

*A common ecosystemic currency for assessing regional tradeoffs in ecosystem services*

# **Ecological quantification of ecosystem service capacity**

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# land use change

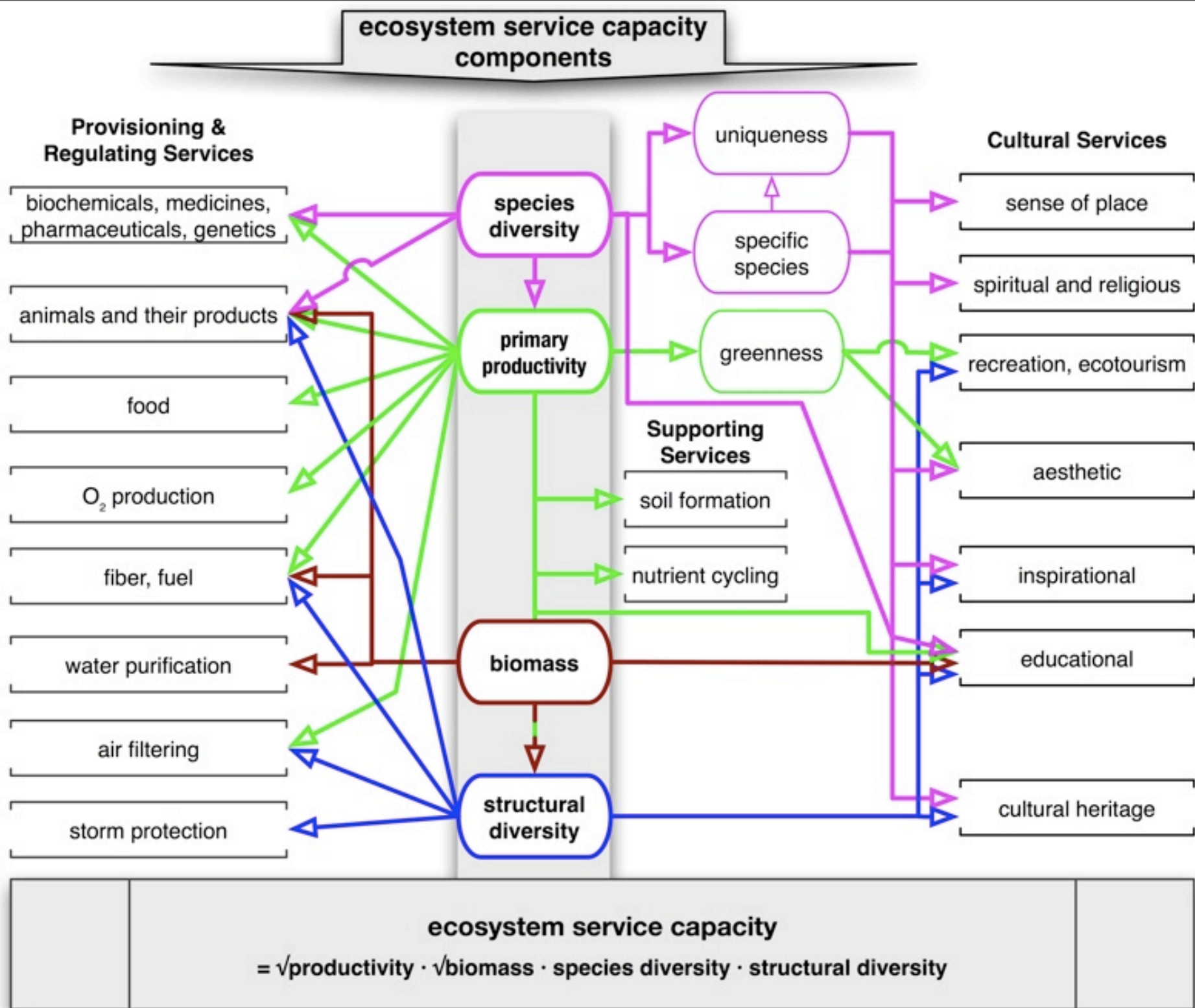
- ▶ land use change
  - greatest contributor to carbon sequestration (or loss) ⇒ climate change
  - often directly effected by humans
  - often due to economic goals
- ▶ land use planning to control
  - trade-off: conservation vs economy
  - decisions based on political goals
  - no quantitative measure for ecosystem state: subjective tradeoffs

# €cosystem service 'value'

- ▶ putting a price tag on ecosystem services
  - allows economic comparisons
  - does not account for non-linearities, integration, and feedbacks in ecosystems
  - price varies with situation:  
supply, demand: access, tradition, region, species identity
  - does not account for intrinsic value

# integration of ecosystem services

- ▶ strengthening the intrinsic value of nature
- ▶ putting ecology before economy
- ▶ independent of political agendas, regional traditions, economic valuation method
- ▶ integrated look at all ecosystem services, for all land use types,
- ▶ improved communication to public and across disciplines



# ecosystem service capacity

$$\sqrt{\text{productivity} \times \text{biomass}} \\ \times \text{species diversity} \times \text{structural diversity}$$

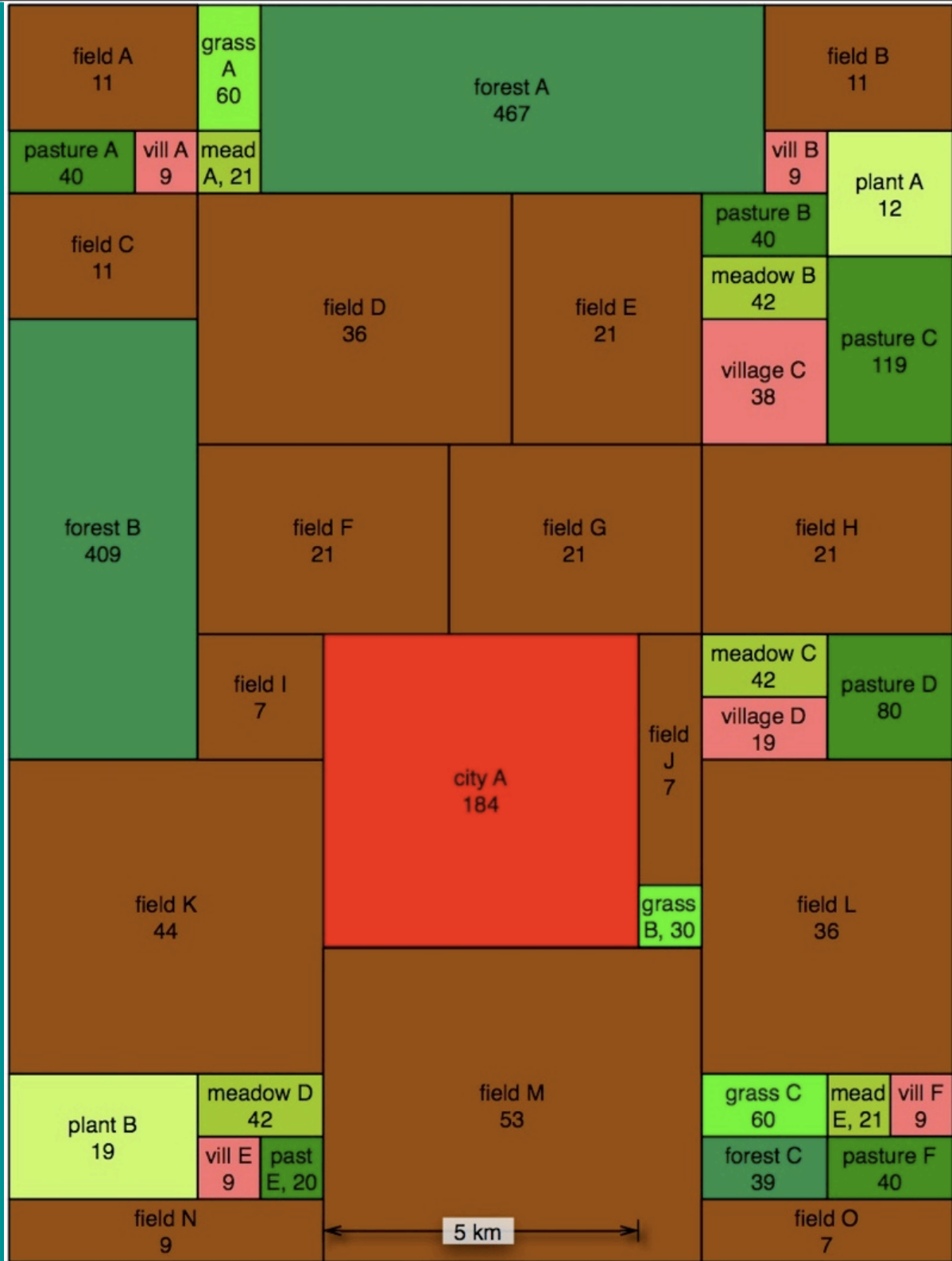
- emphasizes the individual contributions
- square root allows summing over area
- product allows for different units and ranges
- base unit: kg · species

# practical considerations

- ▶ aboveground primary productivity
- ▶ aboveground (shoot) plant biomass
- ▶ number of plant species weighted by biomass:  
effective species richness, **exp**(Shannon index)
- ▶ structural diversity:  
proportion woody – herbaceous biomass

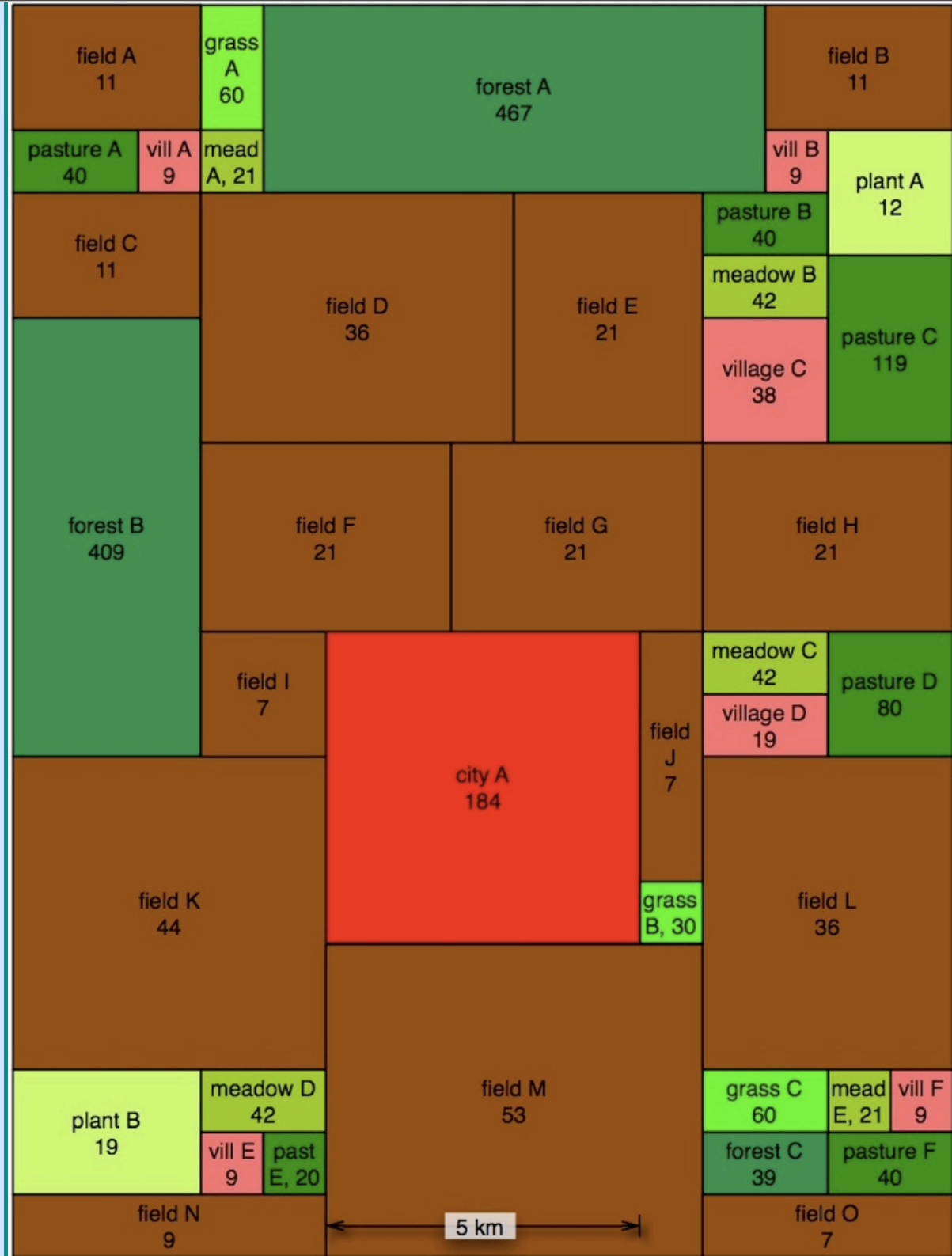
land use	productivity kg ha <sup>-1</sup> yr <sup>-1</sup>	avg. biomass kg/ha	max. diversity <b>exp(H<sub>0</sub>)</b>	structural diversity	area ha	ecosystem service capacity Mg · species
grassland (dry)	6000	6600	47.5	1.00	500	149
meadows (hay)	20000	3000	27.1	1.00	800	168
pastures (cattle)	30000	4000	18.2	1.00	1700	339
forests (decid.)	12000	324000	2.7	1.15	4700	914
fields (wheat)	25000	7500	1.3	1.00	17800	316
plantations (aspen)	11000	12100	1.5	1.84	1000	31
villages (agricultural)	1760	9930	12.2	1.84	1000	94
cities	3200	32700	3.7	1.96	2500	184
<b>total</b>					30000	<b>2195</b>

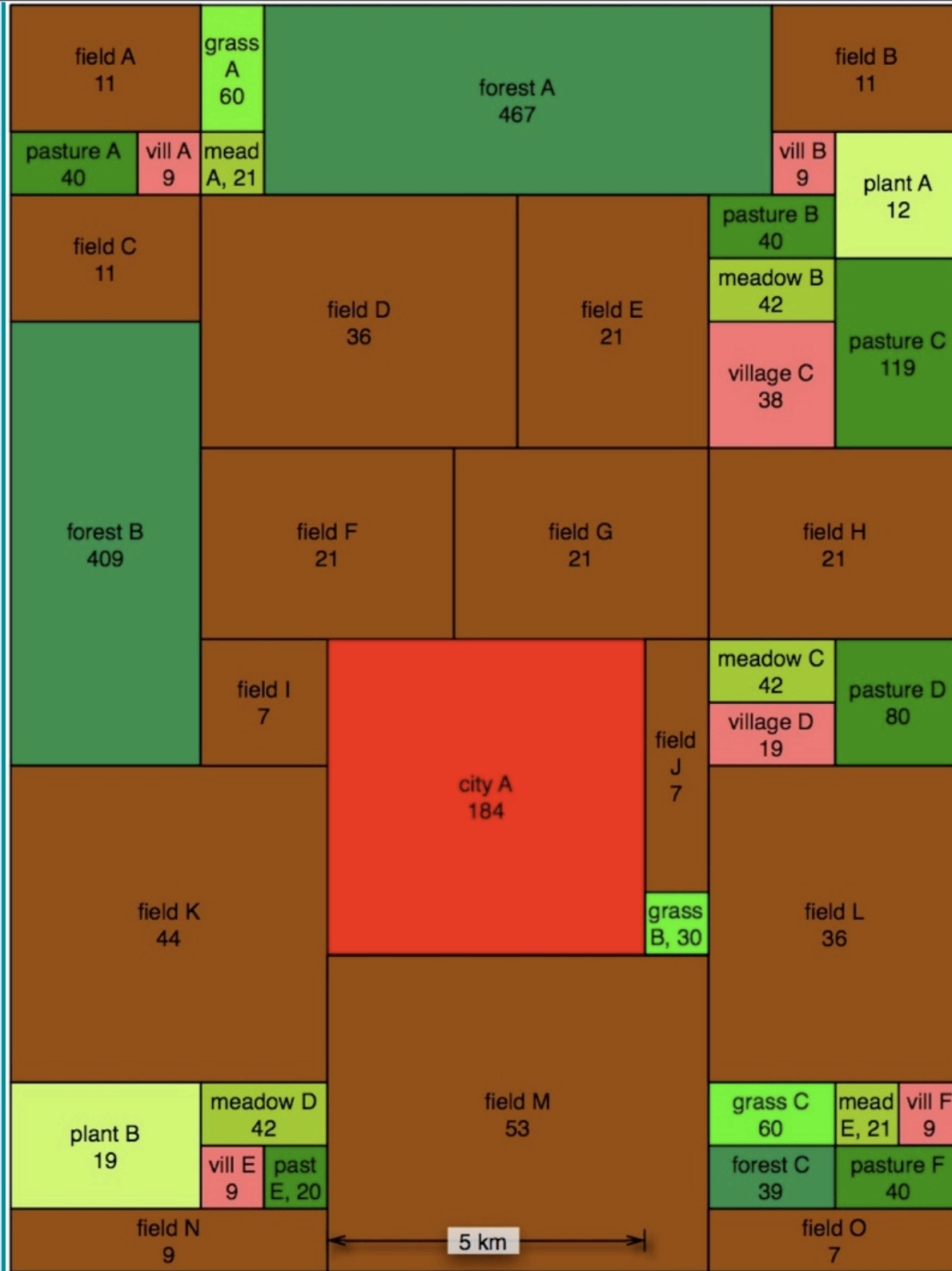




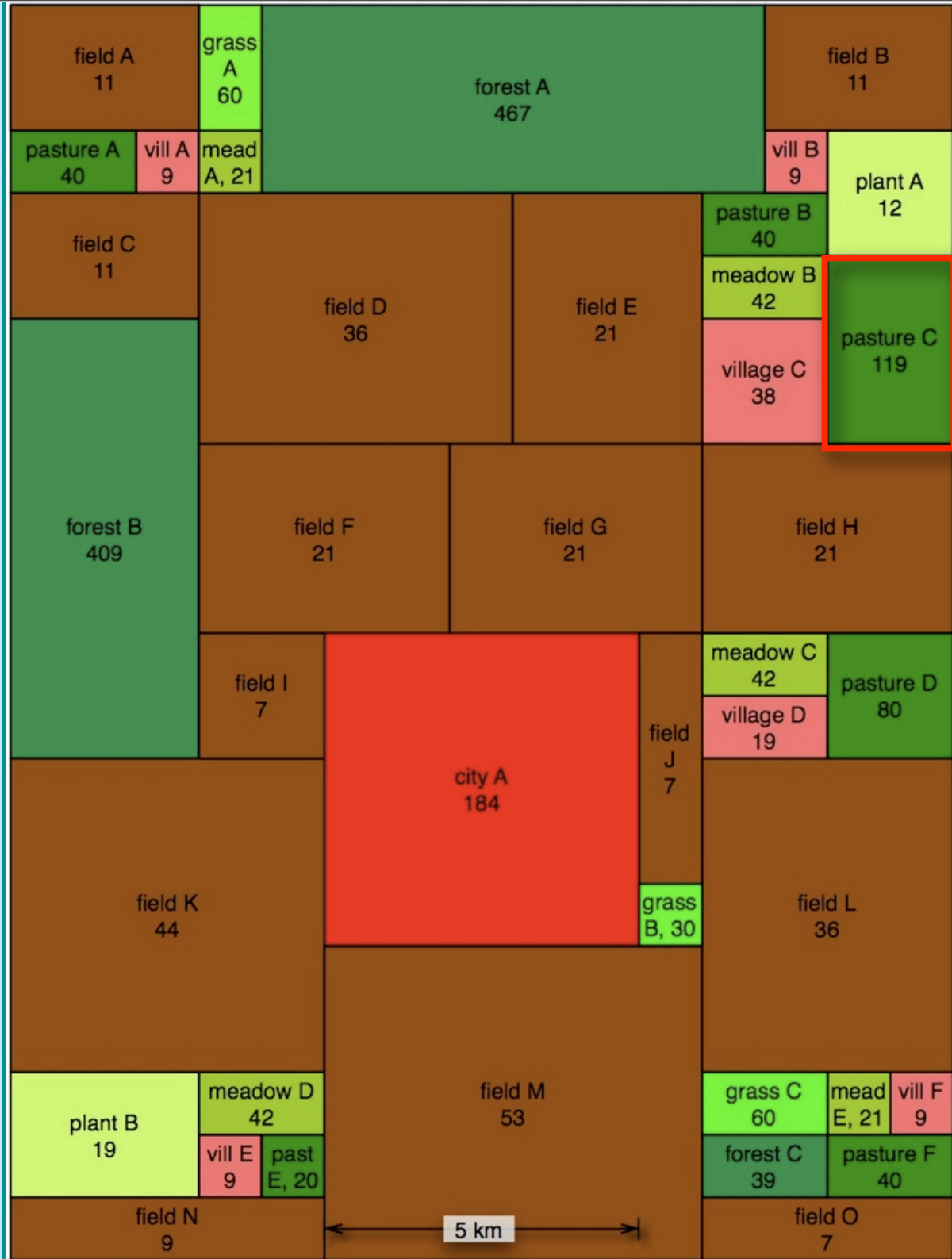
## example landscape

- typical values for each land use type
- biodiversity scaled with area
- summary value for planing  
 $2195 \text{ Mg} \cdot \text{species}$





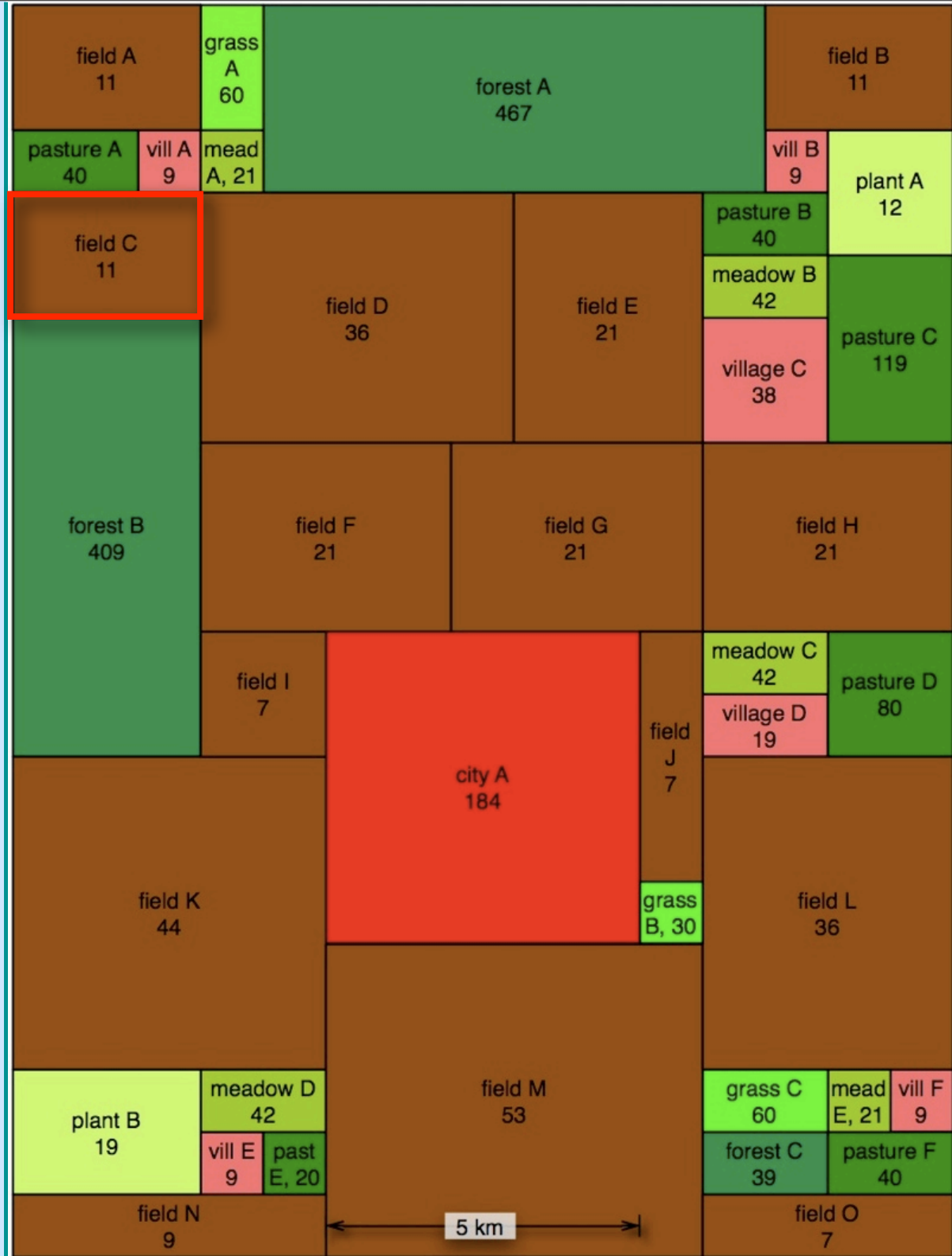
- current capacity:  
2195 Mg · species



- current capacity:  
2195 Mg · species

### scenarios

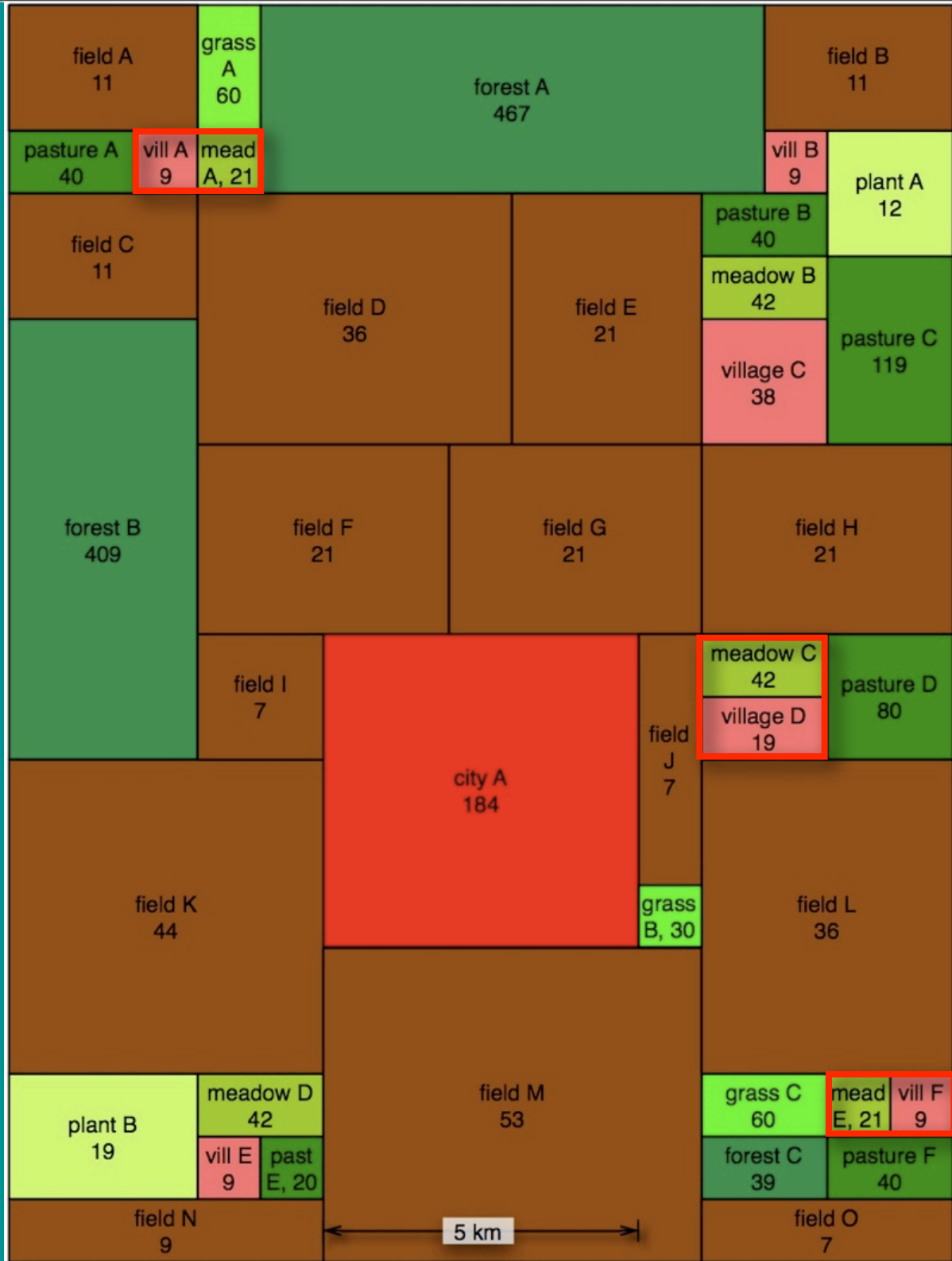
- pasture C ⇒ wheat field  
2086 Mg · species



- current capacity:  
2195 Mg · species

### scenarios

- pasture C ⇒ wheat field  
2086 Mg · species
- field C ⇒ woody crop  
2203 Mg · species

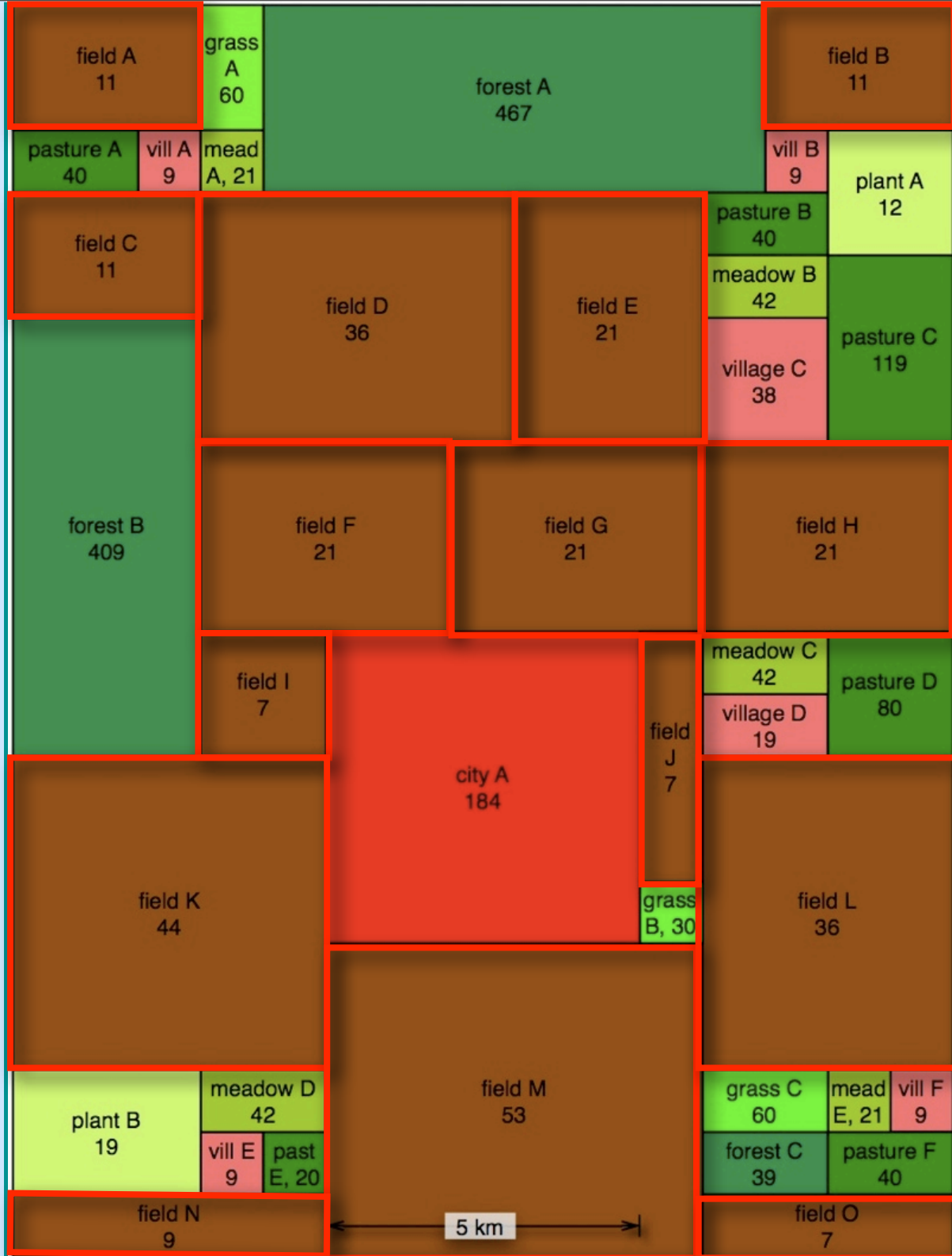


- current capacity:  
2195 Mg · species

### scenarios

- pasture C ⇒ wheat field  
2086 Mg · species
- field C ⇒ woody crop  
2203 Mg · species
- village expansion into meadow:  
2125 Mg · species

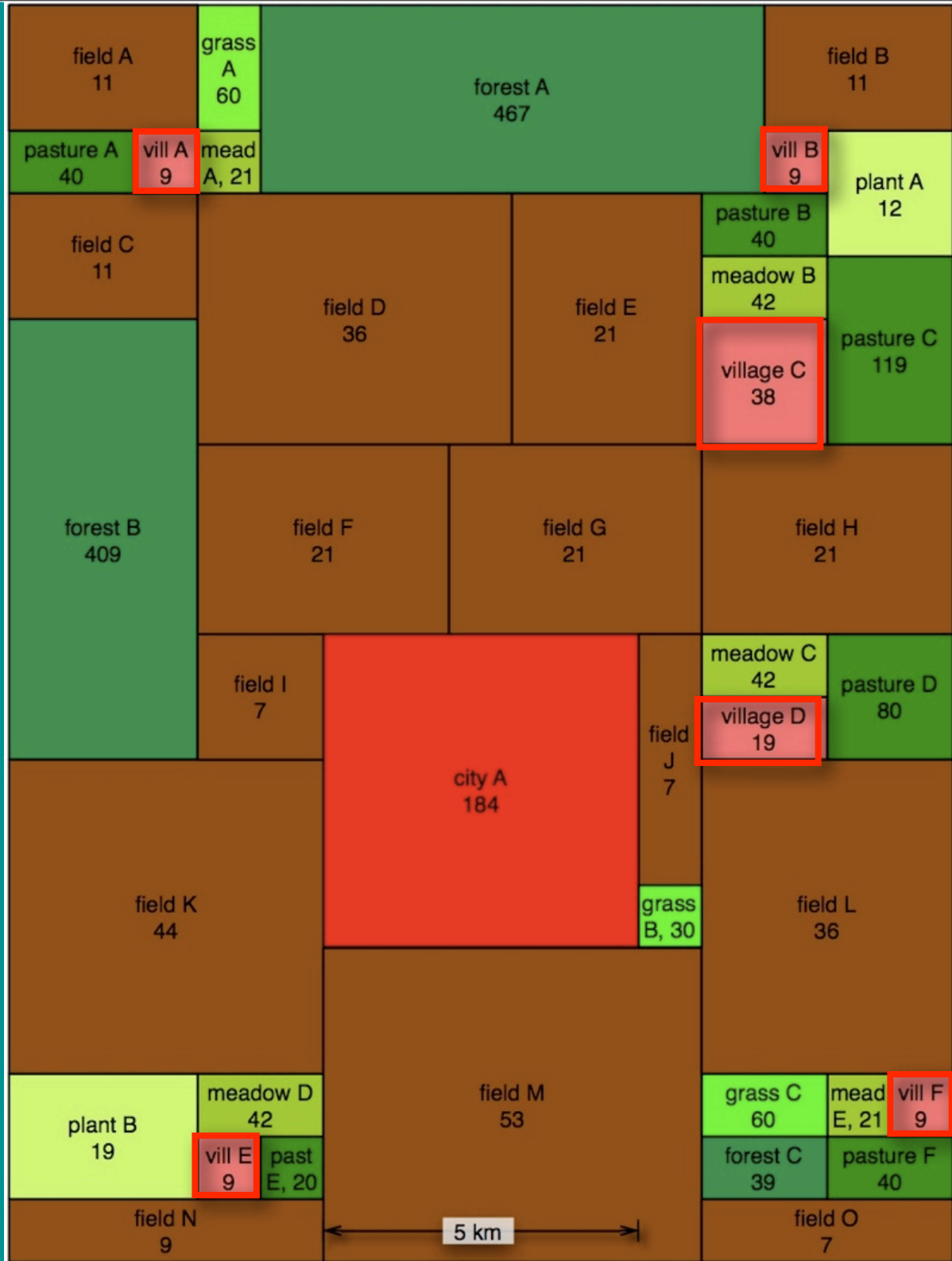




- current capacity:  
2195 Mg · species

### scenarios

- pasture C ⇒ wheat field  
2086 Mg · species
- field C ⇒ woody crop  
2203 Mg · species
- village expansion into meadow:  
2125 Mg · species
- Field Margin conservation programme:  
2194 Mg · species

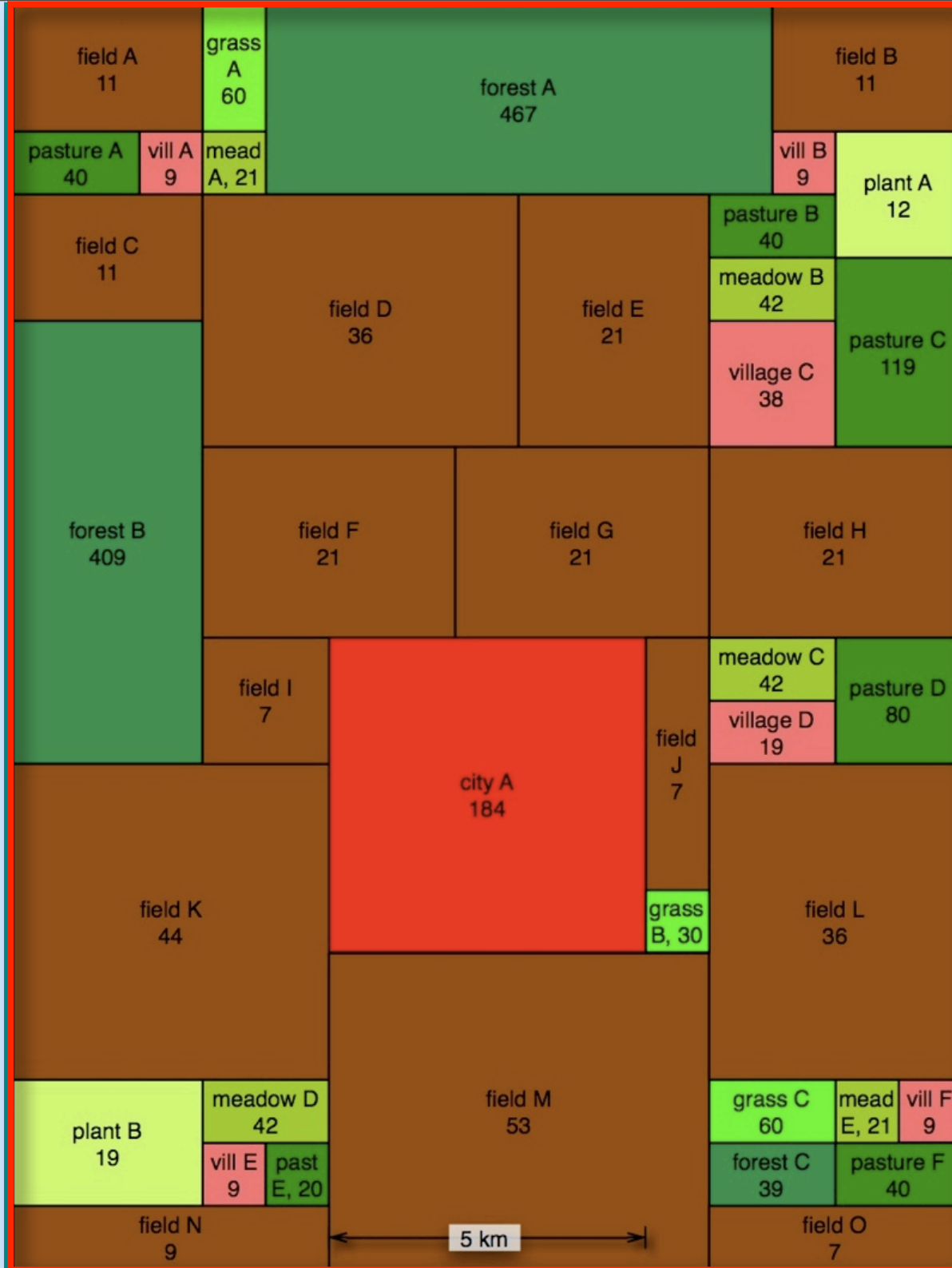


- current capacity:  
2195 Mg · species

### scenarios

- pasture C ⇒ wheat field  
2086 Mg · species
- field C ⇒ woody crop  
2203 Mg · species
- village expansion into meadow:  
2125 Mg · species
- Field Margin conservation programme:  
2194 Mg · species
- Tidy Village Competition:  
2043 Mg · species

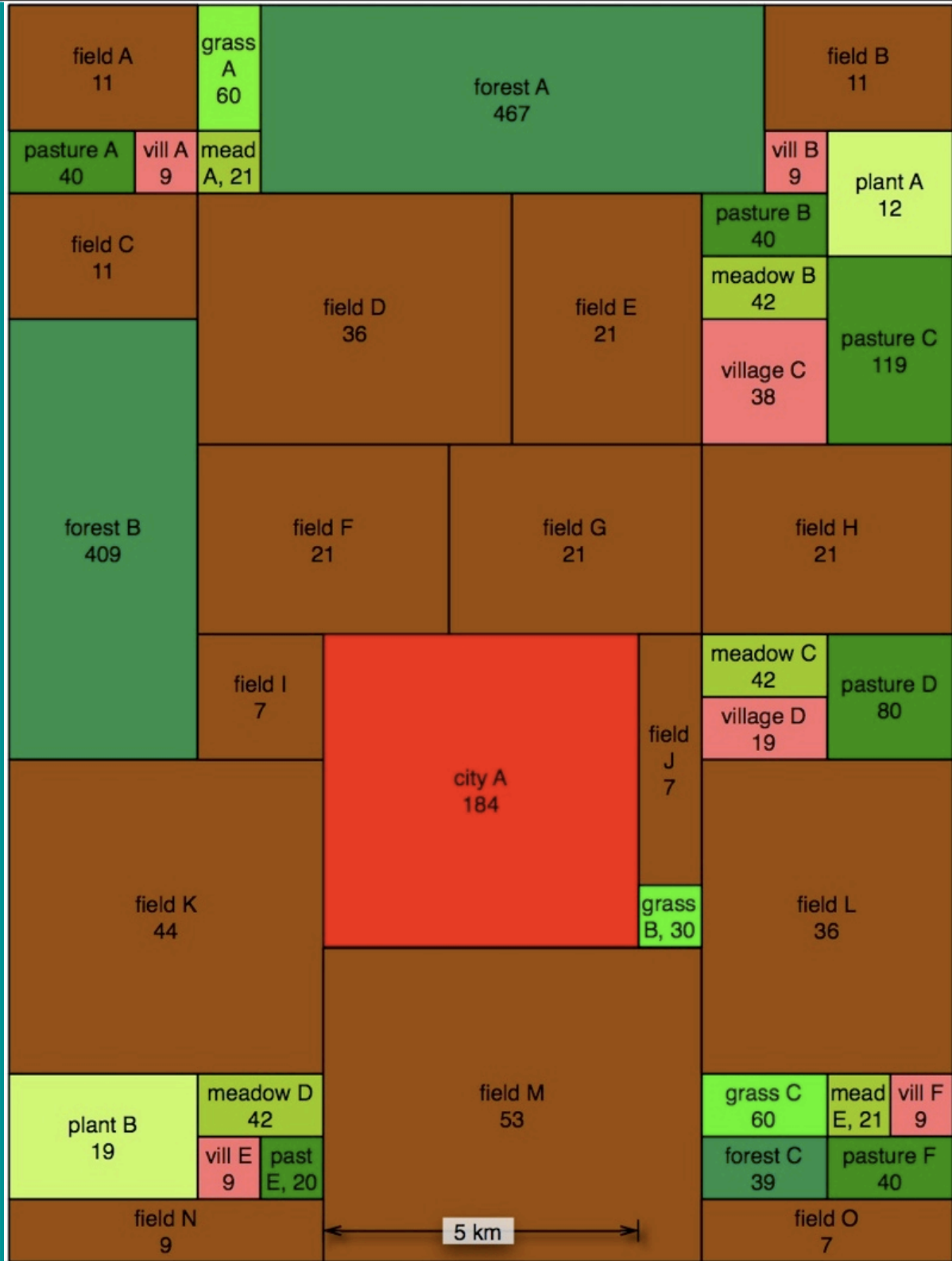




- current capacity:  
2195 Mg · species

### scenarios

- pasture C ⇒ wheat field  
2086 Mg · species
- field C ⇒ woody crop  
2203 Mg · species
- village expansion into meadow:  
2125 Mg · species
- Field Margin conservation programme:  
2194 Mg · species
- Tidy Village Competition:  
2043 Mg · species
- eutrophication (N dep.):  
2302 Mg · species



● current capacity:  
 2195 Mg · species

### climate change scenario

- ◆ warmer, less rain, C-fertilization, species migration
- dry grasslands: no change (Grime et al. 2008)
- pastures, meadows: 5% lower productivity (droughts)
- forests: no change in productivity (Beedlow et al. 2004), more tree species
- fields, woody crops: 5% higher productivity (C-fert., warmer + irrig.)
- villages, cities: higher productivity (warmer + irrig.), more species (invasion, ornam.)
- projected capacity:  
 2268 Mg · species

# ecosystem service capacity – monetary value

- ▶ compatible with several methods
- ▶ can be linked to capacity (kg · species)
- ▶ e.g. benefit transfer,  
using regressions of economic statistics on  
capacity values for each land use type

# ecosystem service capacity – what is it good for?

- ▶ can be extracted from (global) vegetation models or GIS, summarizes trends
- ▶ puts important ecosystem features first
- ▶ land use planning, maintaining “ecosystem health” trade-offs with economic development compensation measures
- ▶ communication of ecosystem change
- ▶ base for assessing ecosystem resilience, sustainability, €