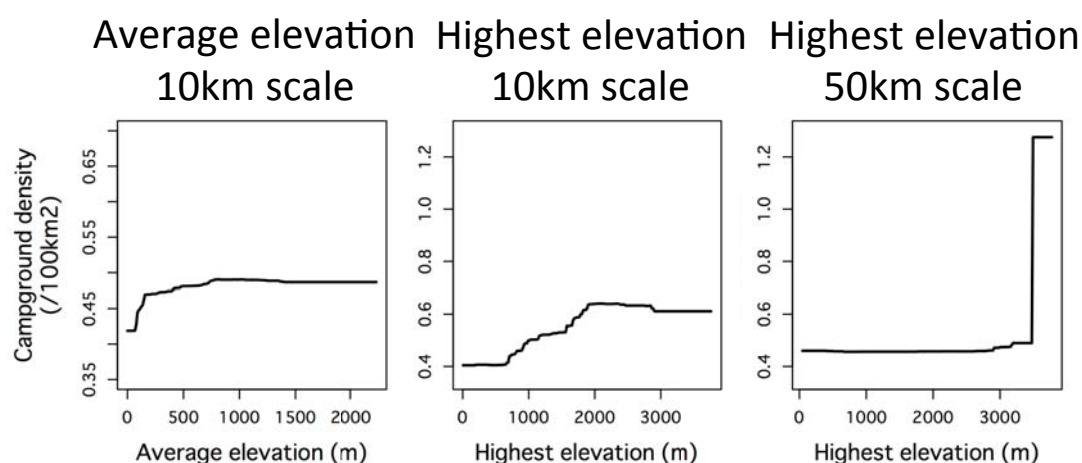
Elevations are important at 10–110km scale

Partial effects of natural attributes



- Forest cover, River density, Lake coast density and Natural Park cover have positive effects on campground density at 10km scale
- But their effects are non-linear

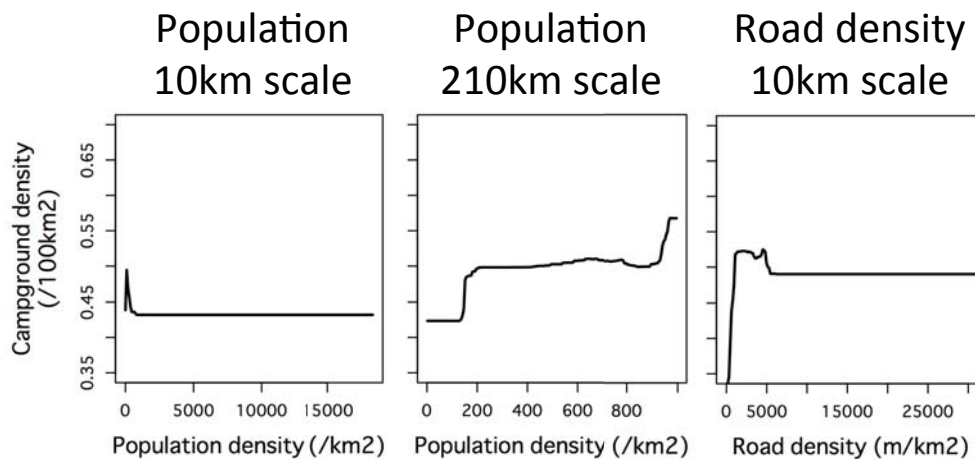
Partial effects of natural attributes



- High elevation at 10km scale has positive effects on campground density
- Highest elevation of >3,500m (Mt. Fuji) at 50km scale has strong positive effect on campground density

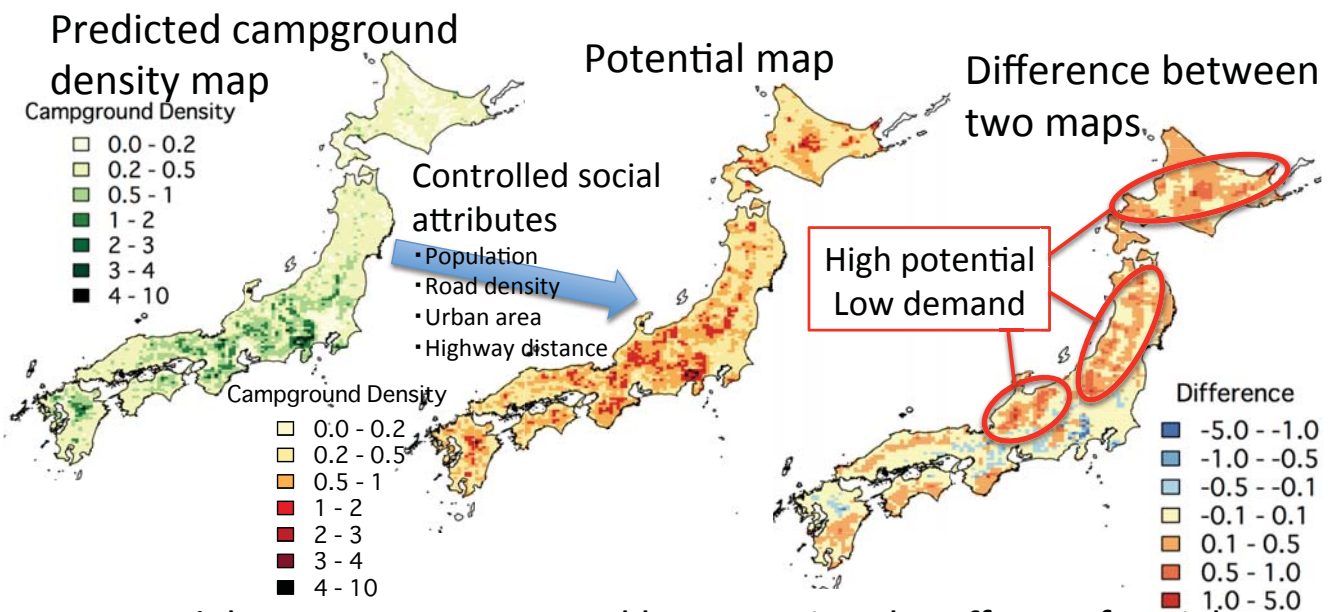


Partial effects of social attributes



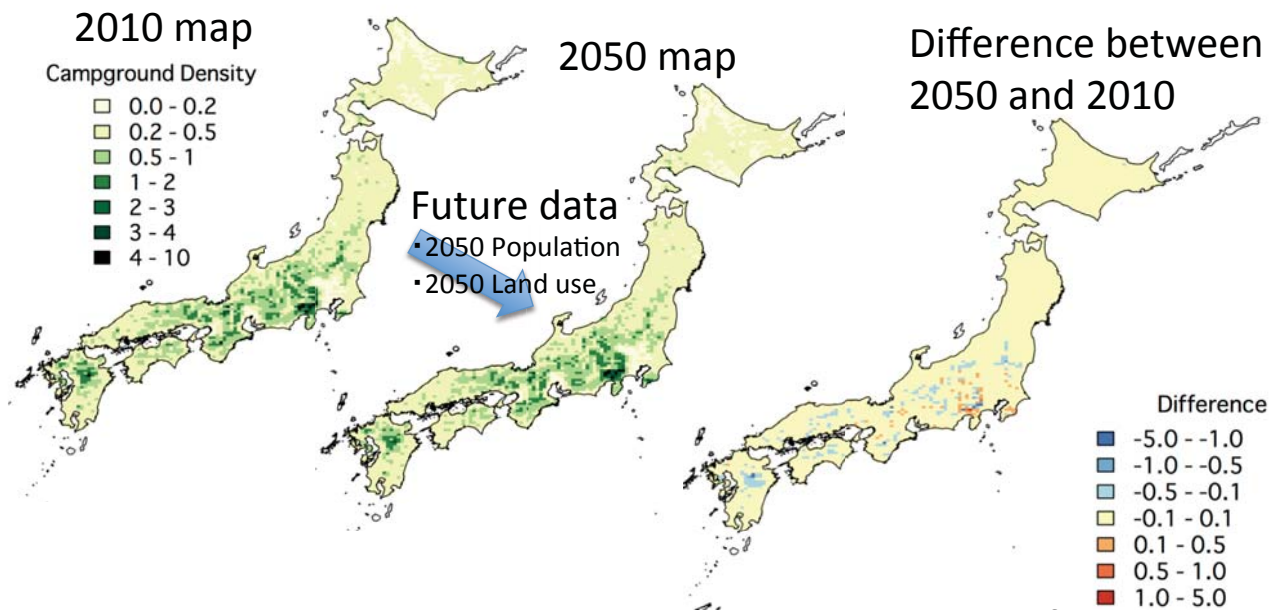
- Low population and road density at 10km scale have positive effects on campground density
- However, zero population and zero road density at 10km scale has negative effects.
- At 210km scale, higher population density have positive effect on campground density.

Potential map



- Potential map was constructed by removing the effects of social attributes.
- Northern part of Japan has high potential for camping (i.e., good nature), but low demand (i.e., low accessibility, low population)

Future scenario map



- Future campground density map was made by applying future population and land use scenario data to the model
- Predicted campground density was slightly decrease in response to decreasing population density (demand)

Conclusions

- (i) How natural attributes affect campground density?
 - Forest, lake, river, natural park and high elevation at 10km scale have non-linear positive effect on campground density
 - Naturalness of forest does not affect campground density
- (ii) Which spatial scale of natural and social attributes affect campground density?
 - Natural attributes affect at 10km scale, but social attributes affect 10–210km scale
 - Highest elevation at 50km scale strongly affect campground density, and this should be the effect of view of Mt. Fuji
- (iii) Does the most important spatial scale differ between natural and social attributes?
 - Yes, and by considering multiple-spatial scale attributes, we successfully model and map recreational services in Japan