

K.LAB Modeler example

22 May 2019

K.HAYASHI

Nagoya University, Institute of Materials
and Systems for Sustainability

k.Modeler: Japan ES model

- 10m grid: DEM10m, LU10m
- Carbon stock
- Micro-climate regulation: Forest volume, LST
- Air pollution regulation: NO₂, SO_x, etc.
- Agri-product supply: Rice, Agri-product
- Culture ES:

Carbon stock survey

- DBH (≥ 5 cm) and tree height (H) were measured by a 15 m tree pole supported by a Laser range finder (Nikon Laser 550A S) to calculate above ground biomass (AGB).
- DBH and H in a 100 m².
- H of the 300 m² were estimated by DBH and H in the 100 m²
 - Näslund tree height curves: Yamamoto (1985) and Matsumura (2003)
- the AGBs of each tree were estimated based on Tadaki et al. (2004) in Formulas.

```

/////////// carbon stock///////////
model "local:maruhaya:es.japan.ep:JnHRLULC16.02WGS84EastE134_153"
as landcover:LandCoverType
classified into
landcover:WaterBody if in (1 91),
landcover:UrbanFabric if in (2 71),
landcover:RiceField if in (3 11),
landcover:AgriculturalVegetation if 4,
landcover:NaturalGrassland if in(5 51),
landcover:DeciduousBroadleafForest if in (6),
landcover:DeciduousConiferousForest if in (7),
landcover:EvergreenBroadleafForest if in (8),
landcover:EvergreenConiferousForest if in (9),
landcover:BareArea if in (10 61),
/* " JAXA(2017) High-Resolution Land Use and Land Cover (HRLULC) map of Japan (Released in Sep. 2016 / Version 16.09)"
dc:url "http://www.eorc.jaxa.jp/ALOS/lulc/lulc_jindex_v1602.htm#main" */
define CARBON_STOCK_TABLE_JAPAN as {{
    landcover | carbonstock_per_ha
-----
    landcover:WaterBody | 0,
    landcover:UrbanFabric | 0,
    landcover:RiceField | 5, ////unitt/ha////
    landcover:AgriculturalVegetation | 0,
    landcover:NaturalGrassland | 0,
    landcover:DeciduousBroadleafForest | 88.0,
    landcover:DeciduousConiferousForest|125.2,///unitt/ha, used by CF///
    landcover:EvergreenBroadleafForest |107.9, ////uintt/ha////
    landcover:EvergreenConiferousForest|125.2, ///unitt/ha,used by CF///
    landcover:BareArea | 0,
}};

model chemistry:Organic chemistry:Carbon im:Mass in t/ha
observing landcover:LandCoverType named lc
lookup (lc, ?) into CARBON_STOCK_TABLE_JAPAN ;

```

Micro climate regulation

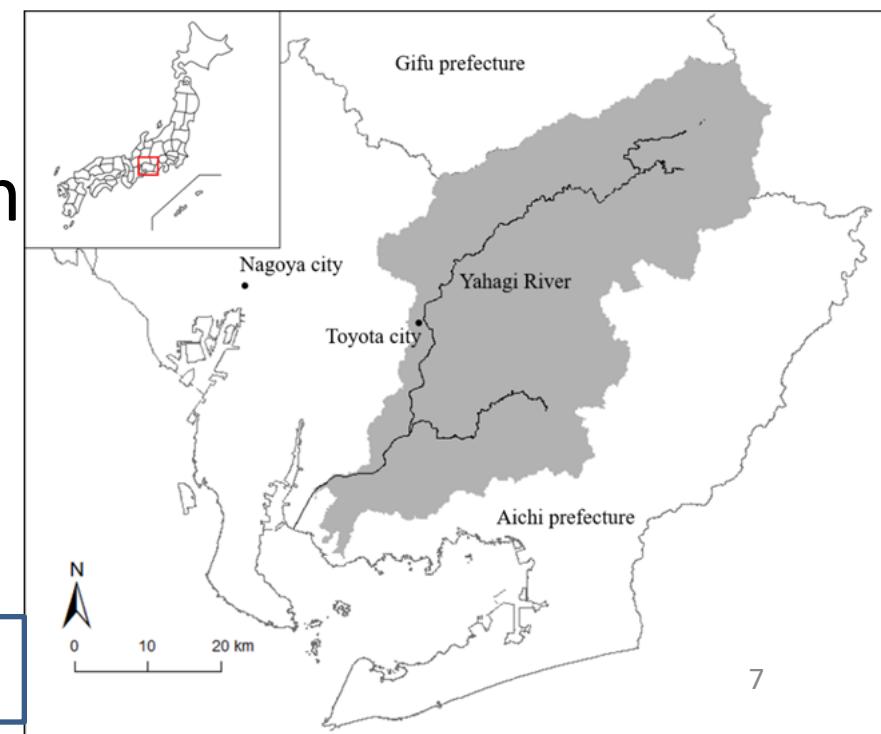
- Hiruta and Ishikawa (2012) studied the heat-reduction effect by green spaces
 - Indicators: forest canopy coverage, tree volume, and ground coverage.
- Tree volume: largest especially for daytime in summer.
- Our study focused on micro climate regulation.
 - Forest volume by Formula (2) using forest cover and average tree heights (DBH \geq 5 cm) (Kobayashi et al. 2016).
- $Vi = 104 * (CovHov - (1 - Cov)CmidHmid) + (1 - Cov)(1 - Cmid)CundHund\}$ (2)
 - Vi : forest volume in 100 m² site i (m³/ha)
 - Cov : overstory cover (10 m>)
 - Cmid : midstory cover (10 m \geq , >5 m)
 - Cund : understory cover (5 m \geq , > 1m)
 - Hov : average height of overstory trees (m)
 - Hmid : average height of midstory trees (m)
 - Hund : average height of understory trees (m)

Micro-Hydro power potential

- Mini and micro hydropower targeted
 - below 1000kW
 - Development of a potential estimation method

Method

- Yahagi River System flows down to Nagano, Gifu, and Aichi Prefectures.
- Stream length: 117 km
- Catchment area : 1,830 km²



Source: Y.Yamazaki, K.Hayashi, N.Kawaguchi, H.Okazawa, F.Villa, GIS-based analysis for the energy potential and social feasibility of small-scale run-of-river hydro powerin Yahagi River, Japan. ICERD10th. 2019.

Flow

- **Supply**
- Micro-Hydro potential site selection
 - River flow
 - Water discharge amount
 - Potential site selection
- Disaster risk factor
 - Sediment erosion
 - Flood possibility
- Environmental risk factor
 - Nature conservation area
 - National park area
 - Wildlife sanctuary area
- Micro-Hydro potential site selection
- **Demand**
- Urban area(10m grid = 1household)
- Electricity consumption
- **Balance**
- Supply and demand relation

Method: Power Generation

- Electricity generating capacity
 - $P_e = 9.8 \times Q \times H_e \times \eta$
 - P_e : amount of power generated (kW)
 - Q : river discharge (m^3/s)
 - H_e : height difference between inlet and outlet of stream (m)
 - Initial value: 5m
 - η : dimensionless efficiency of the turbine
 - Initial value: 0.8
- Targeted power generation
 - 30 to 500 kW

Source: Y.Yamazaki, K.Hayashi, N.Kawaguchi, H.Okazawa, F.Villa, GIS-based analysis for the energy potential and social feasibility of small-scale run-of-river hydro powerin Yahagi River, Japan. ICERD10th. 2019.

Method: Cost factor

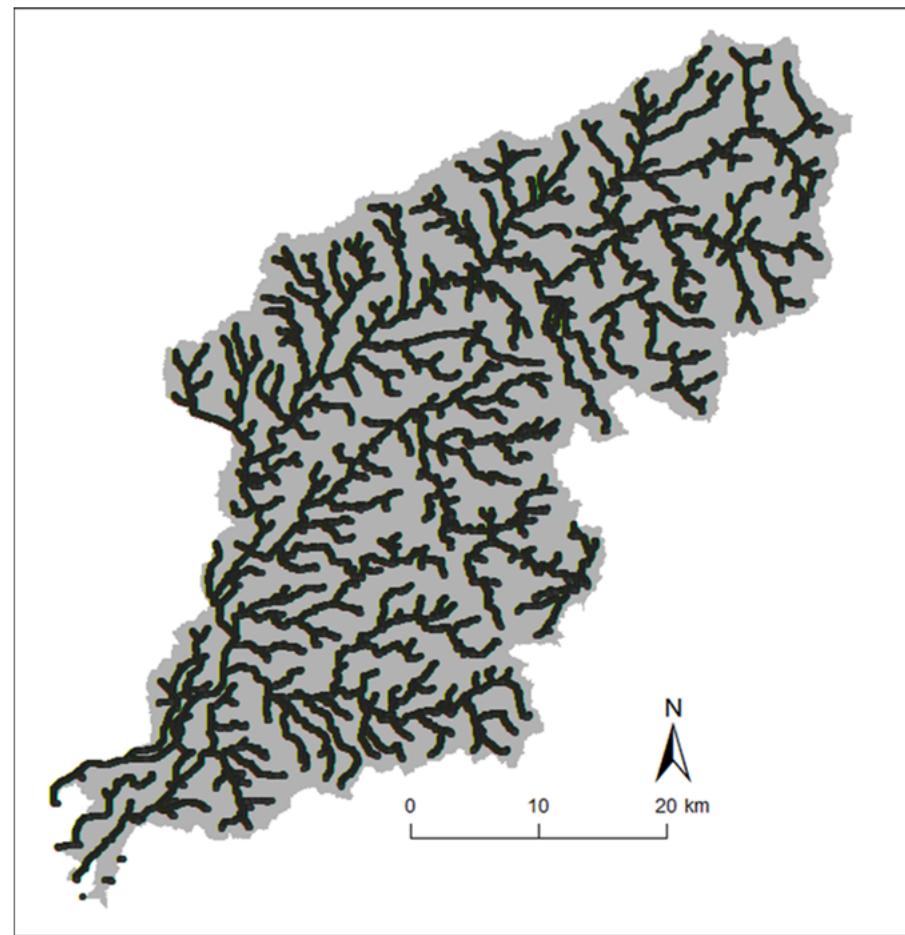
- Distance to road :
 - as a cost factor, connecting electricity power line
- Maximum value of 1.0 in the case of 100 m or less
 - Within river
- Other wise,
 - $Pn = 100 \div Dn$
 - Pn : normalized value of the potential points(n)
 - Dn : distance from potential points(n).

Method: Demand

- High Resolution Land-Use and Land-Cover Map (Ver. 16.09; 10 m grid resolution; JAXA, 2016)
 - Each urban land use pixel represents one house
 - Number of household in around potential site
 - Parameter: 300m
- Annual power consumption per household (2005 to 2010; The Federation of Electric Power Companies of Japan, 2017)

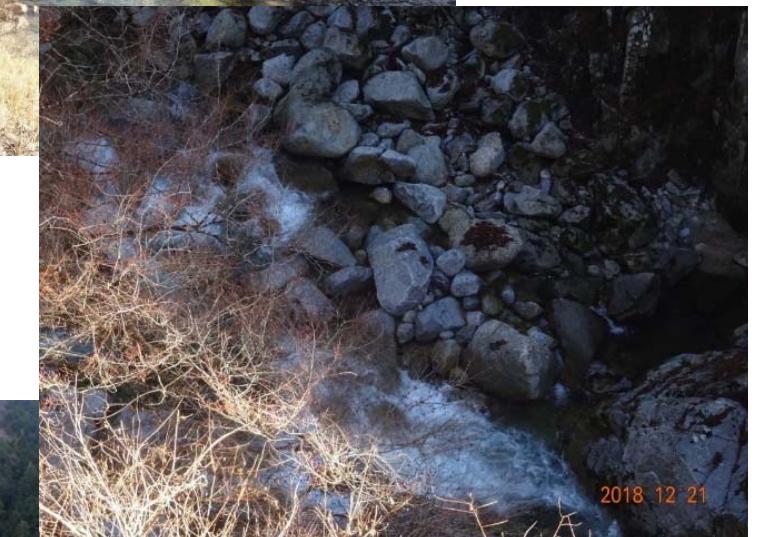
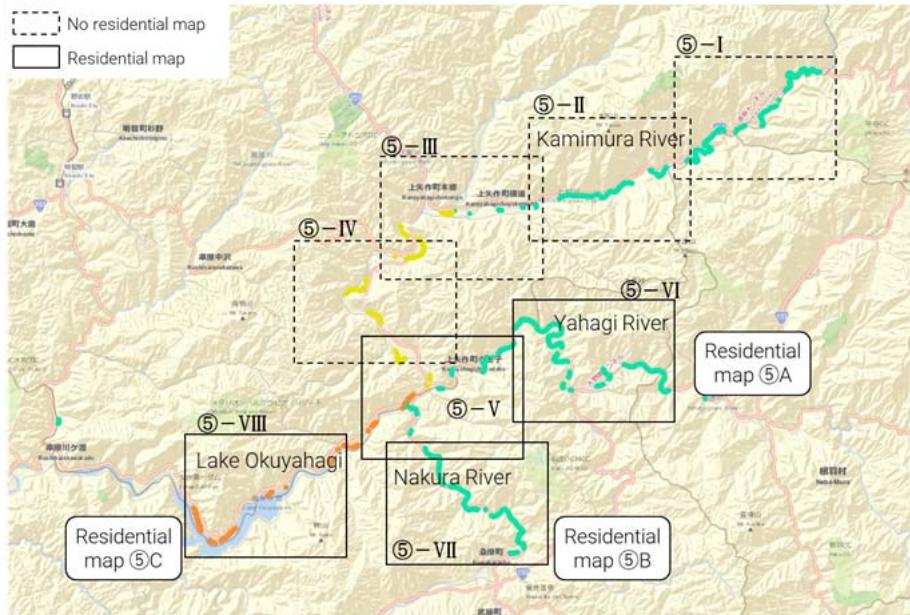
Results

- Watershed
- DEM 10m
- Stream extraction
- Potential points
- Grouping
 - Connecting points is grouped as one section.
- potential estimation after excluding disaster risks and environmental risks: 30 kW-500 kW



Source: Y.Yamazaki, K.Hayashi, N.Kawaguchi, H.Okazawa, F.Villa, GIS-based analysis for the energy potential and social feasibility of small-scale run-of-river hydro powerin Yahagi River, Japan. ICERD10th. 2019.

Field survey



Source: Y.Yamazaki, K.Hayashi, N.Kawaguchi, H.Okazawa, F.Villa, GIS-based analysis for the energy potential and social feasibility of small-scale run-of-river hydro powerin Yahagi River, Japan. ICERD10th. 2019.

K.Modeler: future development



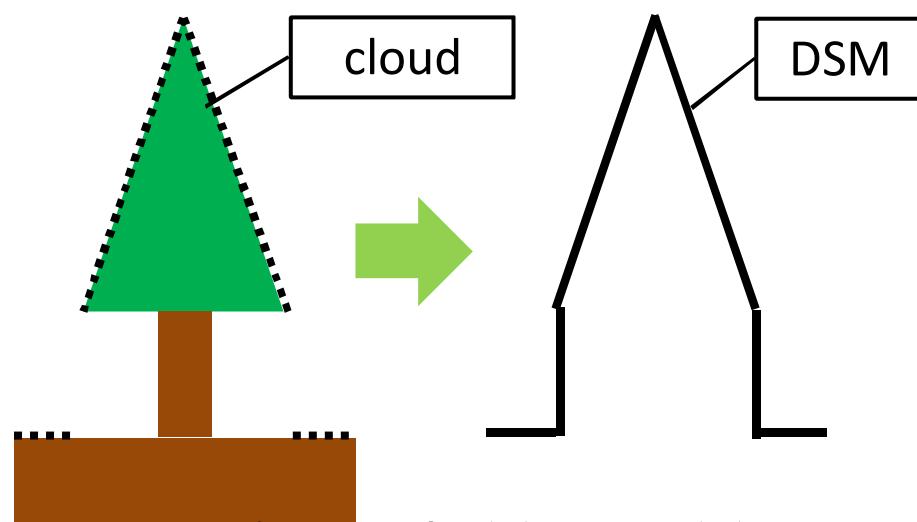
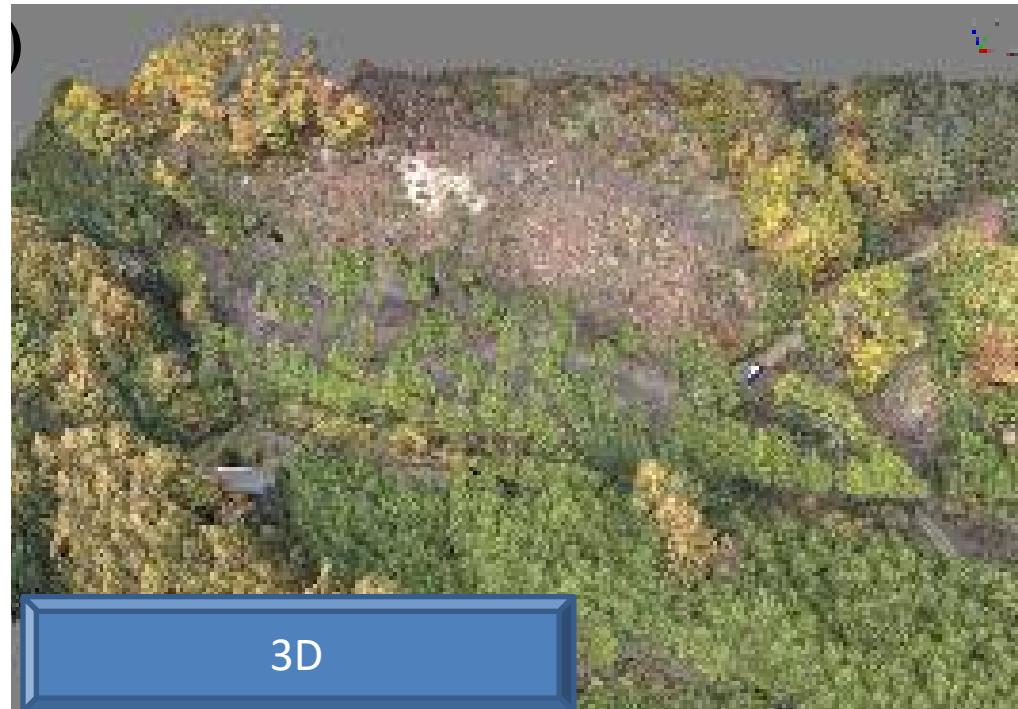
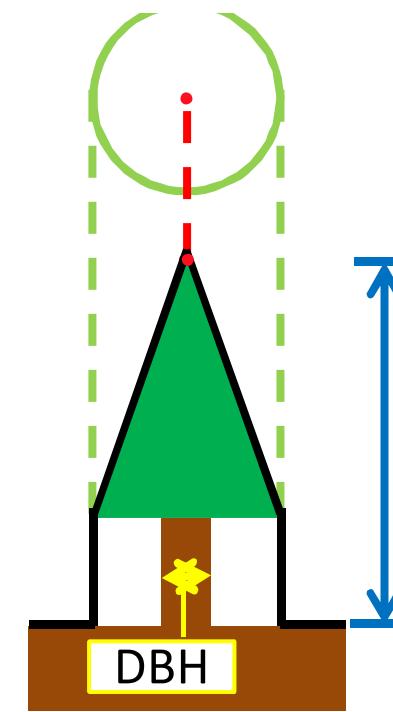
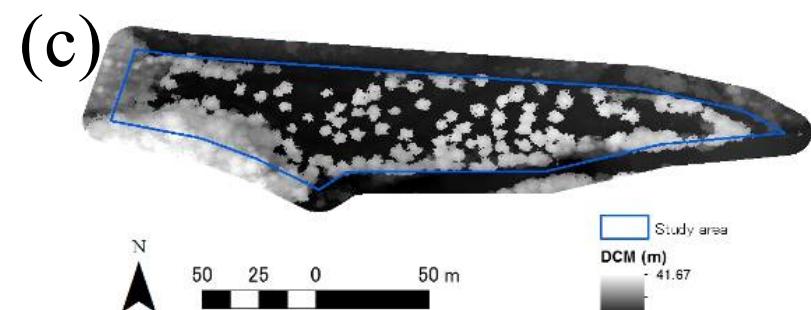
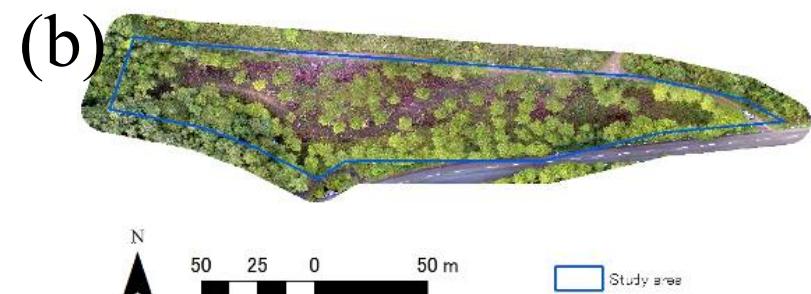
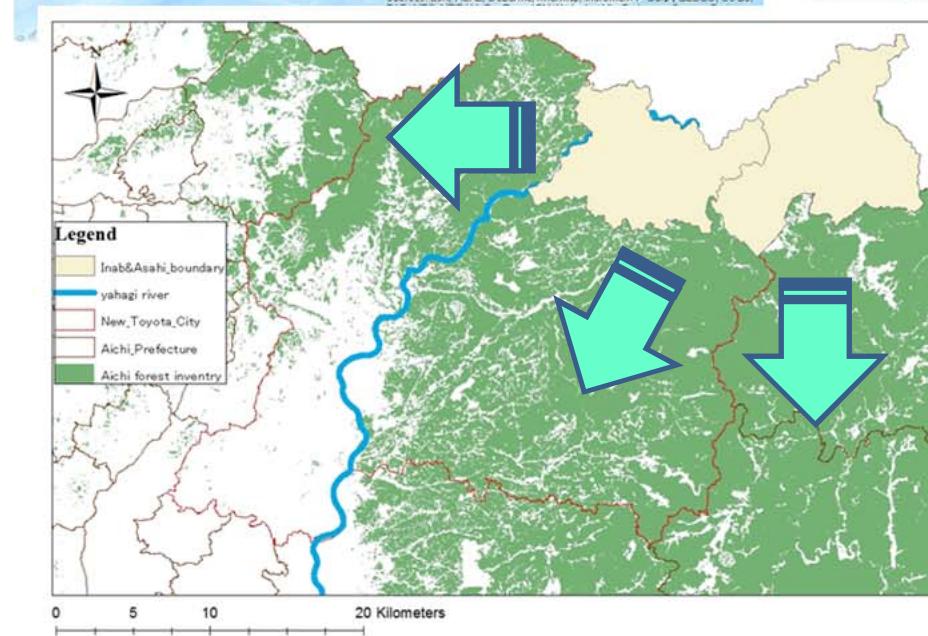
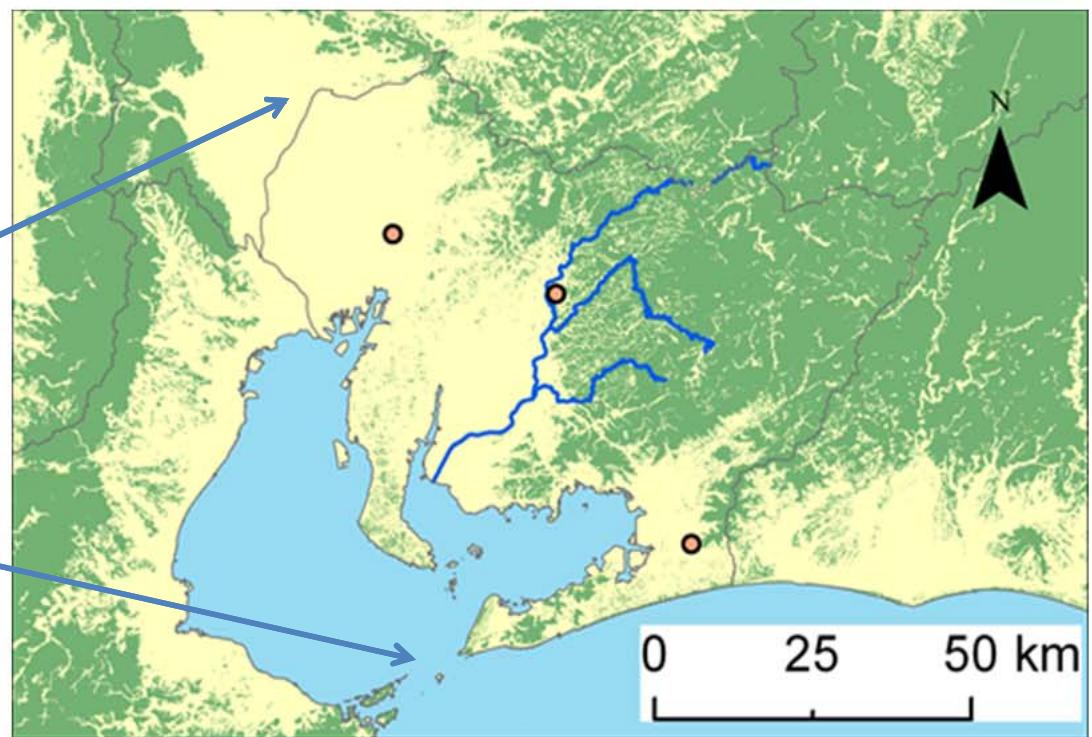
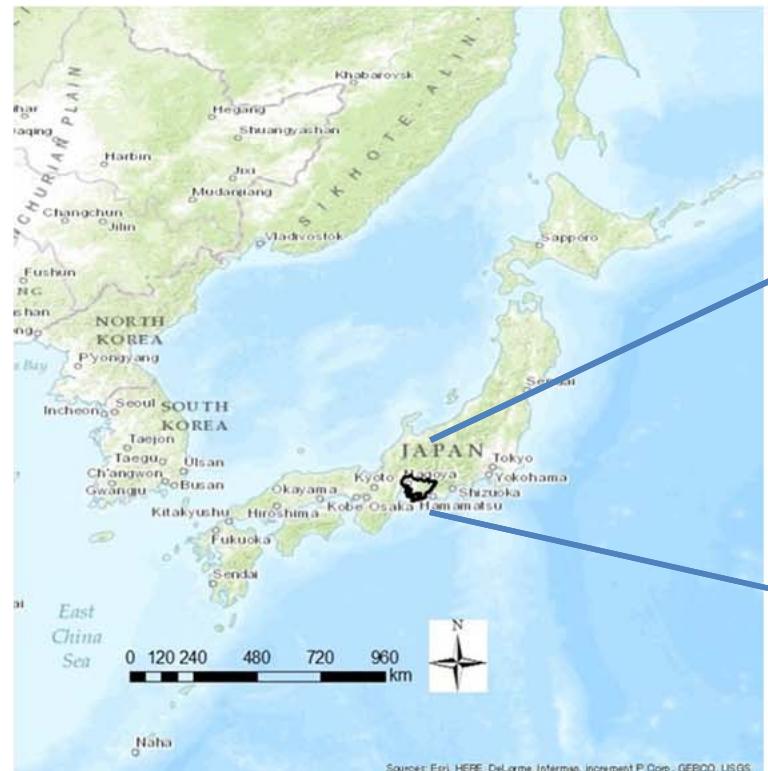


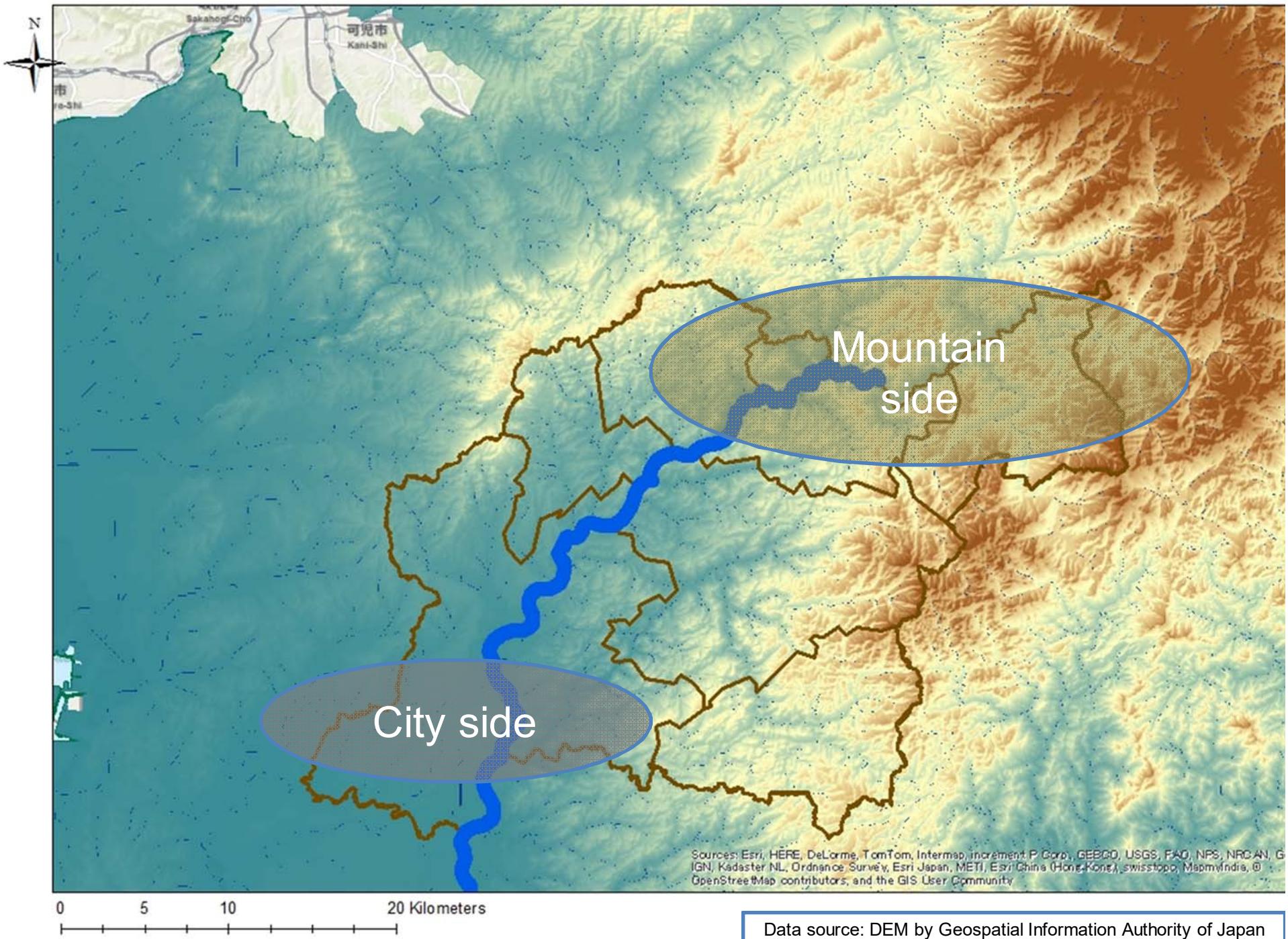
Figure 4. (a) and (b)

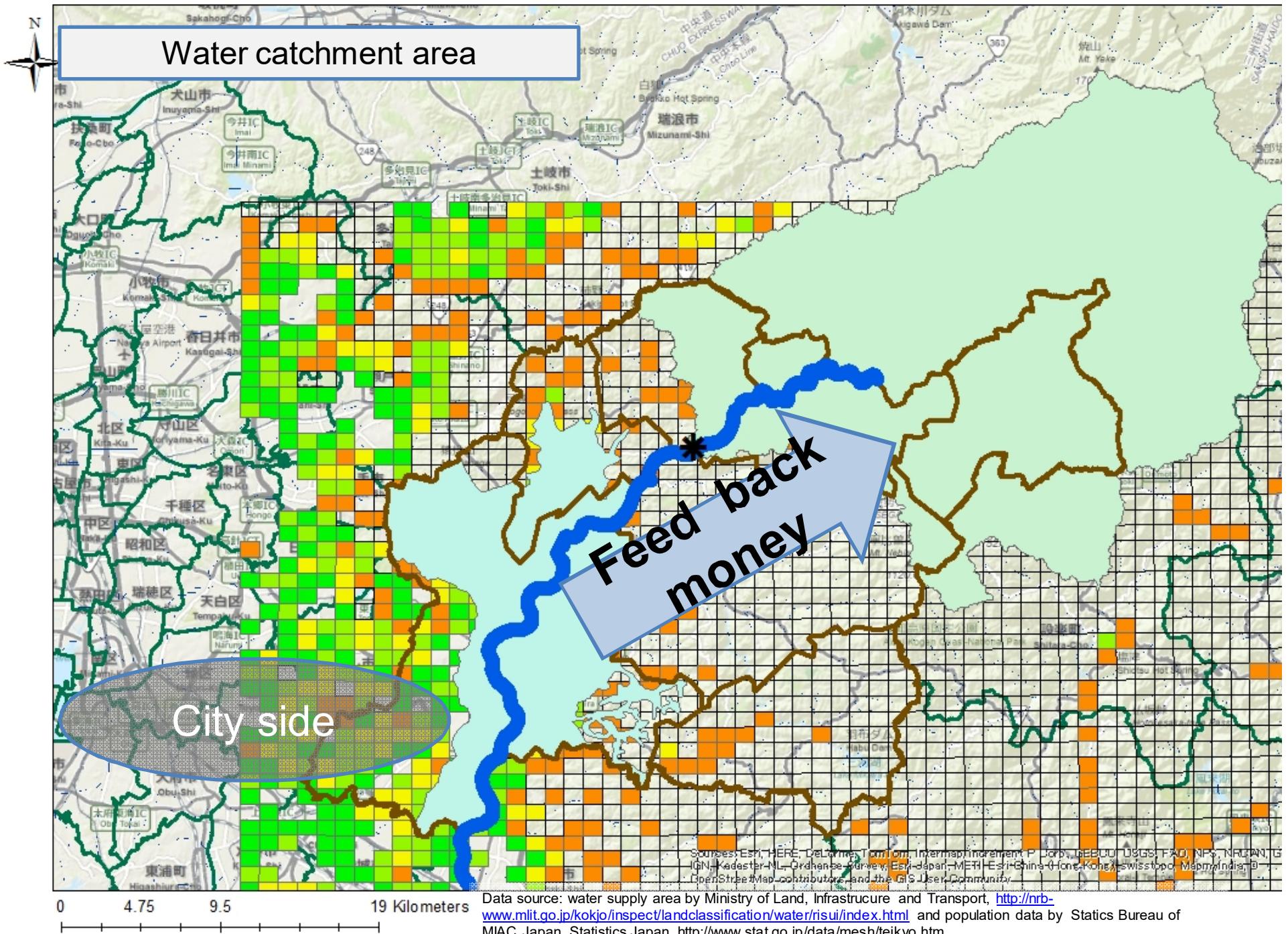




ESs covered

- **14 ESs based on MA(2005) category**
- Provisioning services
 - food, timber and energy, and water
- Regulating services
 - CO₂ absorption, preventing soil erosion, water purification
- Cultural services
 - aesthetic value, recreation and ecotourism, cultural heritage value
- Wildlife Species conservation
 - habitat, valuable species, common species





Thank you for your kind attention

