Supplemental figures and tables for:

Doubling protected land area may be inefficient at preserving the extent of undeveloped land and could cause substantial regional shifts in land use

The figure captions are first, then the figures, then the tables.

Supplemental figure captions

Figure S1. Regional land allocation by land type under different availability constraints. Dots represent the LOW availability scenario and diamonds represent the HIGH availability scenario. There are 32 regions with their figures collected on a single page ((a) – (F)). These are regional versions of Figure 2.

Figure S2. Bioenergy crop yields by water basin for (a) irrigated and (b) rain fed crops.

Figure S3. Marginal absolute changes in land allocation in 2050 due to incremental decreases in land availability, regionally. The x-axis denotes a 10% decrease in land availability from the previous tic, starting at 100% availability. The y-axis values are absolute change in area relative to that at the previous availability level. Circles indicate the current availability and extent of unmanaged forest, grassland, shrubland, respectively, and of these three types combined (on the managed land type lines), based on the 2015 GCAM initial state. The triangles indicate land type availability and extent when protected area is approximately doubled. The absolute change in land allocation of a particular type due to meeting the new protection target is estimated by moving from the circle to the triangle along a given line. Each panel is a region, and these plots are regional versions of Figure 8.

Figure S4. Marginal relative changes in land allocation in 2050 due to incremental decreases in land availability, regionally. The x-axis denotes a 10% decrease in land availability from the previous tic, starting at 100% availability. The y-axis values are percent change in land type area relative to that at the previous availability level. Circles indicate the current availability and extent of unmanaged forest, grassland, shrubland, respectively, and of these three types combined (on the managed land type lines), based on the 2015 GCAM initial state. The triangles indicate land type availability and extent when protected area is approximately doubled. The relative change in land allocation of a particular type due to meeting the new protection target is estimated by moving from the circle to the triangle along a given line. Each panel is a region, and these plots are regional versions of Figure 9.

Figure S1 (a)

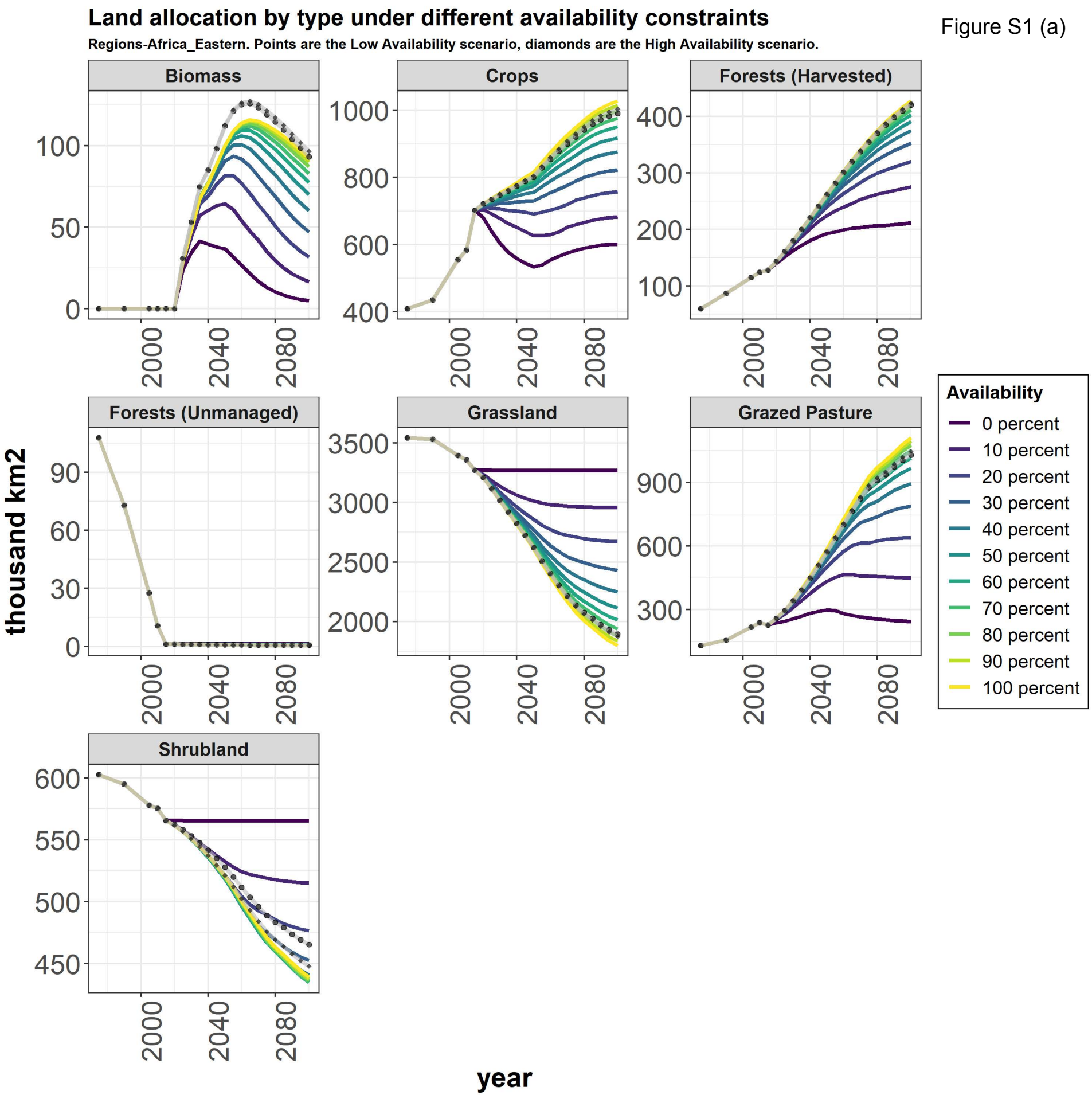

Land allocation by type under different availability constraints
Regions-Africa_Eastern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (b)

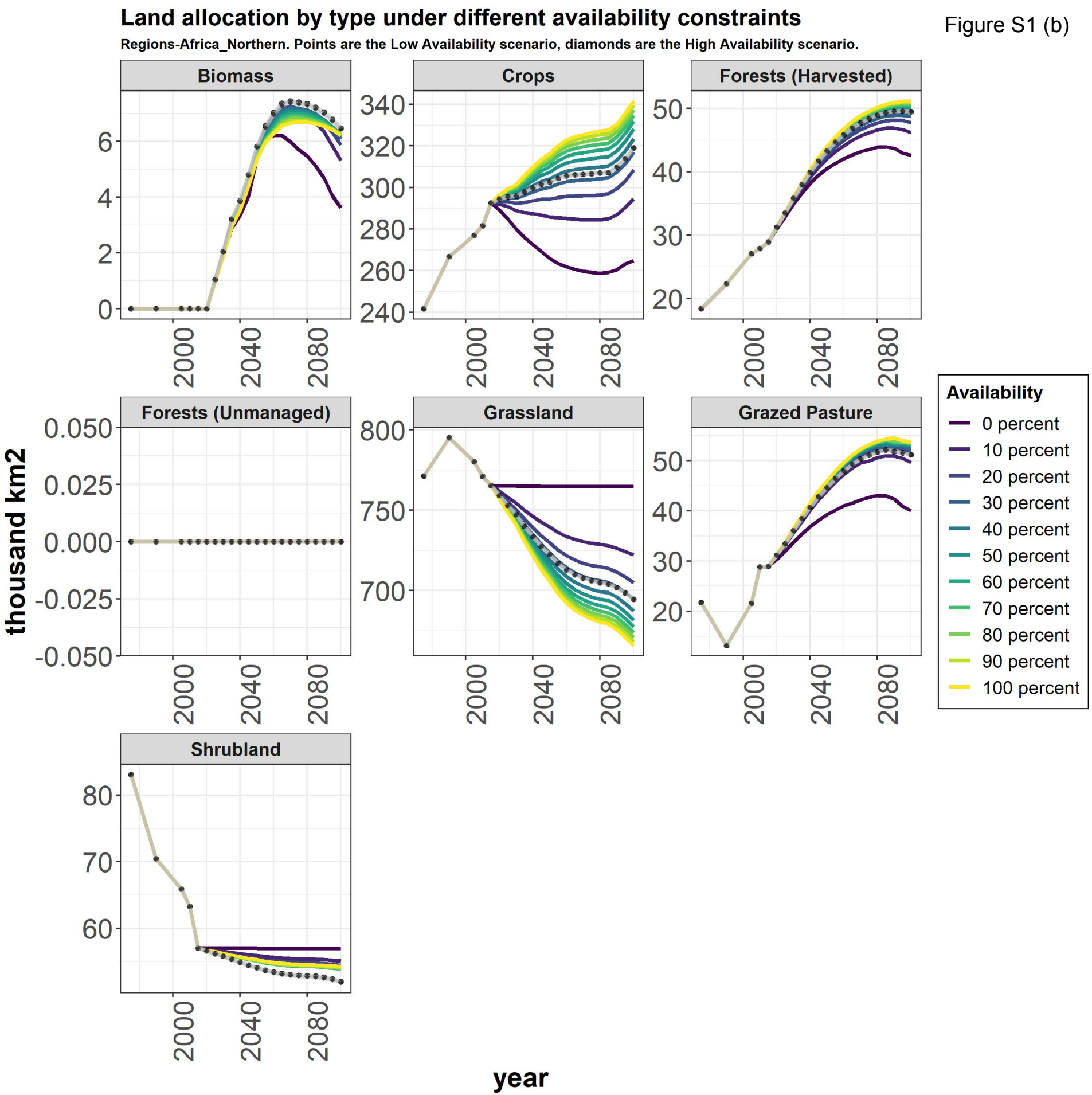

Land allocation by type under different availability constraints
Regions-Africa_Northern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (c)

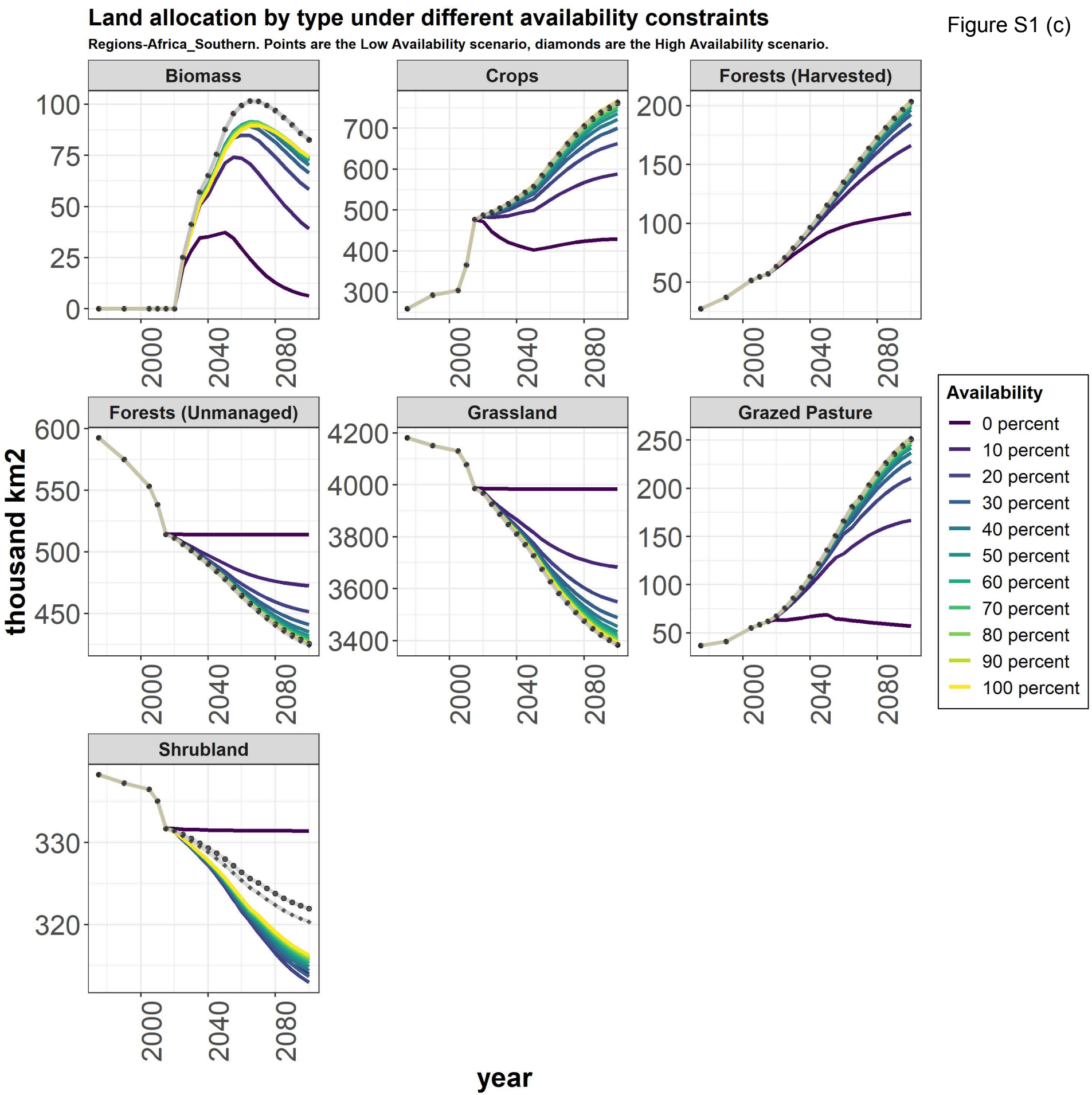

Land allocation by type under different availability constraints
Regions-Africa_Southern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (d)

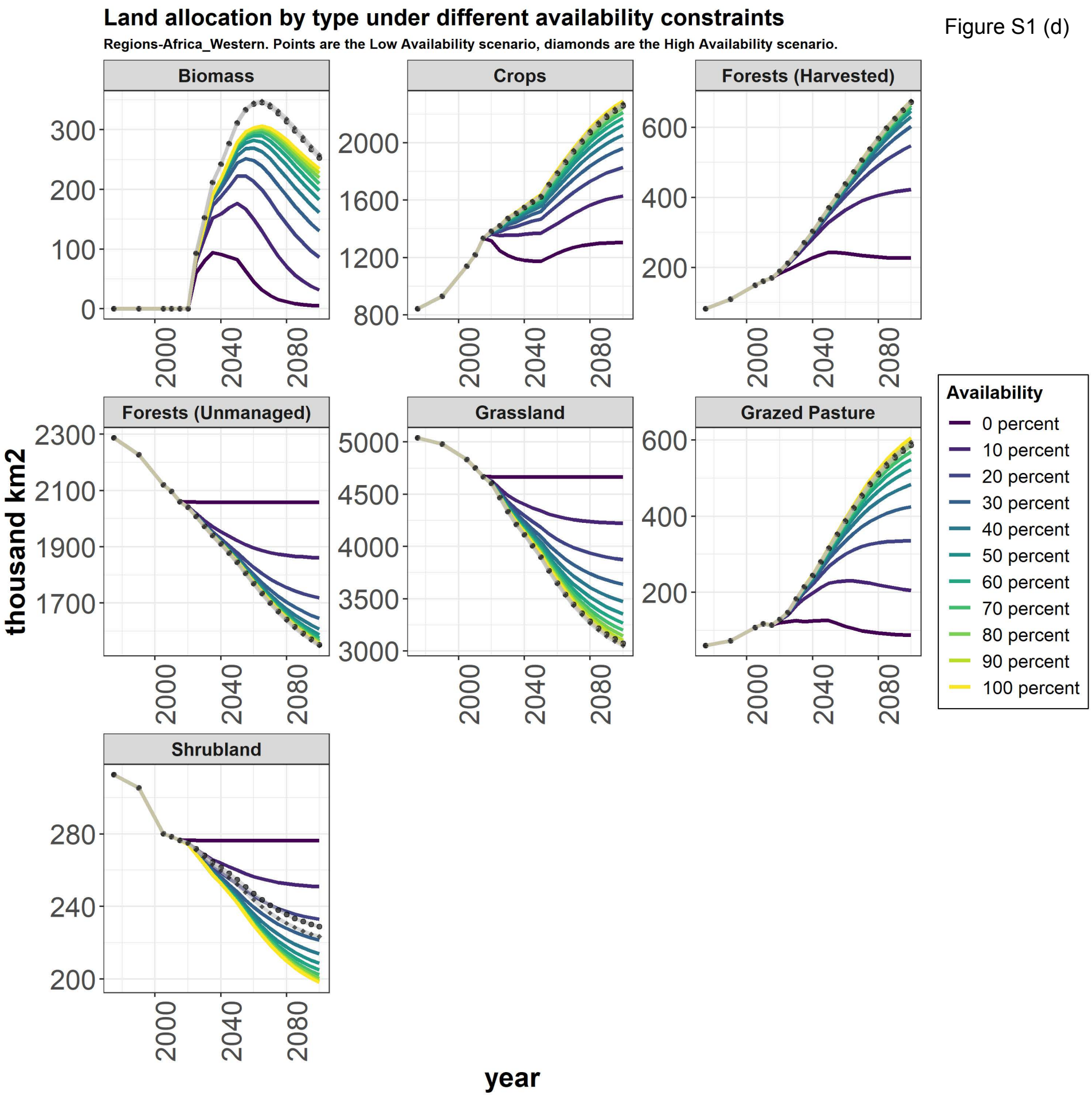

Land allocation by type under different availability constraints
Regions-Africa_Western. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (e)

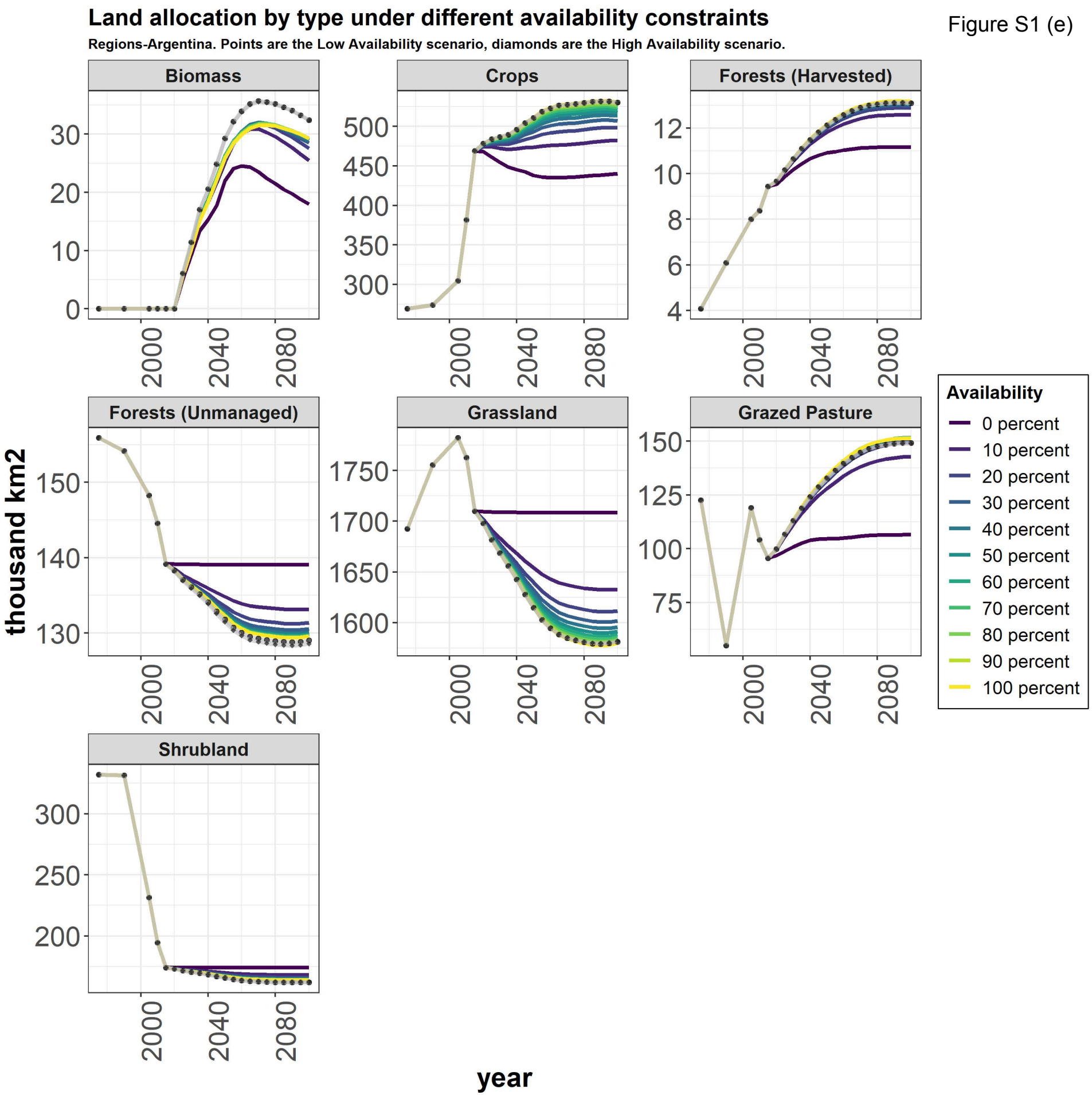

Land allocation by type under different availability constraints
Regions-Argentina. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (f)

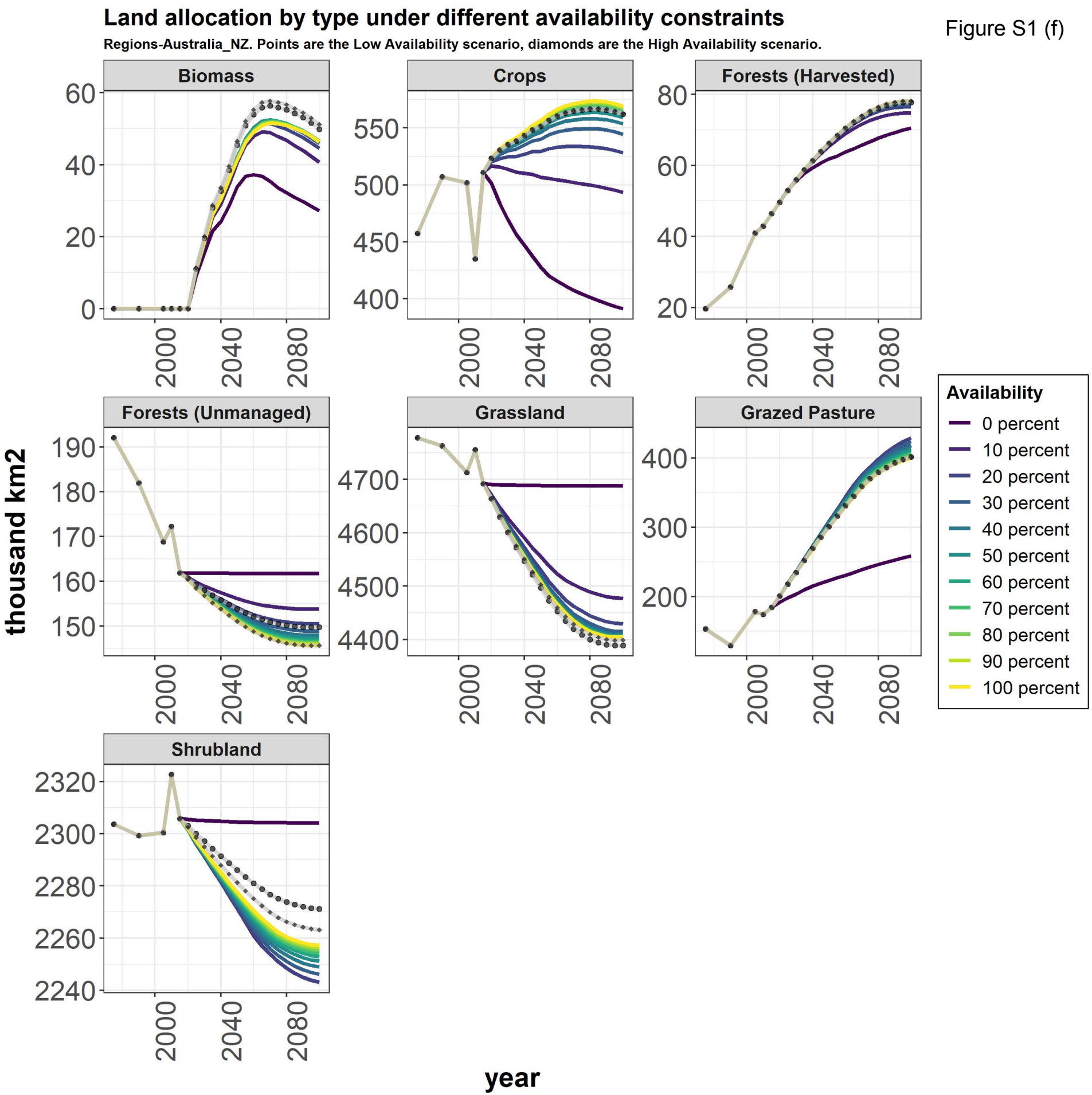

Land allocation by type under different availability constraints
Regions-Australia_NZ. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (g)

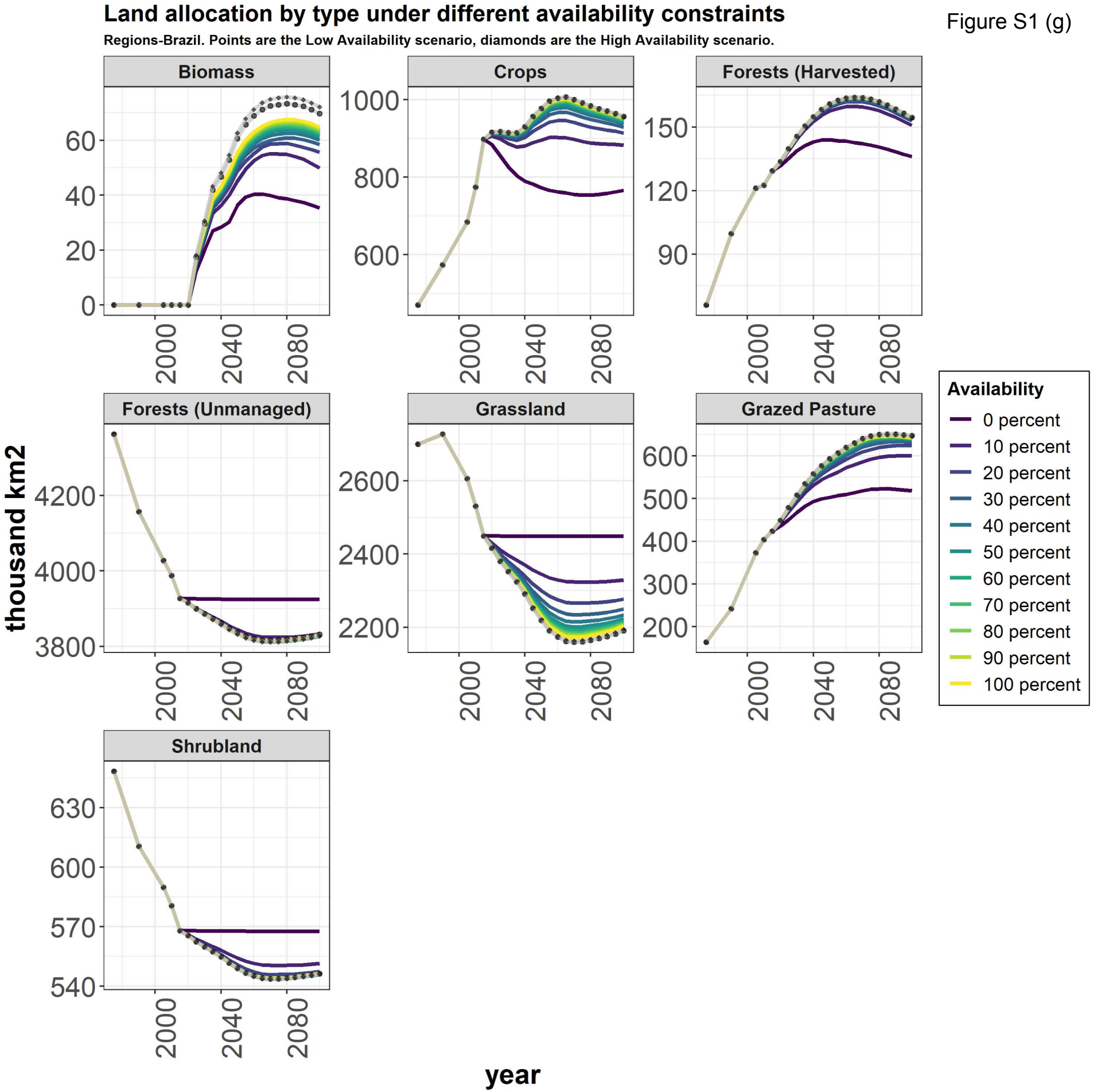

Land allocation by type under different availability constraints
Regions-Brazil. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (h)

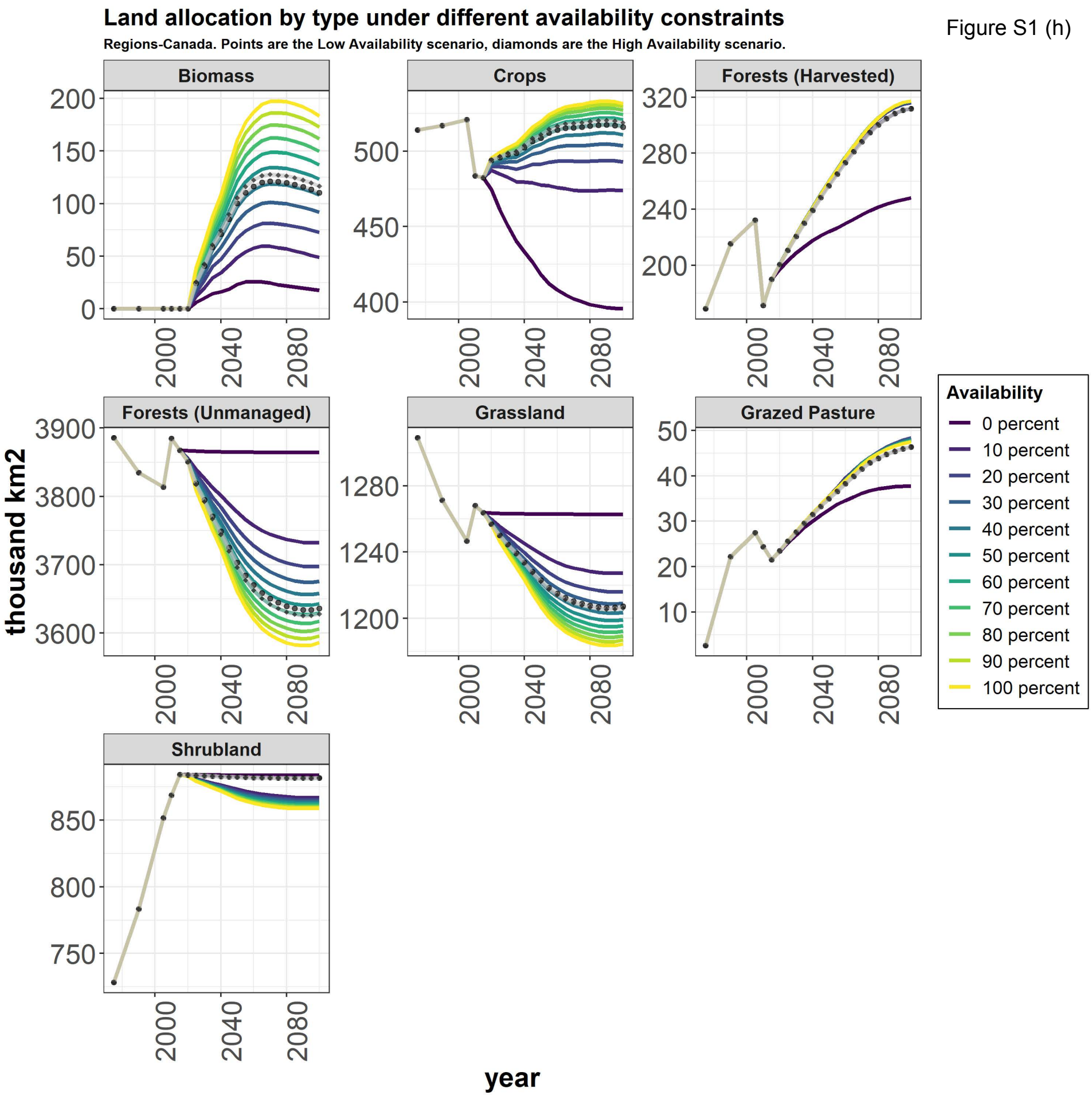

Land allocation by type under different availability constraints
Regions-Canada. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (i)

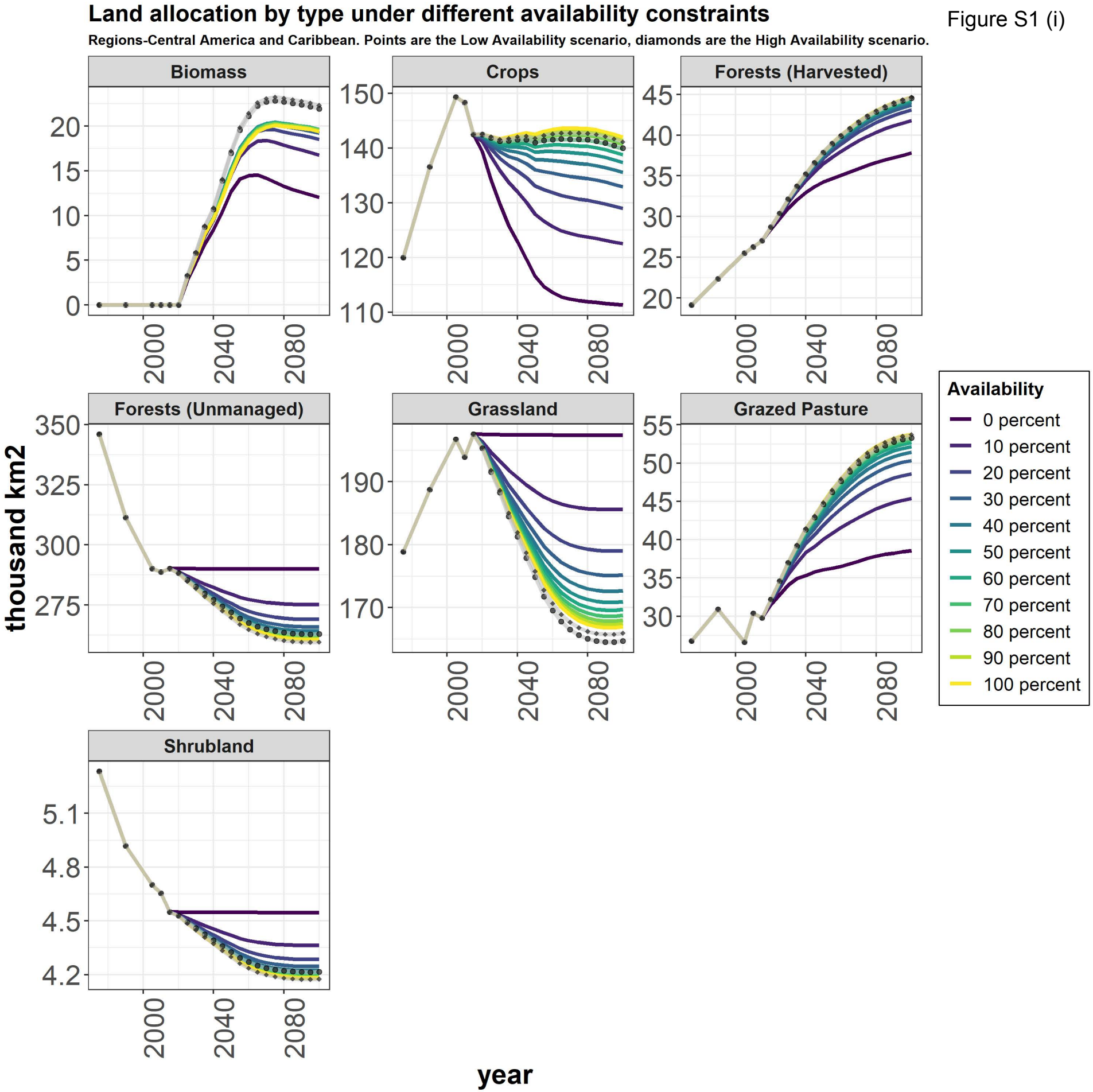

Land allocation by type under different availability constraints
Regions-Central America and Caribbean. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (j)

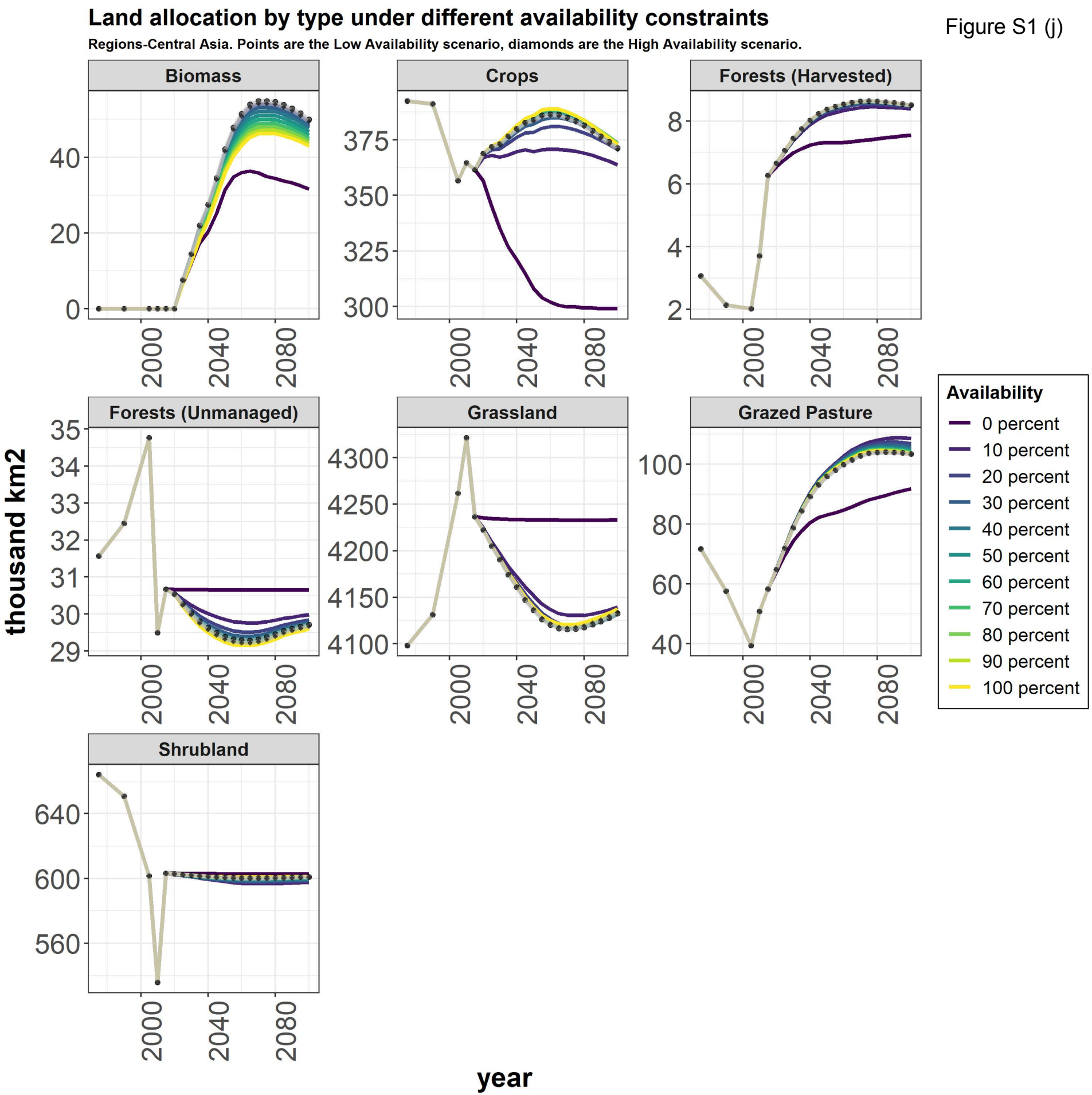

Land allocation by type under different availability constraints
Regions-Central Asia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (k)

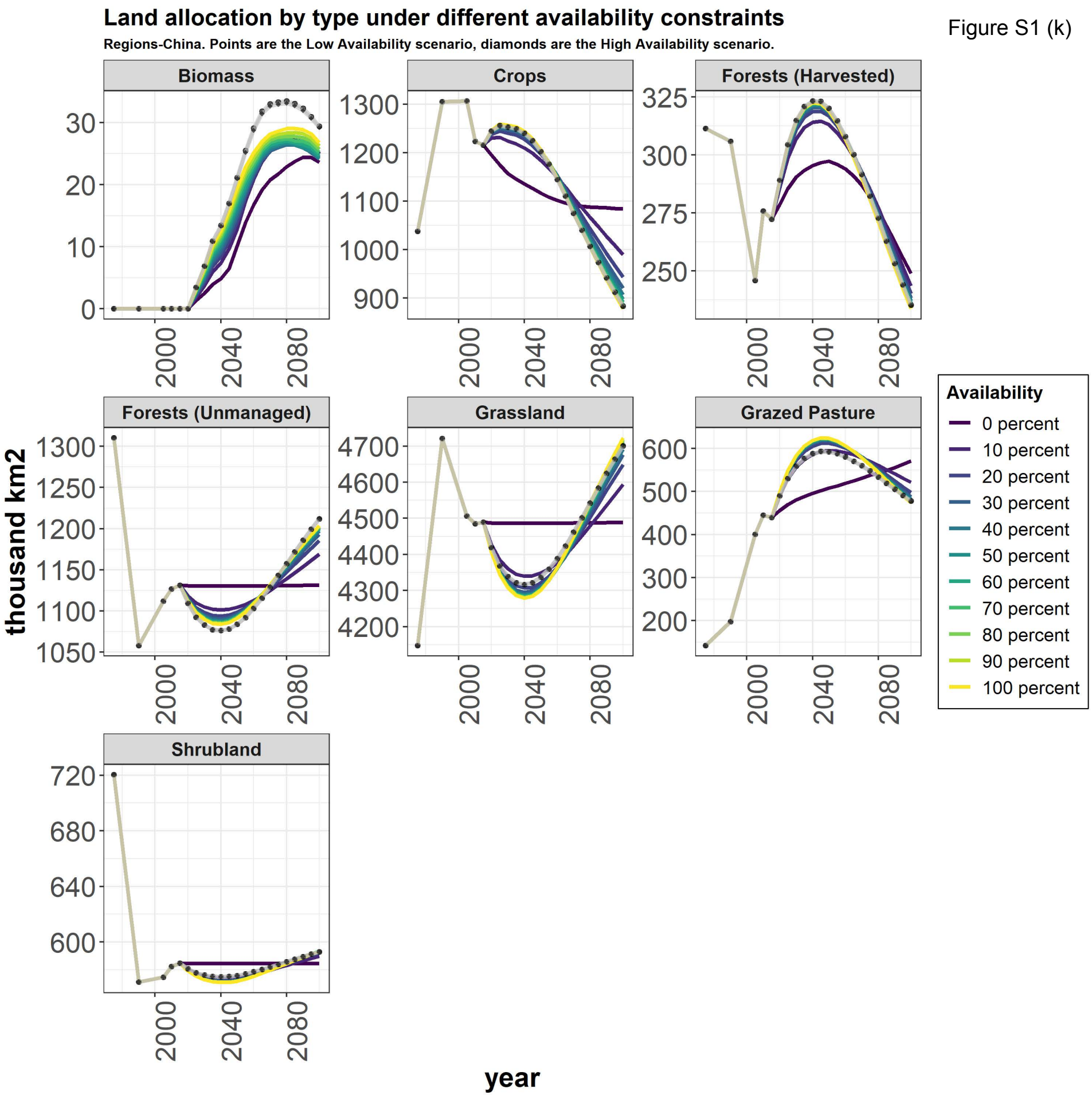

Land allocation by type under different availability constraints
Regions-China. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (l)

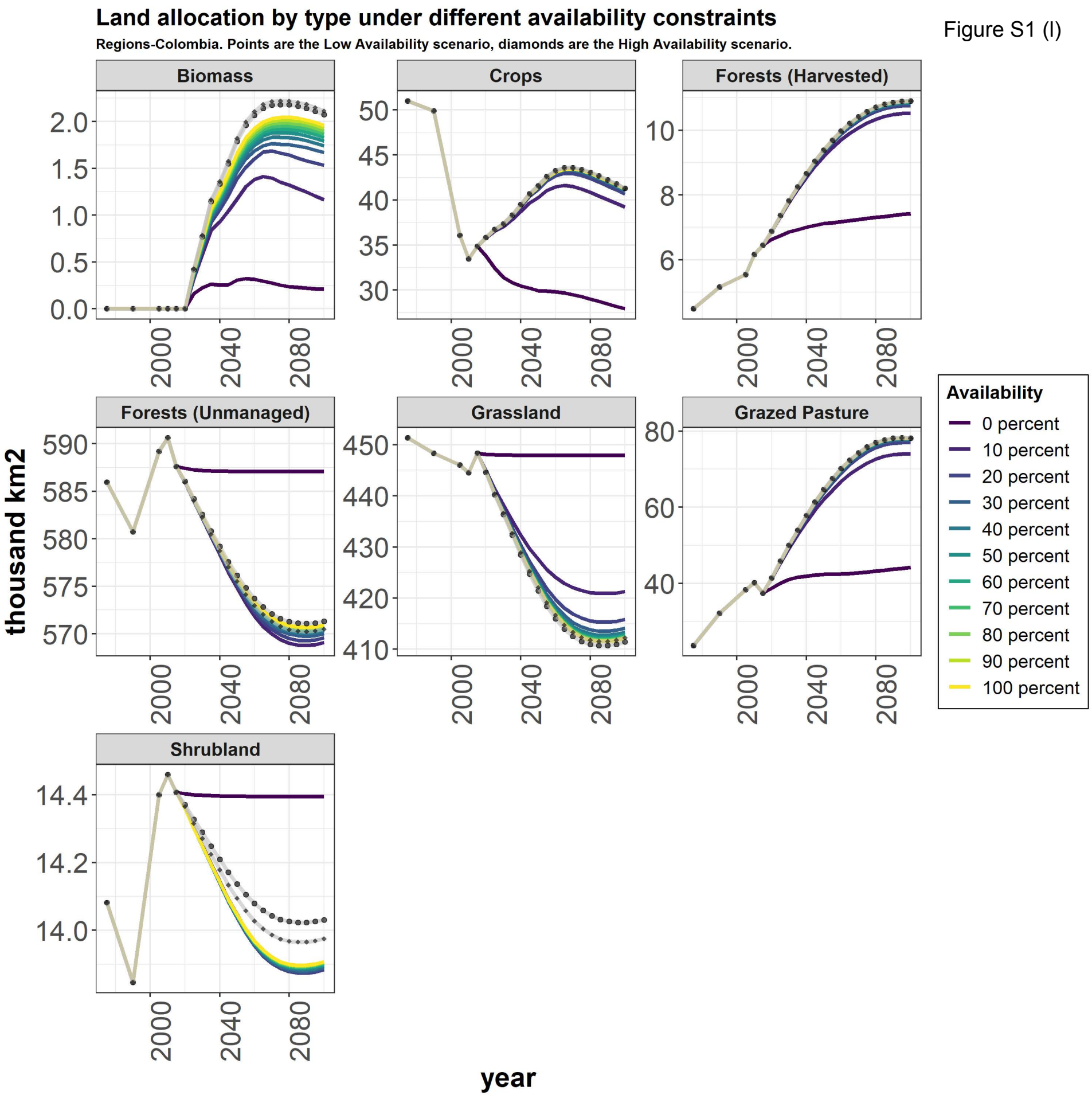
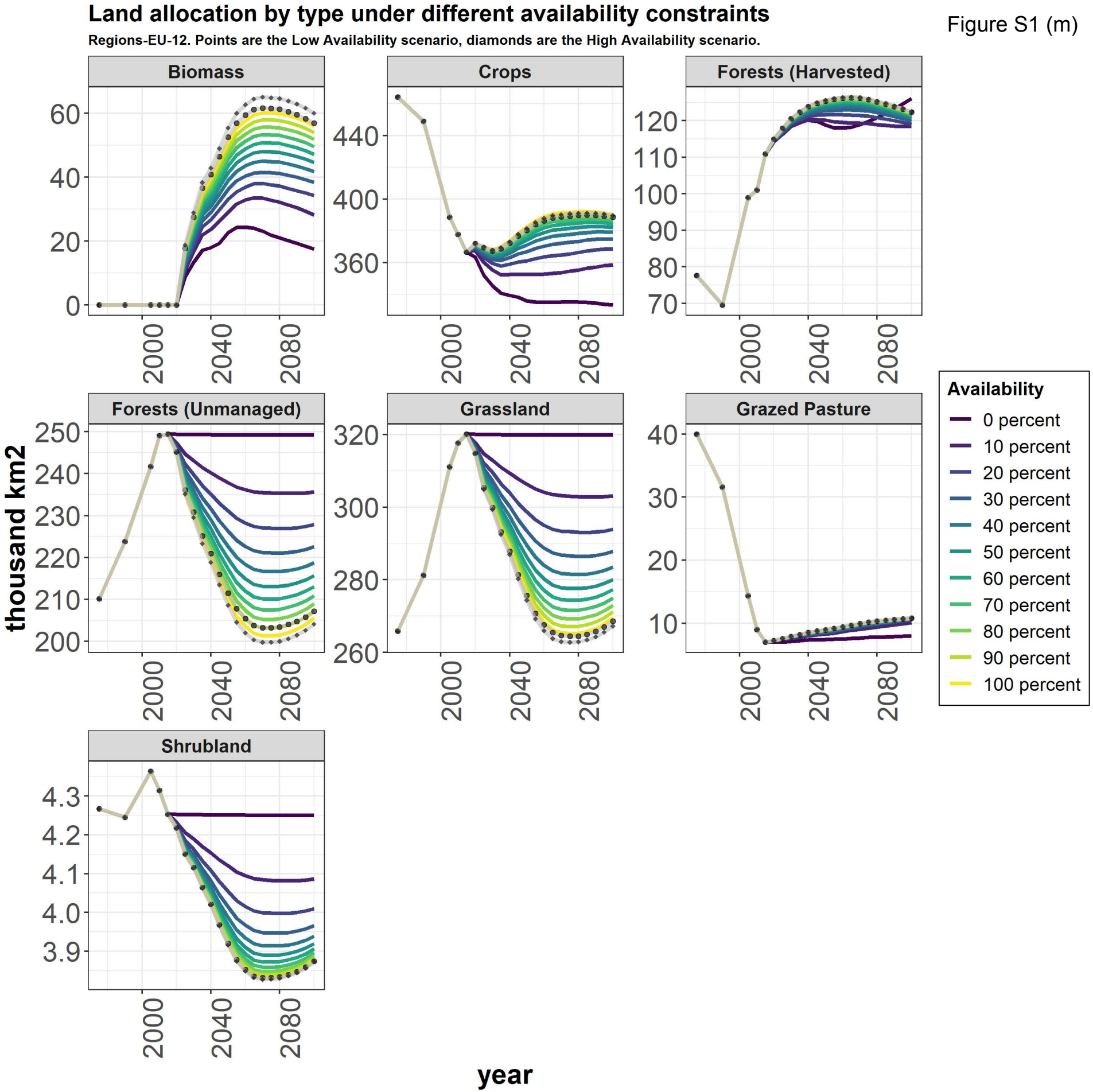

Land allocation by type under different availability constraints
Regions-Colombia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (m)


Land allocation by type under different availability constraints
Regions-EU-12. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

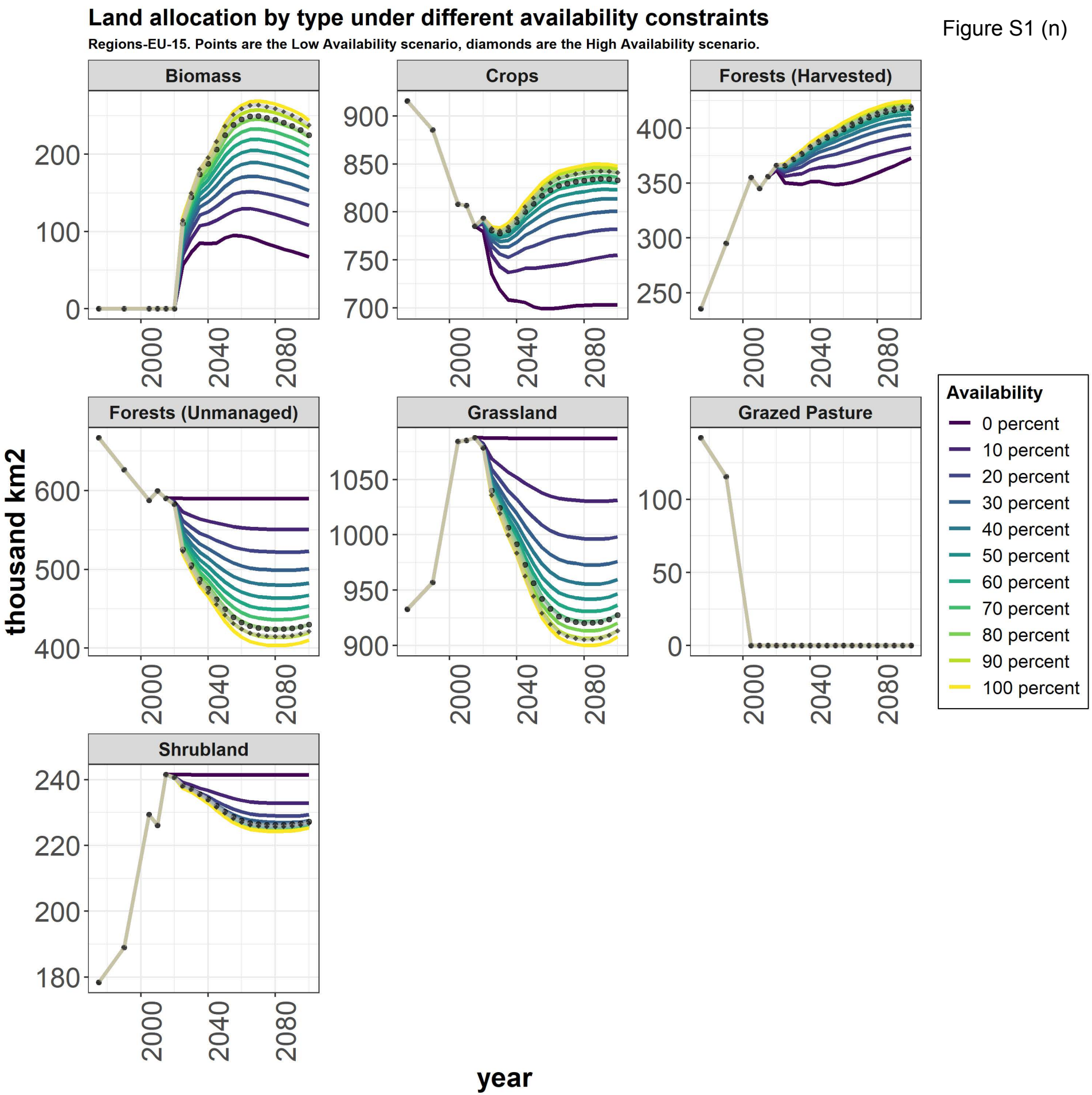

Land allocation by type under different availability constraints
Regions-EU-15. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Figure S1 (n)
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (o)

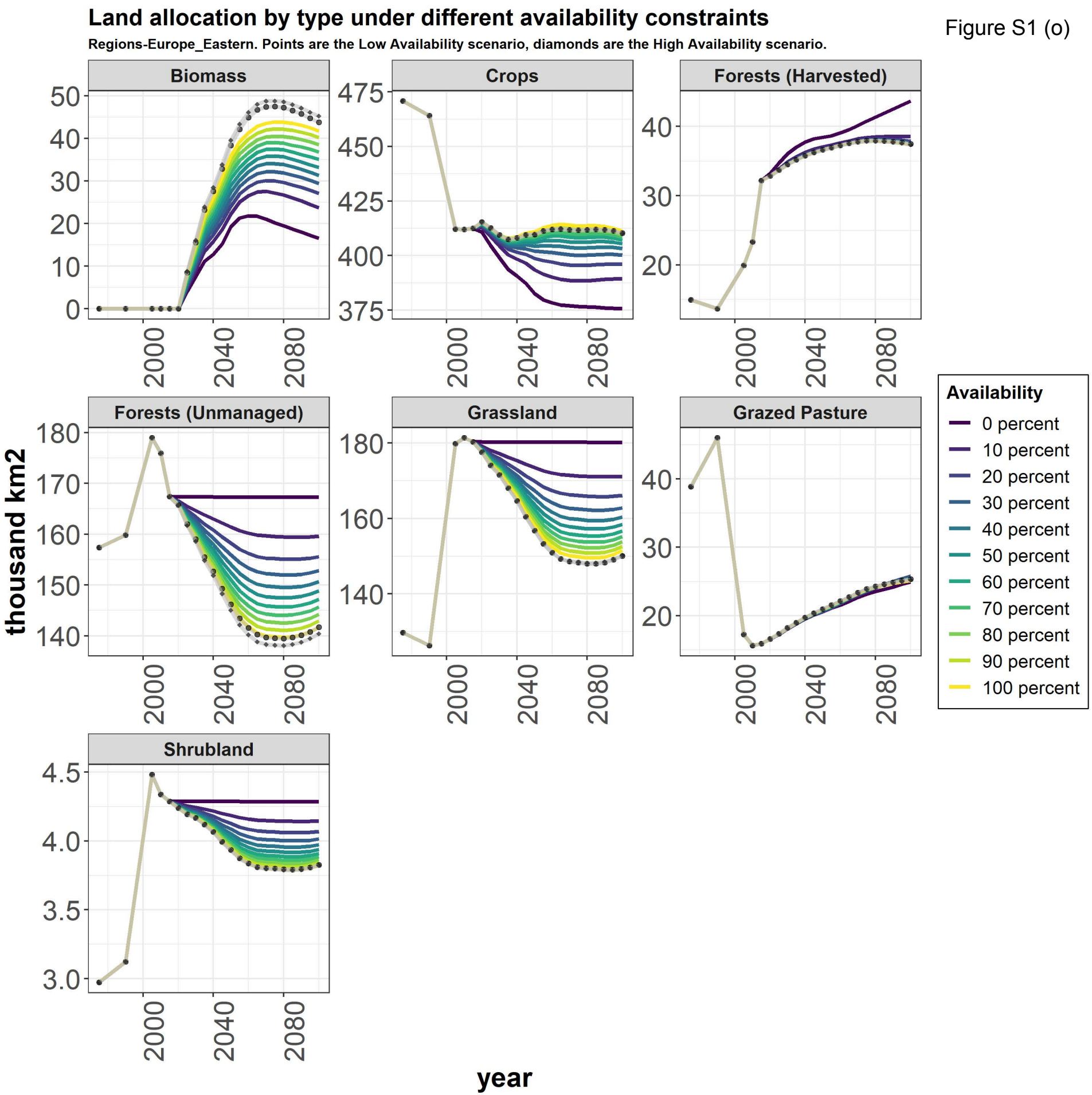
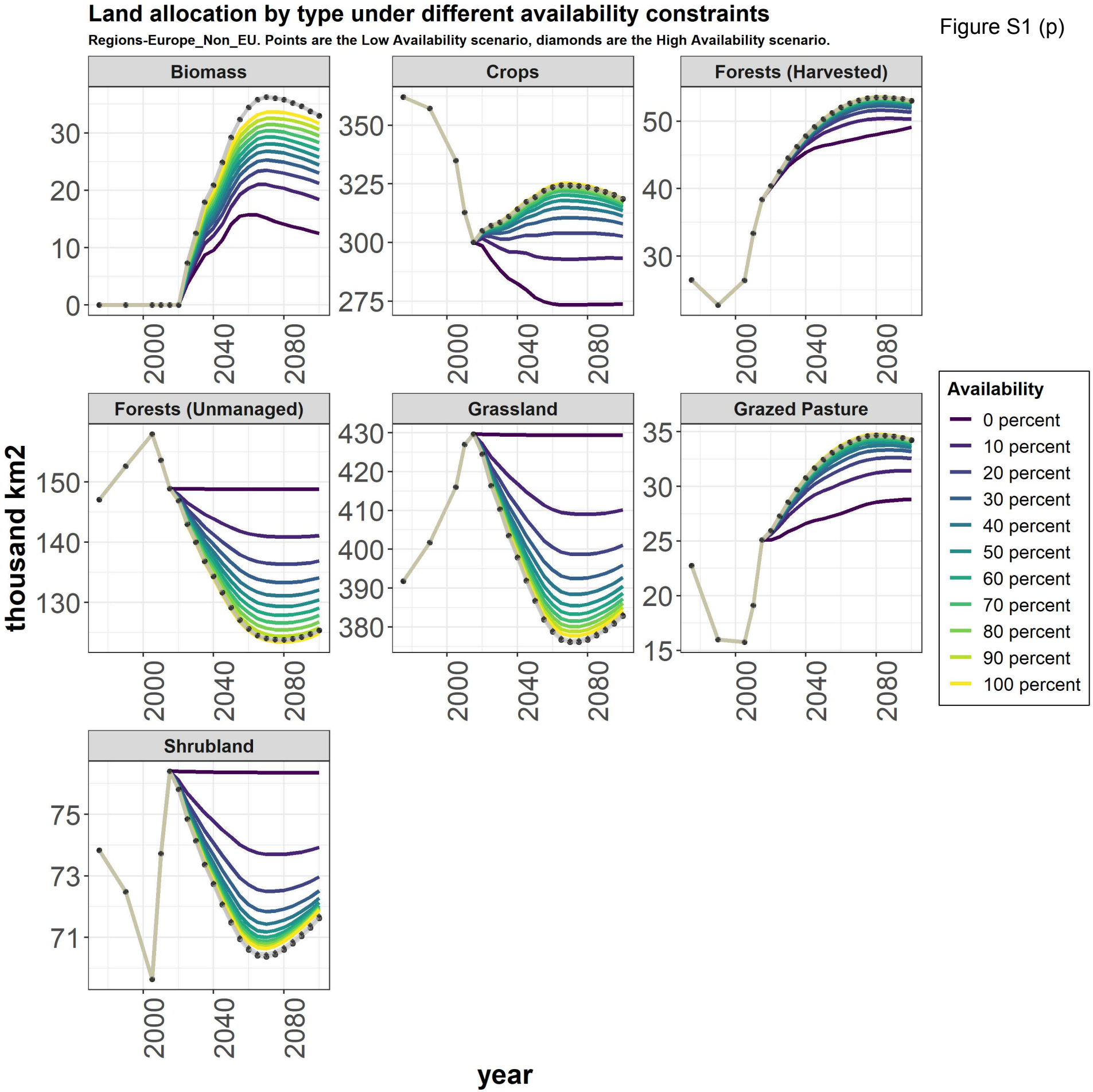

Land allocation by type under different availability constraints
Regions-Europe_Eastern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

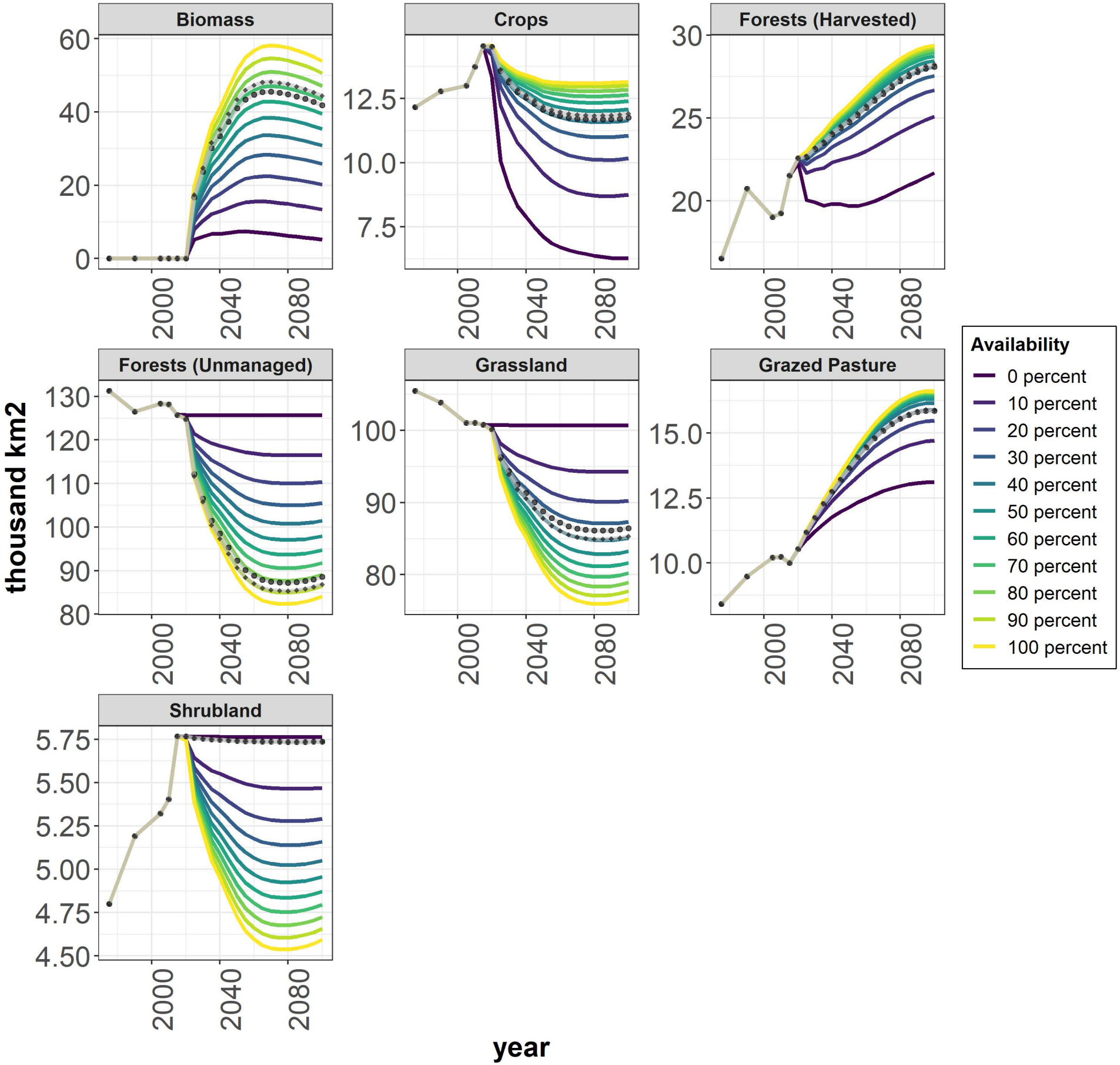
Figure S1 (p)


Land allocation by type under different availability constraints
Regions-Europe_Non_EU. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Land allocation by type under different availability constraints

Figure S1 (q)

Regions-European Free Trade Association. Points are the Low Availability scenario, diamonds are the High Availability scenario.



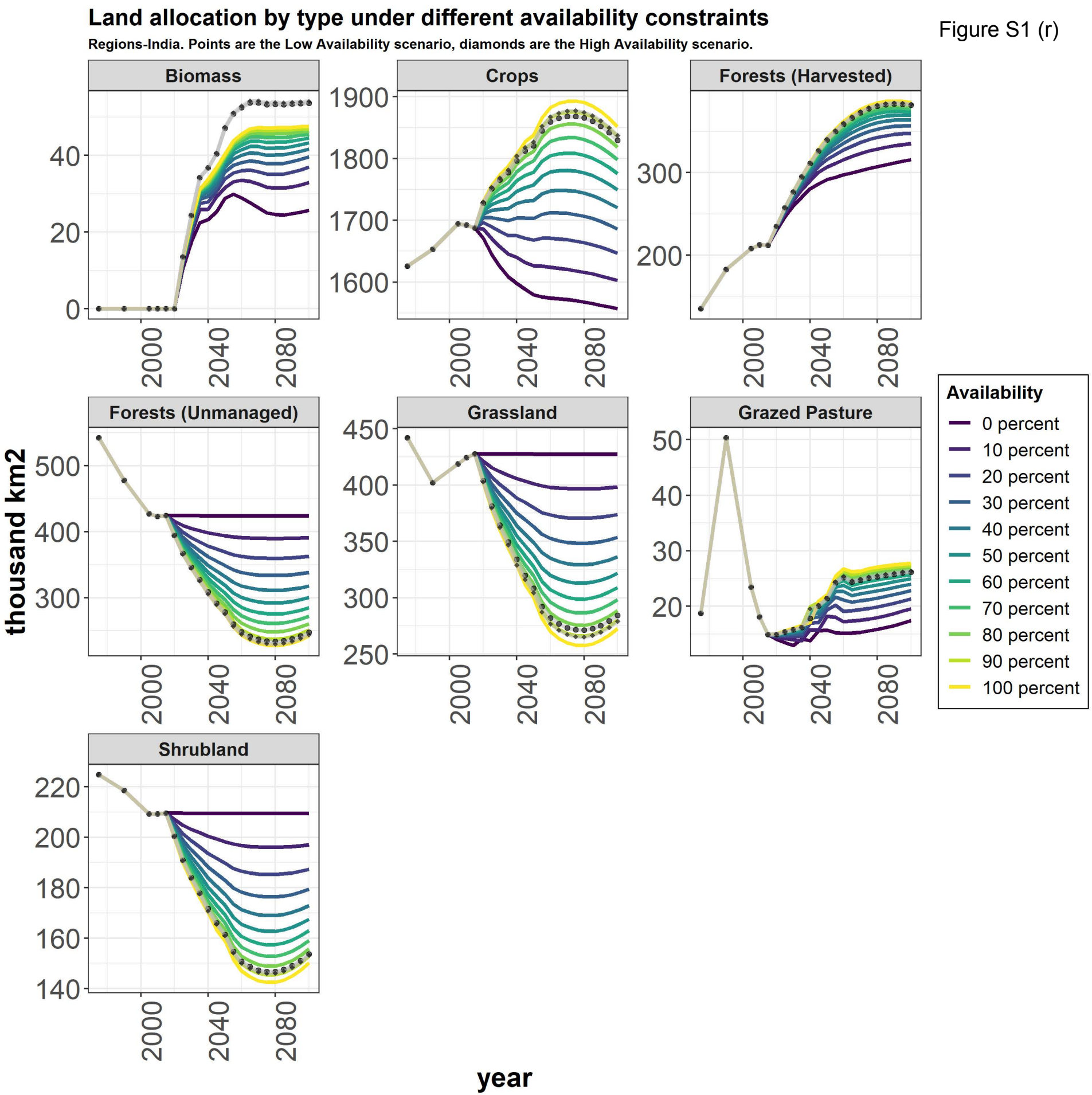

Land allocation by type under different availability constraints
Regions-India. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Figure S1 (r)
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (s)

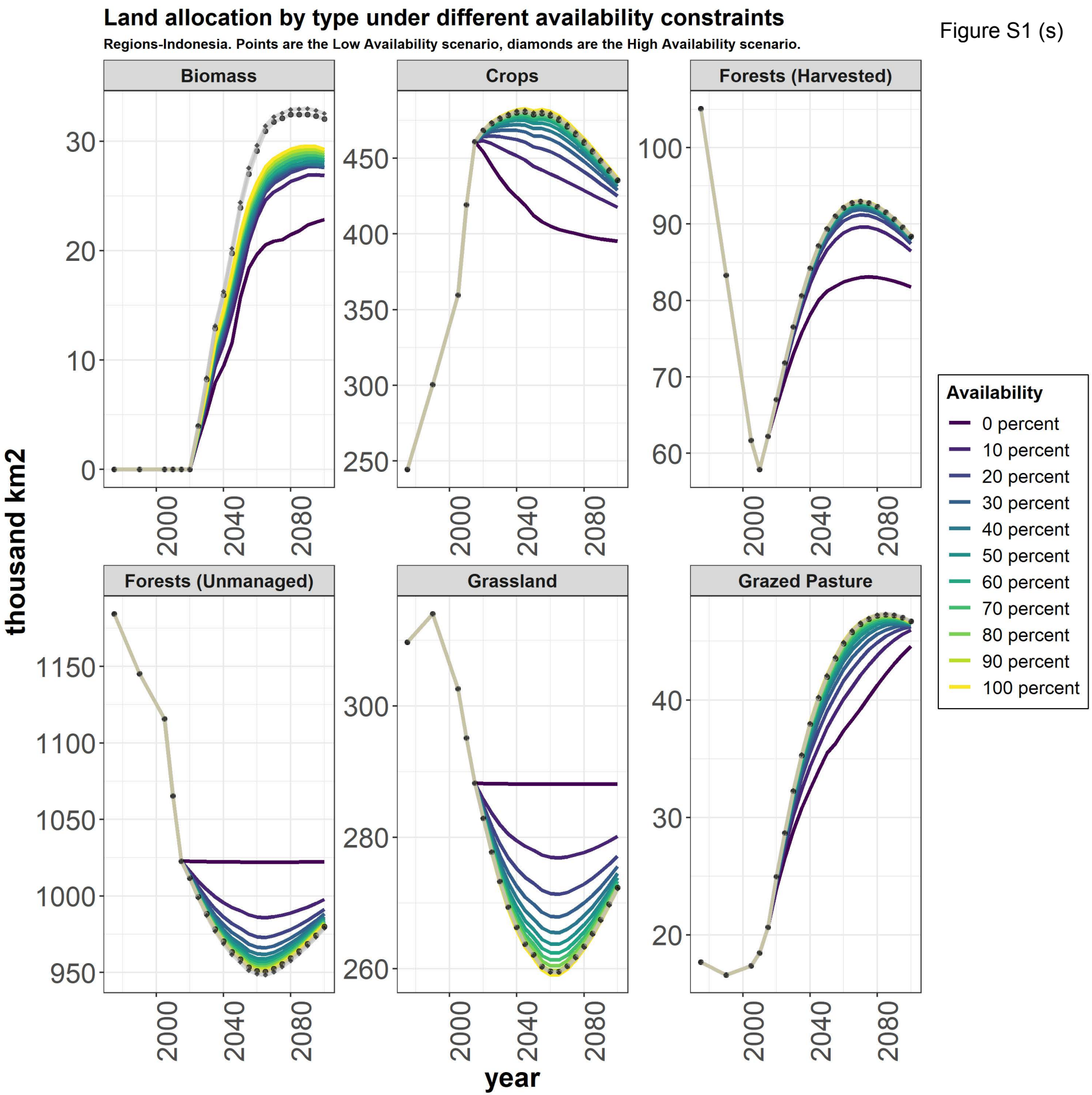

Land allocation by type under different availability constraints
Regions-Indonesia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (t)

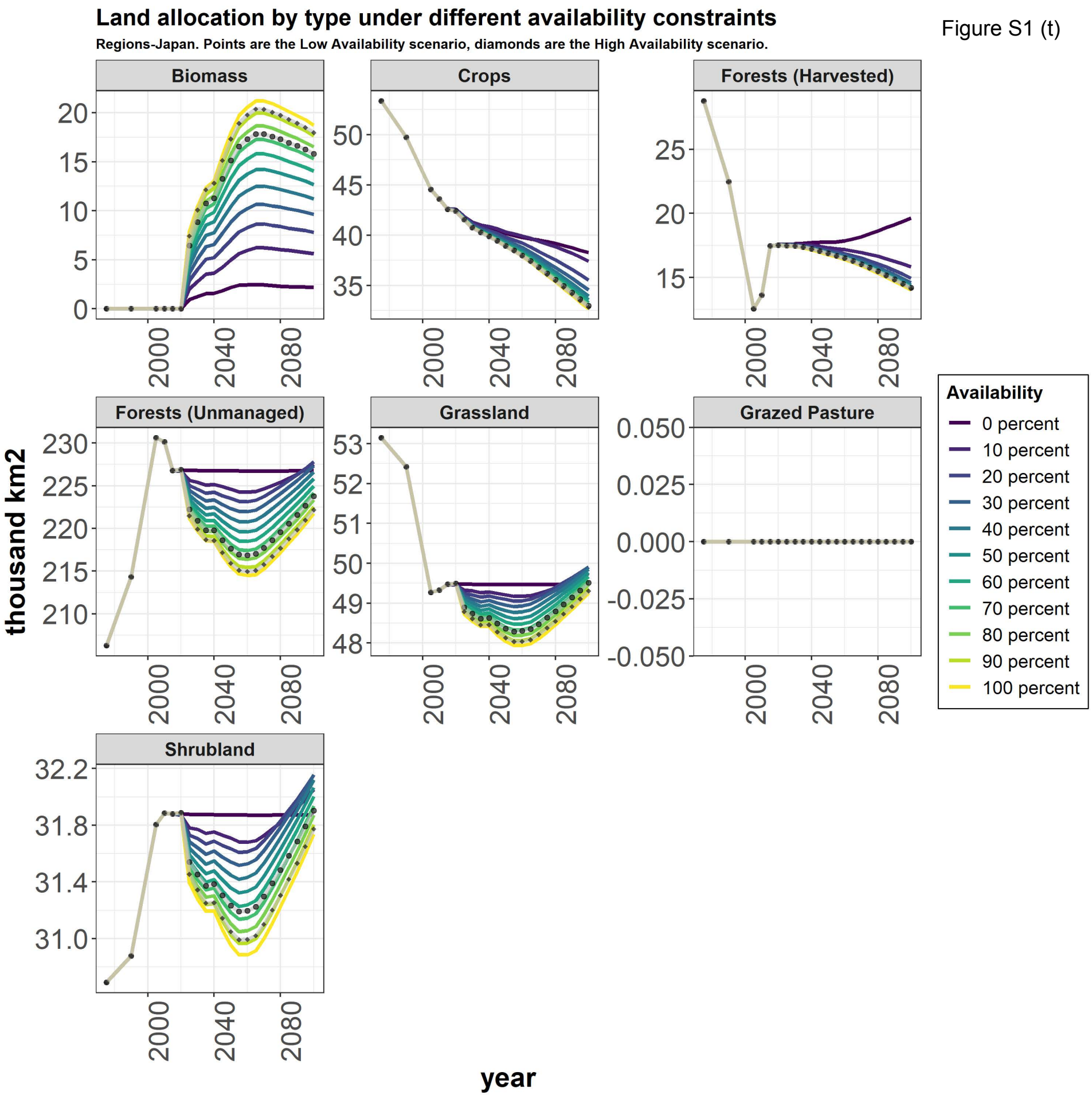

Land allocation by type under different availability constraints
Regions-Japan. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (u)

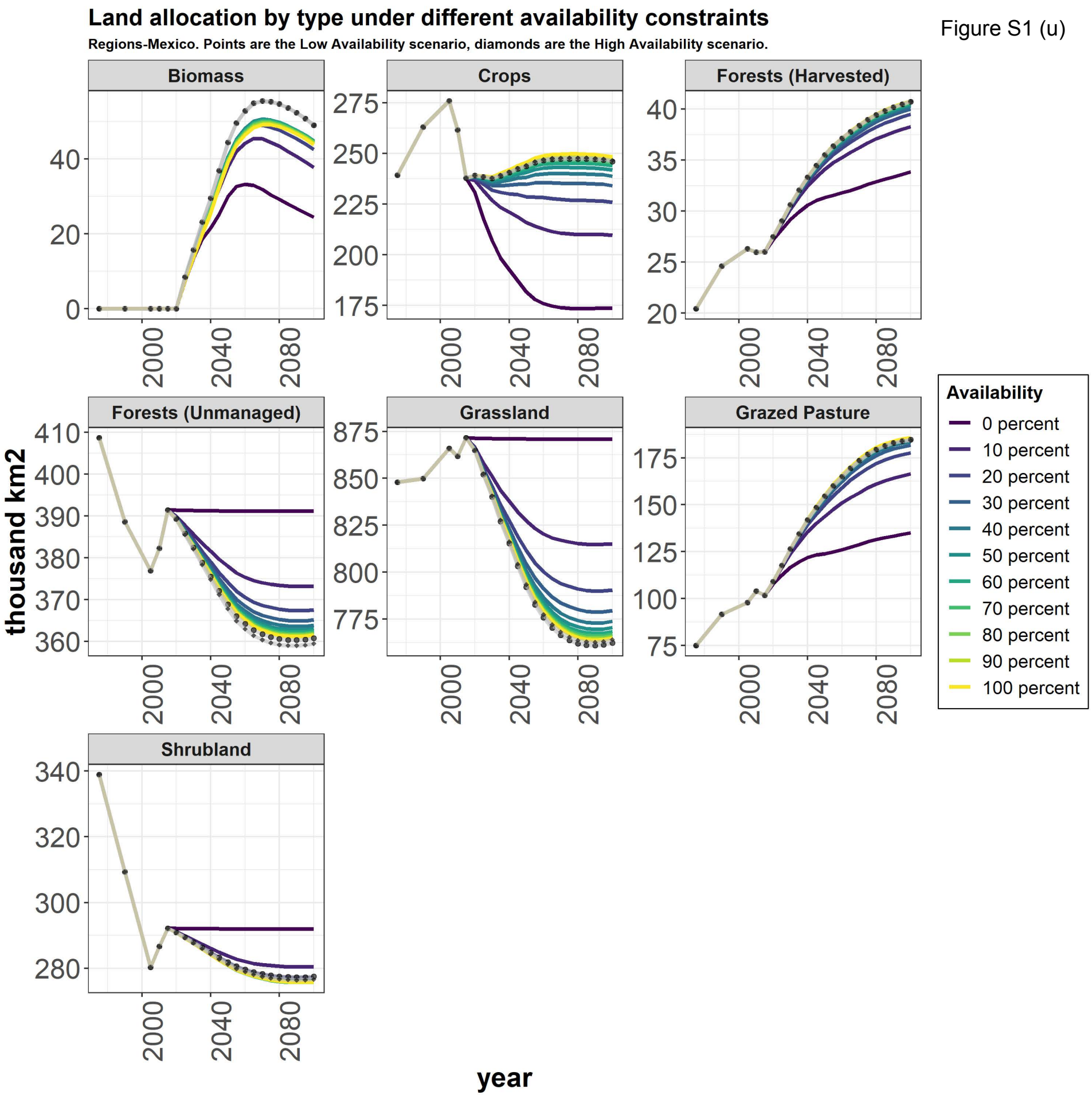

Land allocation by type under different availability constraints
Regions-Mexico. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (v)

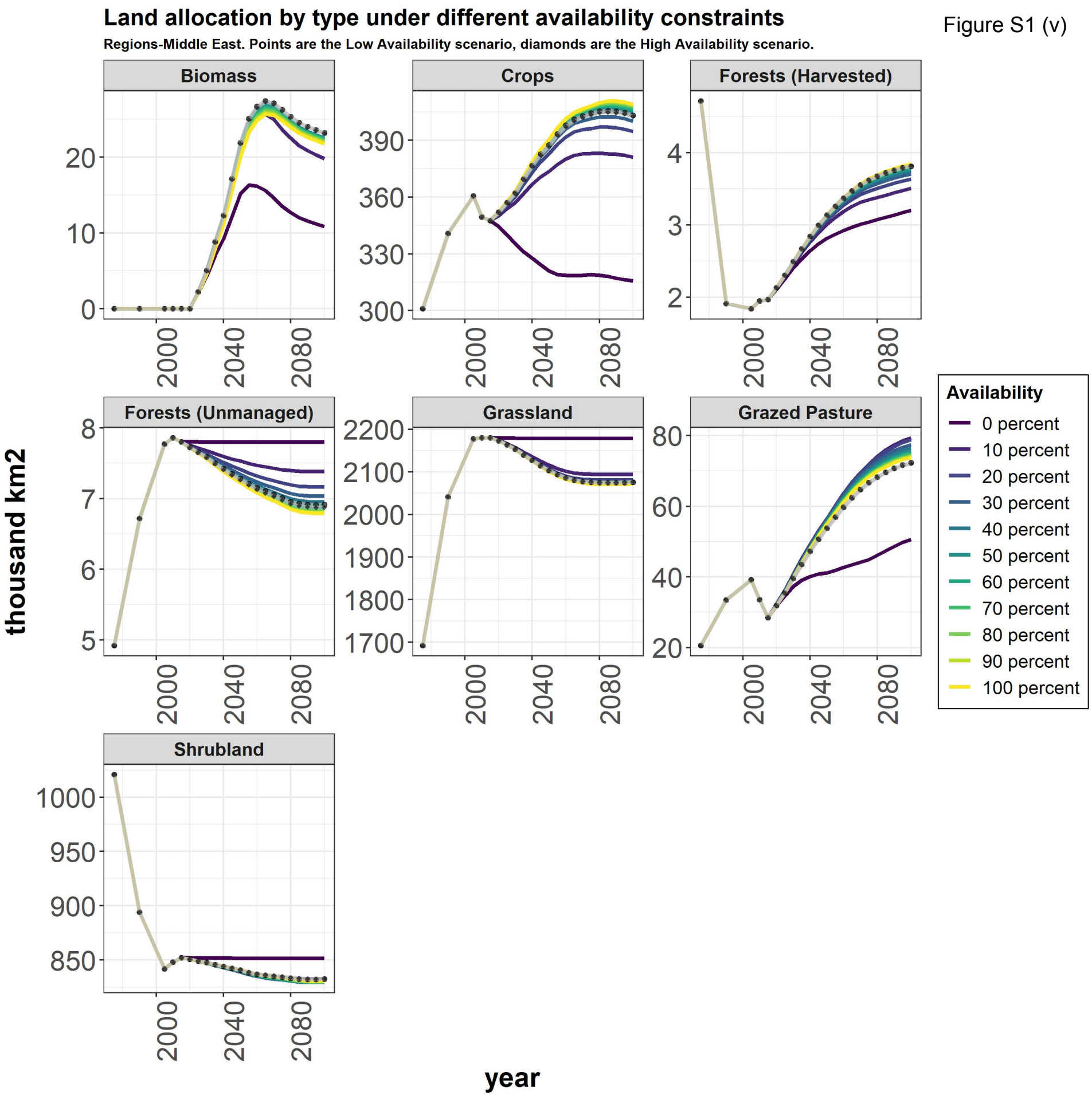

Land allocation by type under different availability constraints
Regions-Middle East. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (w)

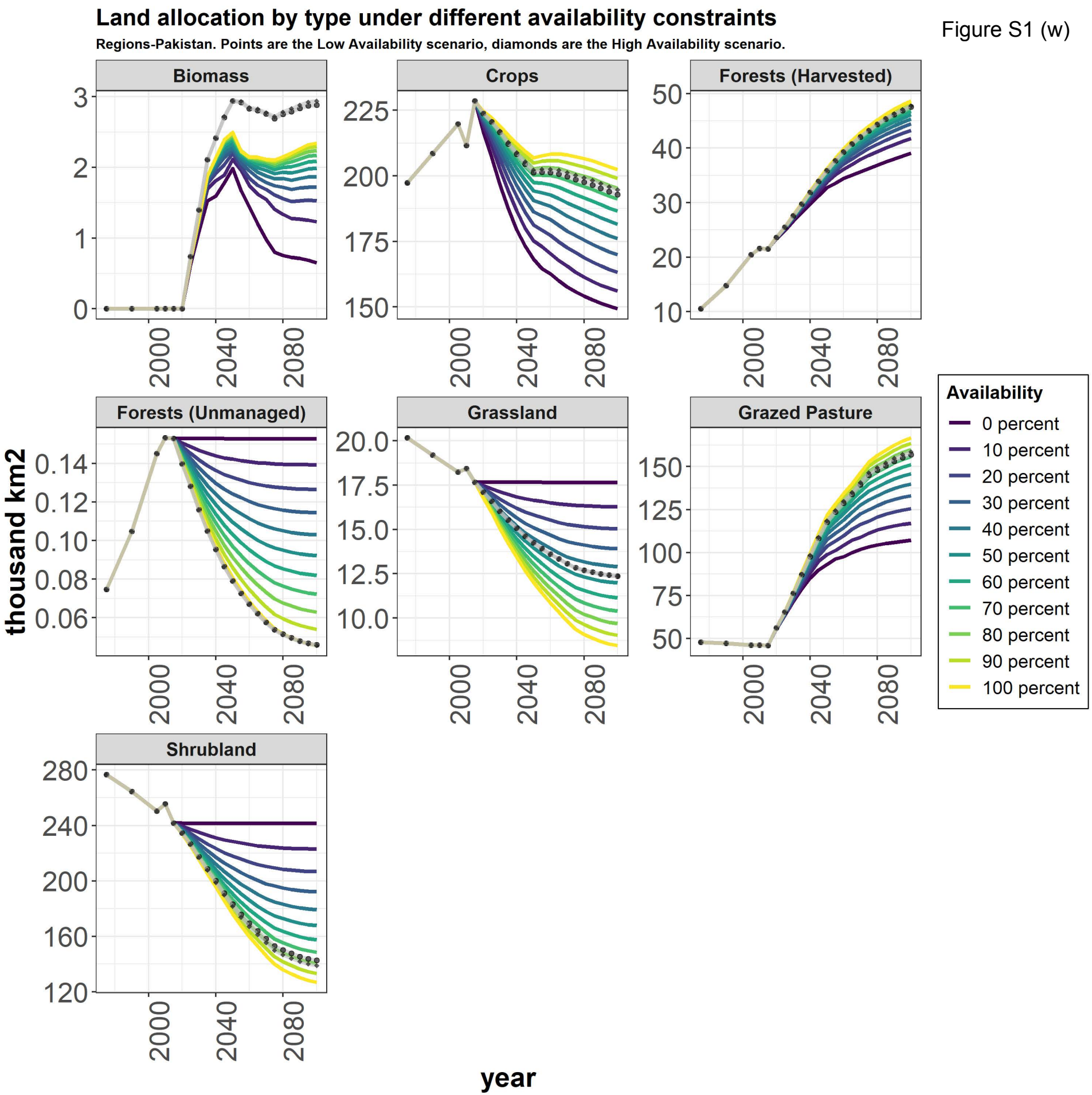

Land allocation by type under different availability constraints
Regions-Pakistan. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (x)

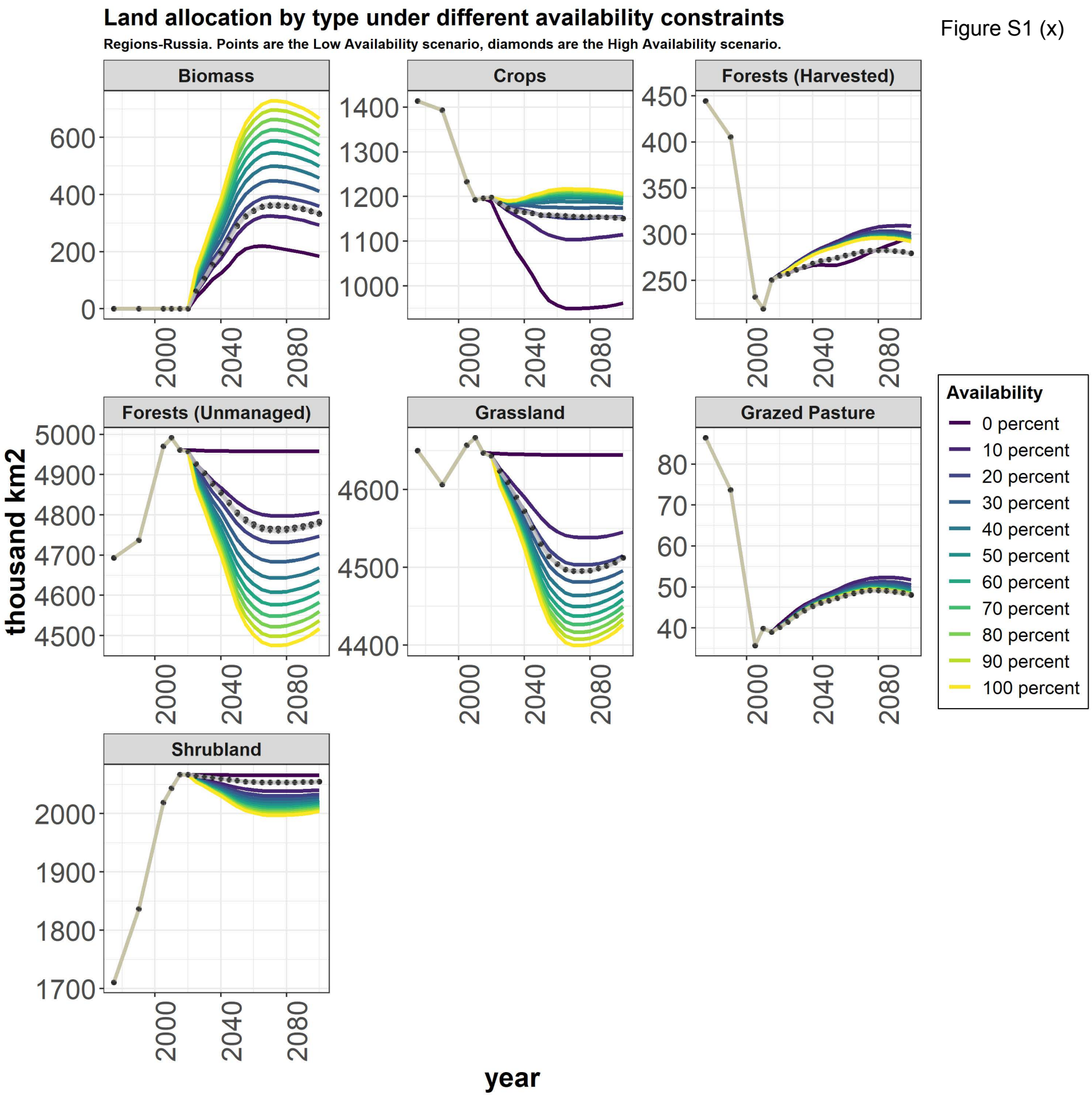

Land allocation by type under different availability constraints
Regions-Russia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (y)

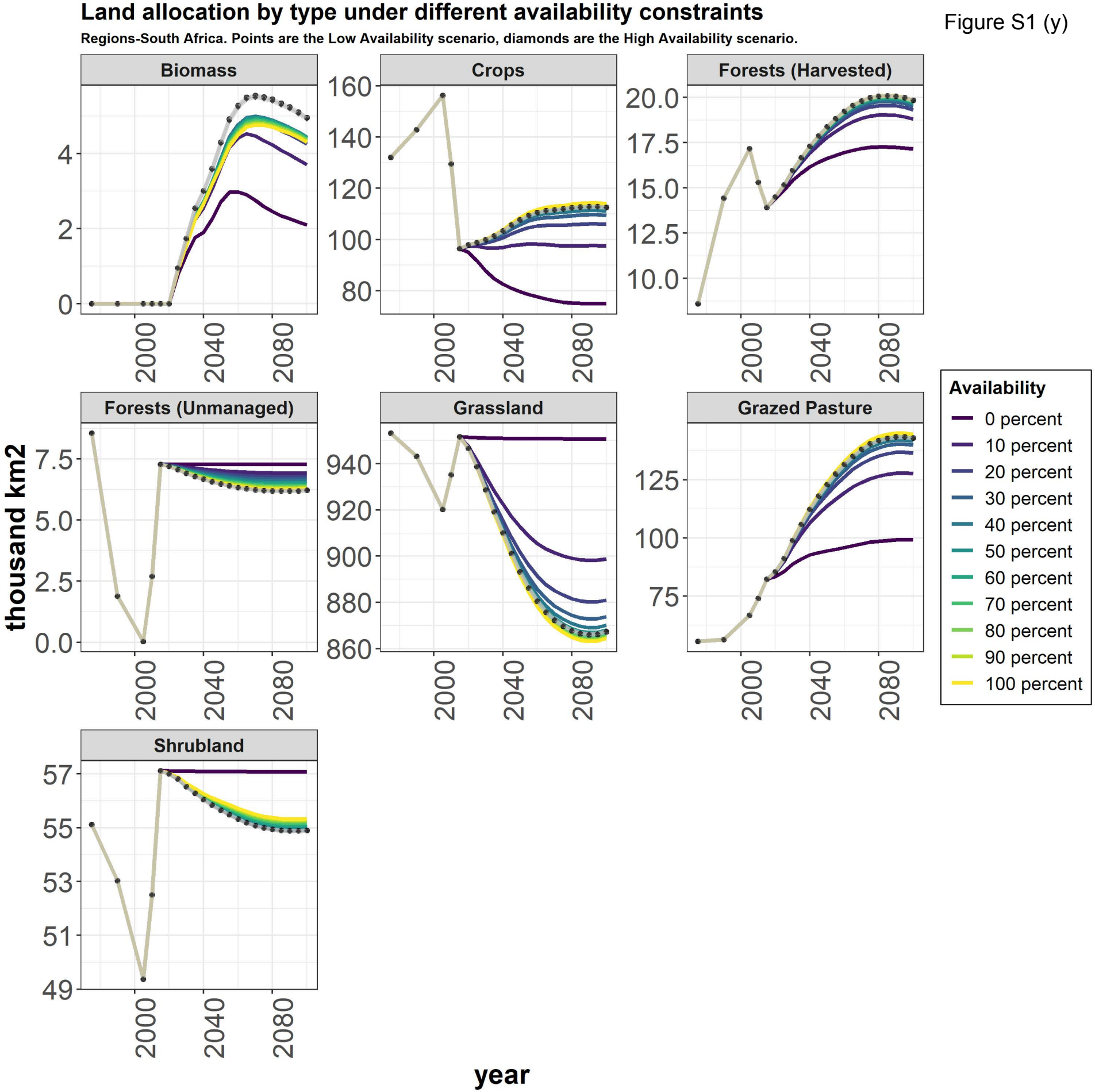

Land allocation by type under different availability constraints
Regions-South Africa. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (z)

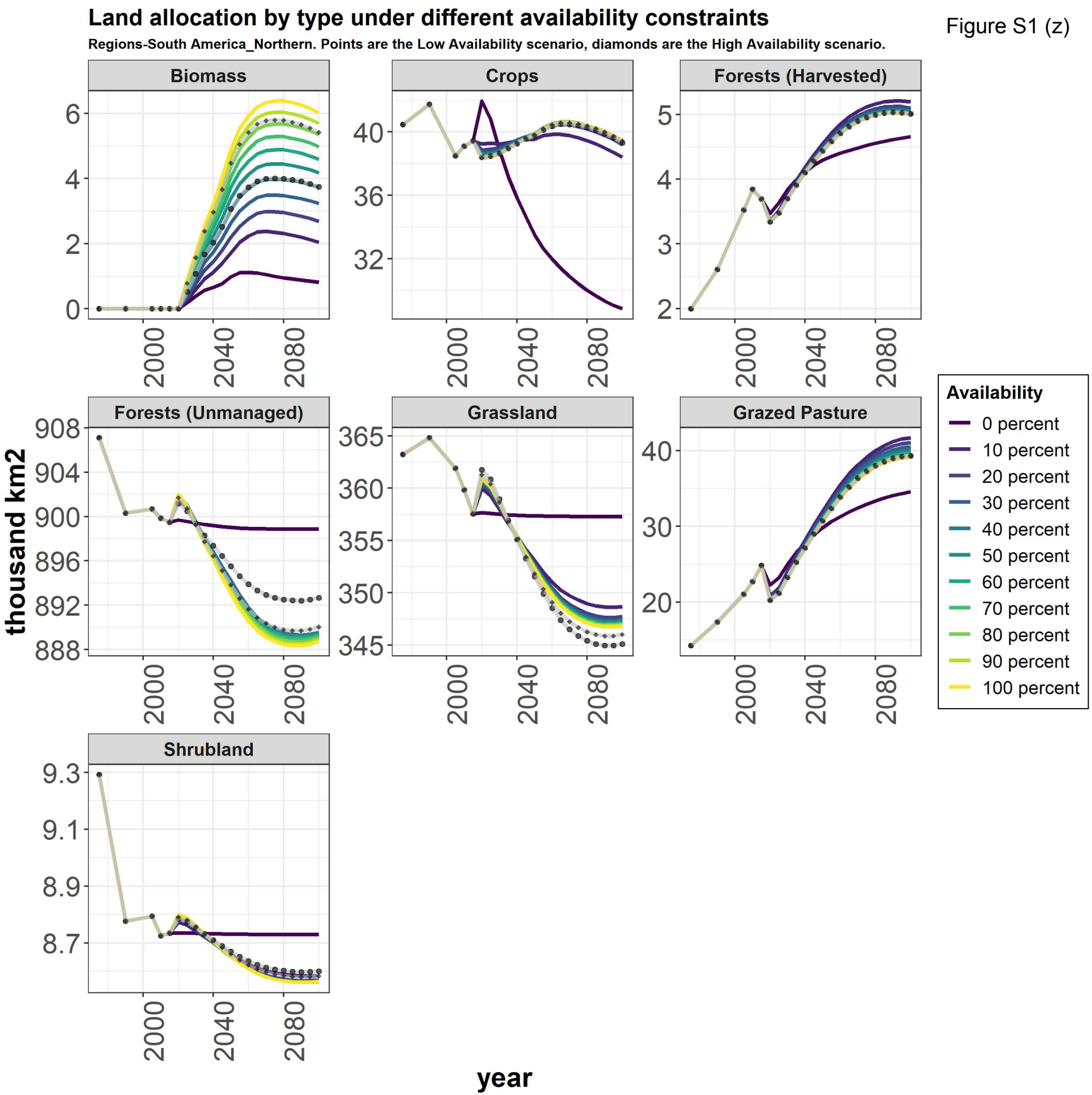

Land allocation by type under different availability constraints
Regions-South America_Northern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (A)

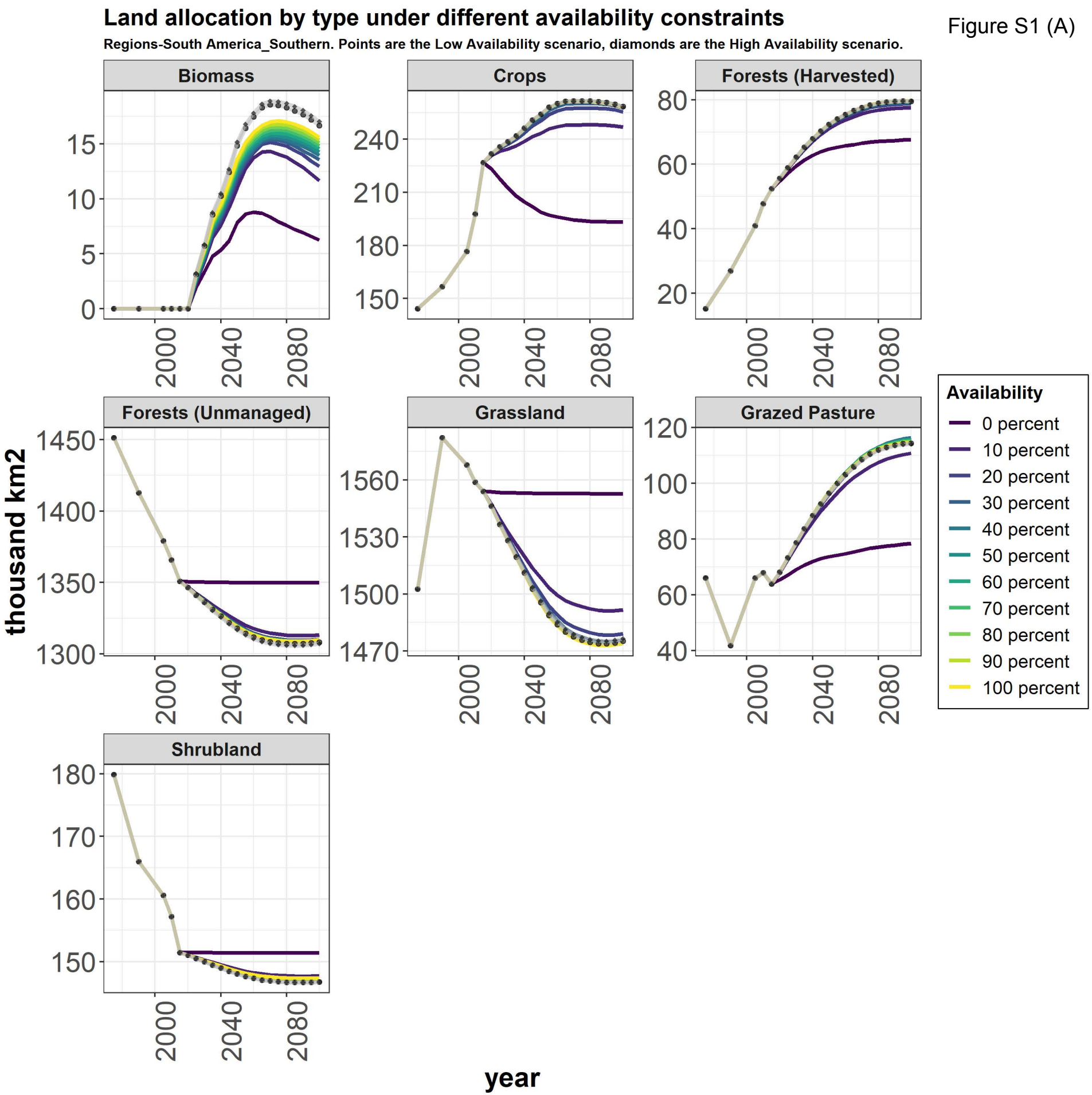

Land allocation by type under different availability constraints
Regions-South America_Southern. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (B)

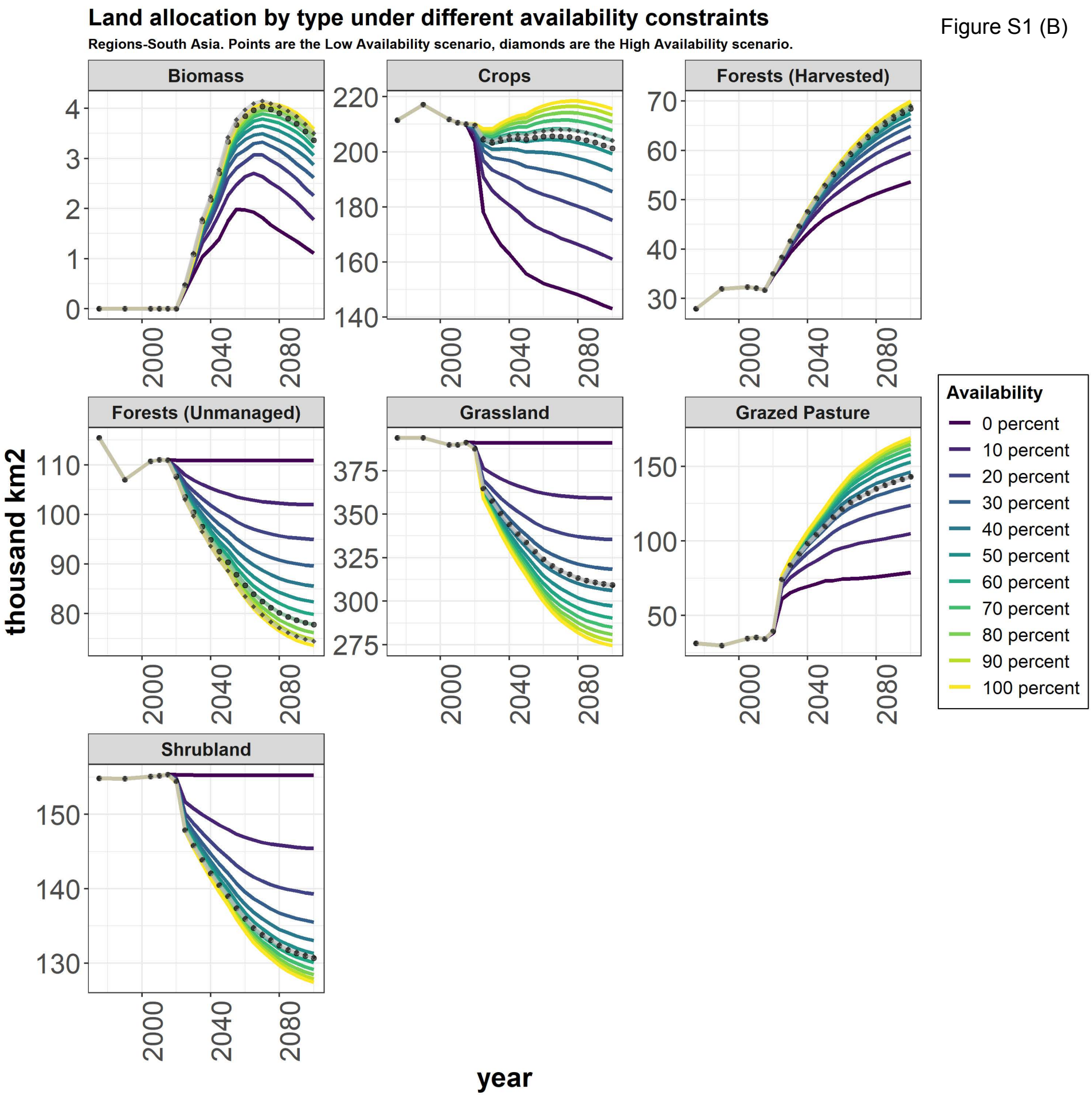

Land allocation by type under different availability constraints
Regions-South Asia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (C)

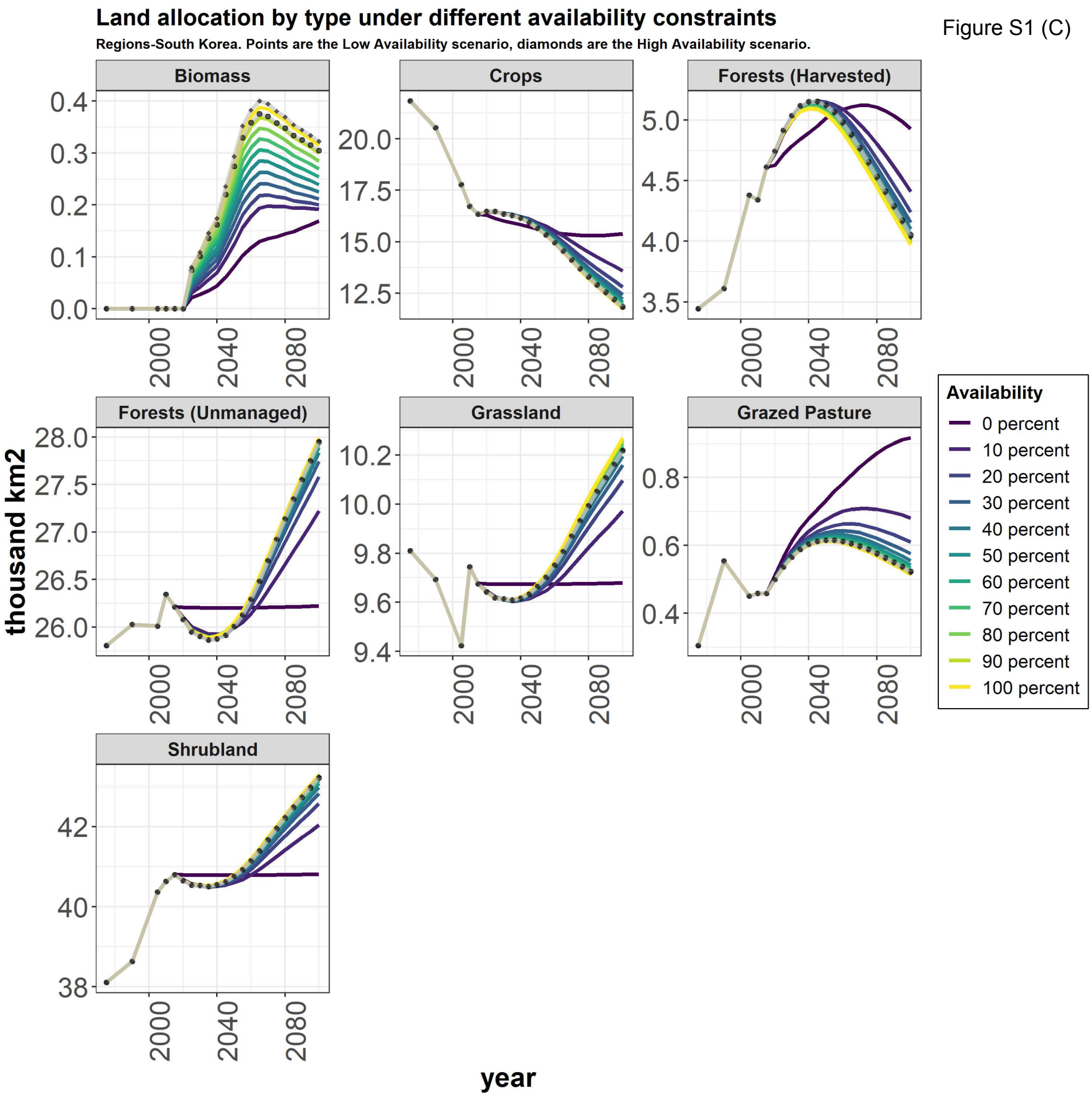

Land allocation by type under different availability constraints
Regions-South Korea. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (D)

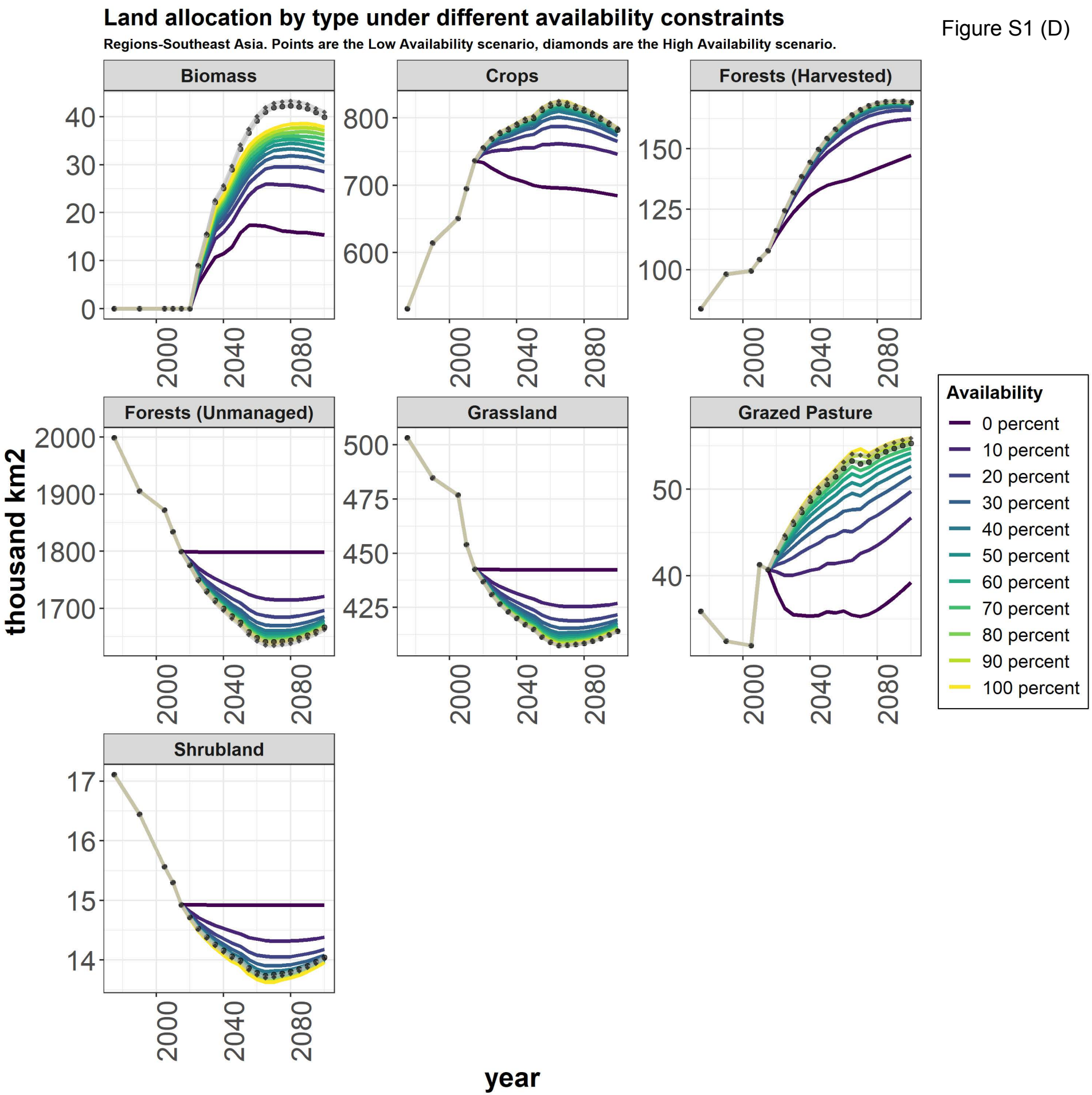

Land allocation by type under different availability constraints
Regions-Southeast Asia. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (E)

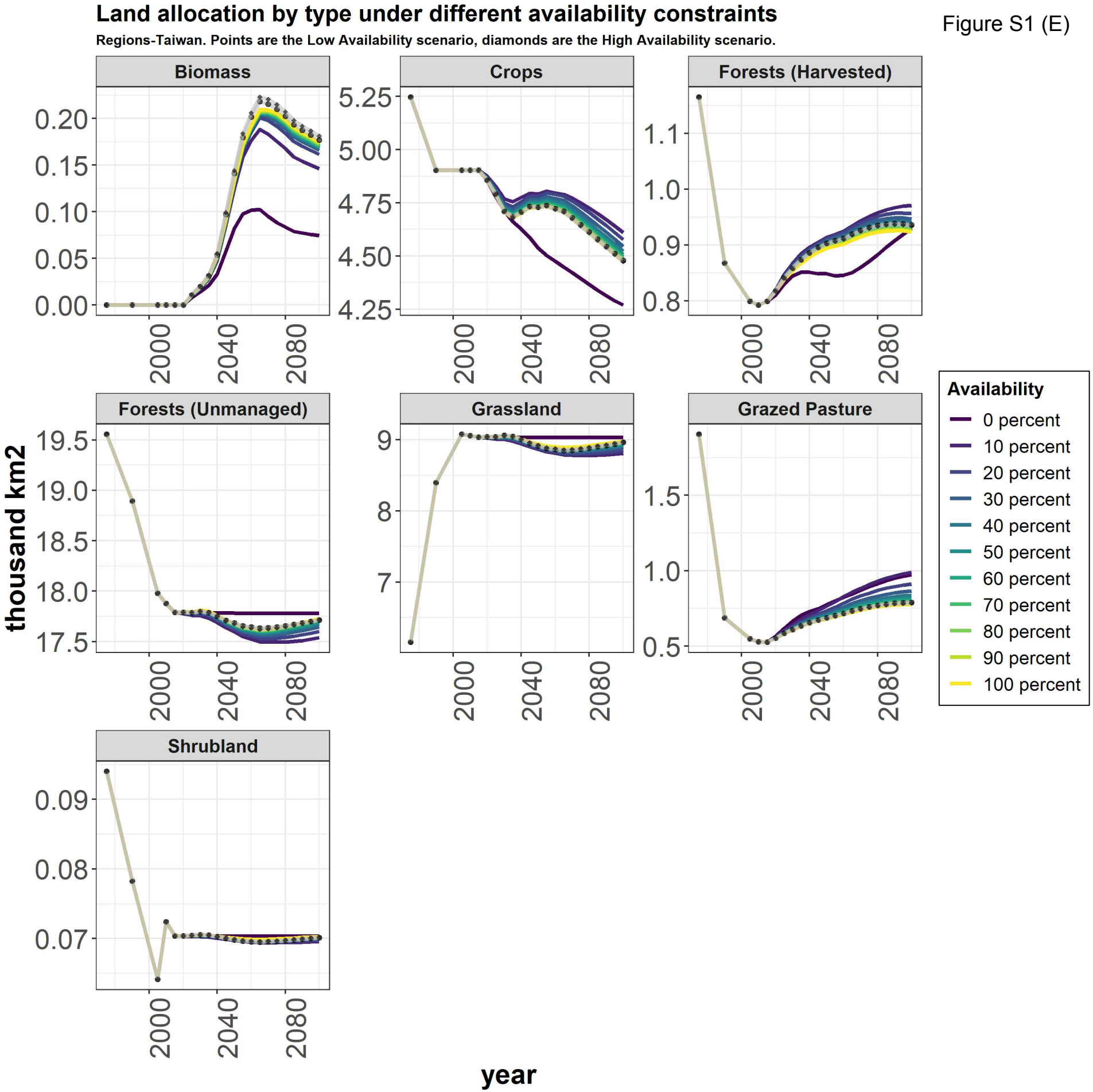

Land allocation by type under different availability constraints
Regions-Taiwan. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S1 (F)

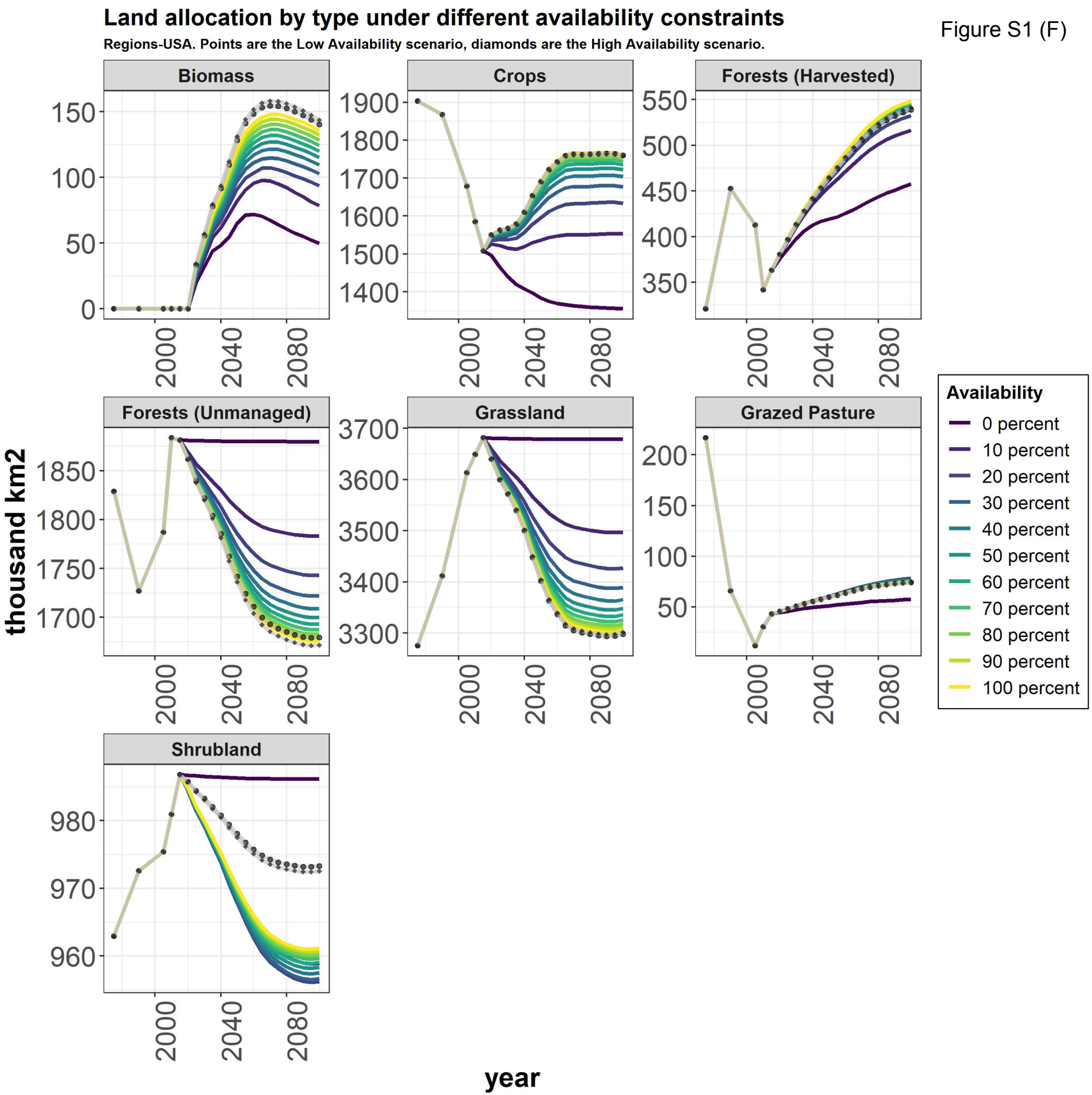

Land allocation by type under different availability constraints
Regions-USA. Points are the Low Availability scenario, diamonds are the High Availability scenario.
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland
thousand km2
year
Availability
0 percent
10 percent
20 percent
30 percent
40 percent
50 percent
60 percent
70 percent
80 percent
90 percent
100 percent

Figure S2 (a)

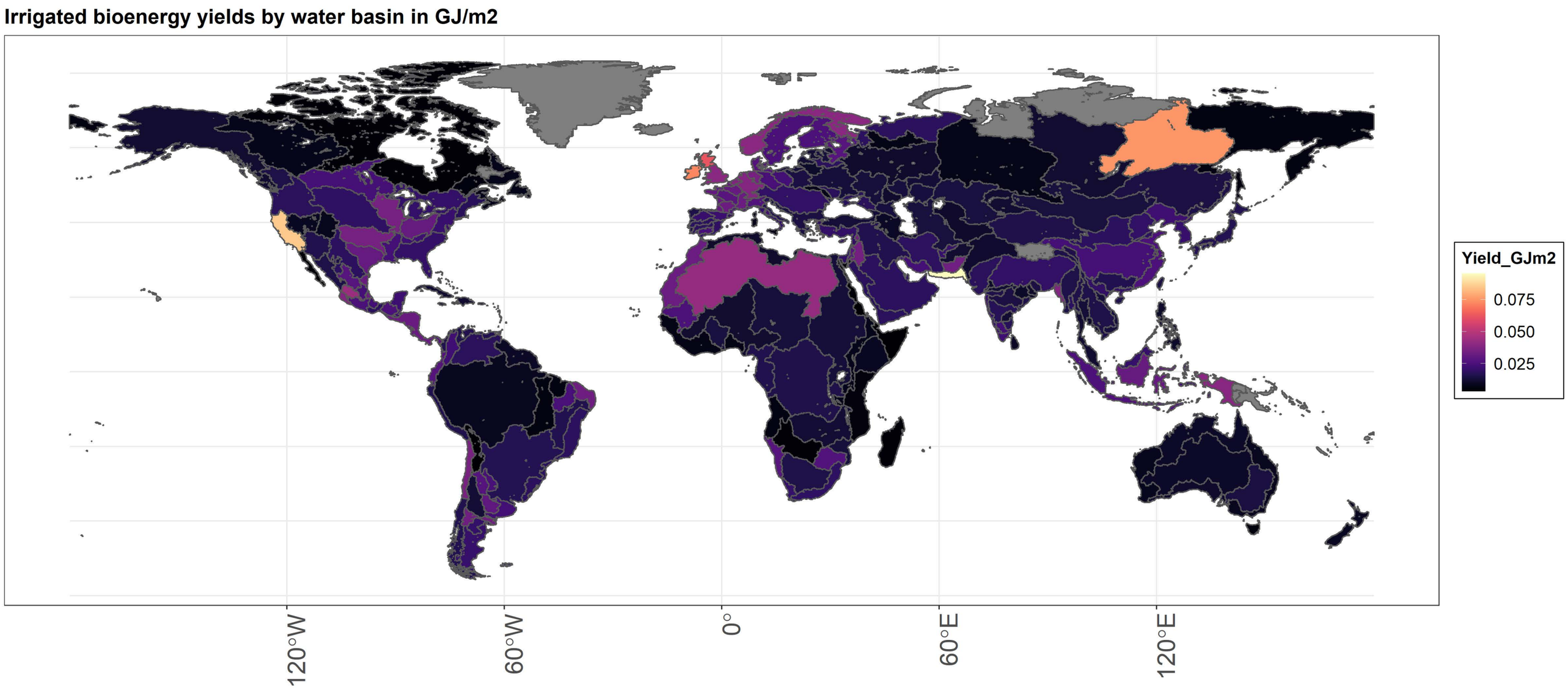
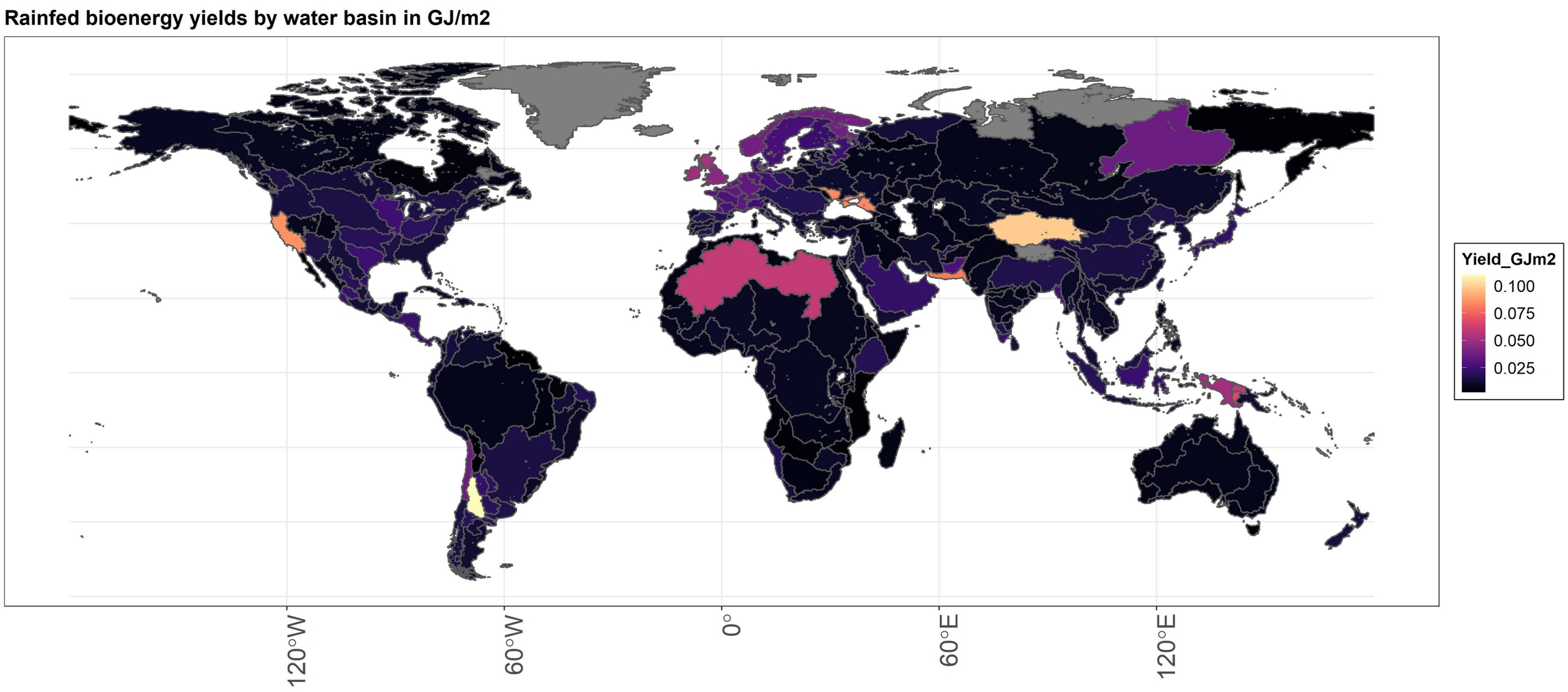

Irrigated bioenergy yields by water basin in GJ/m2
Yield_GJm2
0.075
0.050
0.025
120°W
60°W
0°
60°E
120°E

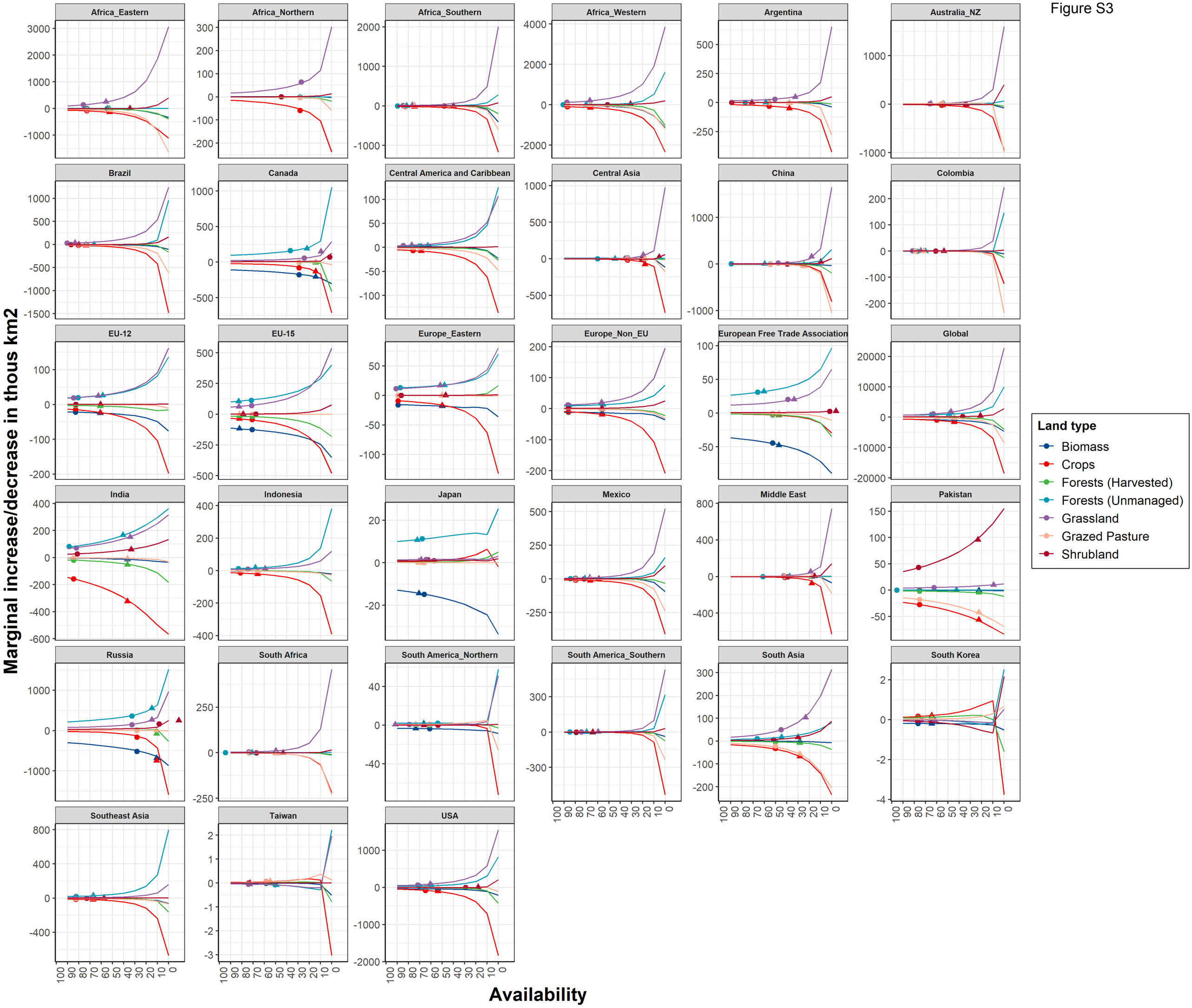
Figure S2 (b)


Rainfed bioenergy yields by water basin in GJ/m2
Yield_GJm2
0.100
0.075
0.050
0.025
120°W
60°W
0°
60°E
120°E

Marginal increase/decrease in land allocation by land type in 2050 with increase in protection

Dots are the starting percent of available land in 2015.Triangles are new percentage of available land after implementing 30 by 30 targets.

Figure S3



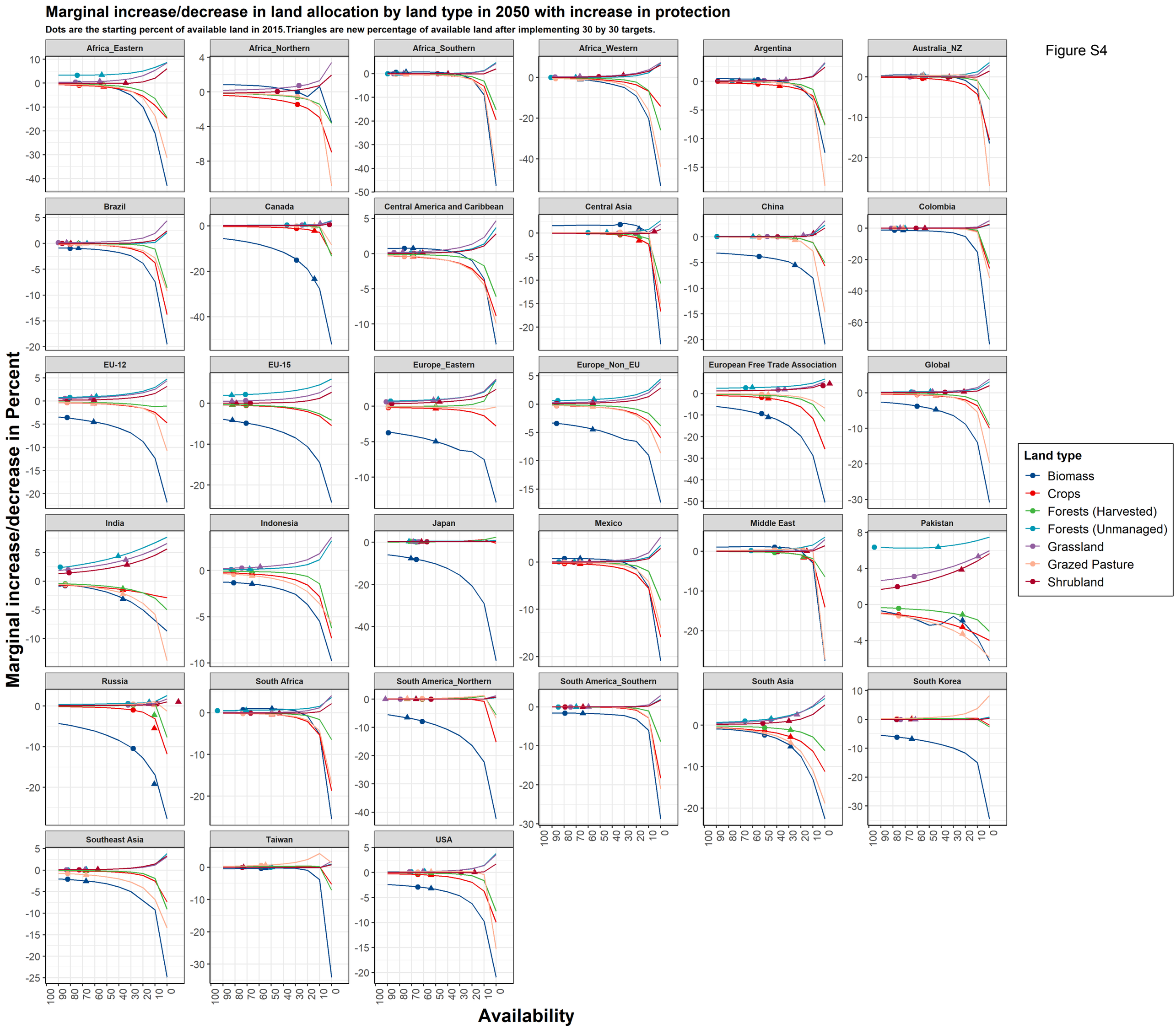

Marginal increase/decrease in land allocation by land type in 2050 with increase in protection
Dots are the starting percent of available land in 2015.Triangles are new percentage of available land after implementing 30 by 30 targets.
Figure S4
Africa_Eastern
Africa_Northern
Africa_Southern
Africa_Western
Argentina
Australia_NZ
Brazil
Canada
Central America and Caribbean
Central Asia
China
Colombia
EU-12
EU-15
Europe_Eastern
Europe_Non_EU
European Free Trade Association
Global
India
Indonesia
Japan
Mexico
Middle East
Pakistan
Russia
South Africa
South America_Northern
South America_Southern
South Asia
South Korea
Southeast Asia
Taiwan
USA
Marginal increase/decrease in Percent
Availability
Land type
Biomass
Crops
Forests (Harvested)
Forests (Unmanaged)
Grassland
Grazed Pasture
Shrubland

Table S1

Table 1. Raster inputs (these have been accessed in June 2018 unless noted otherwise)

Data	Details	Source
Crop yield and harvested area	5 arcmin, 175 crops-same as GTAP, circa 2000, area provided as fraction of land area in grid cell	Monfreda et al., 2008; http://www.earthstat.org/data-download/
Cropland physical extent	5 arcmin, circa 2000, provided as fraction of land area in grid cell	Ramankutty et al., 2008; http://www.earthstat.org/data-download/
Irrigated and rainfed crop harvested area	5 arcmin, hectares, 26 crop classes, circa 2000	Portmann et al., 2010; https://www.uni-frankfurt.de/45218031/data_download/
Crop water footprint data	5 arcmin, mm/yr, 18 crop types, 3 water types, circa 2000	Mekonnen and Hoekstra, 2011; http://waterfootprint.org/en/resources/waterstat/product-water-footprint-statistics/
Fraction of land area in grid cell for crop and water footprint data above	5 arcmin, spherical earth with WGS84 mean radius	D. Plouff and N. Ramankutty provided these data corresponding to the above cropland data (in late 2013). Note that these are the same data used to provide the area values in the current crop yield and harvested area data above
Potential vegetation	5 arcmin, thematic, 15 vegetation types, circa 2000 if no historical land use had occurred	Ramankutty and Foley, 1999; http://www.earthstat.org/data-download/

Land use area	5 arcmin, km^2, 1700-2016 (decadal up to 2000), HYDE 3.2.000 baseline, 12 land use types	Klein Goldewijk et al., 2017; ftp://ftp.pbl.nl/hyde/hyde3.2/2017_beta_release/
Land area in grid cell	5 arcmin, km^2, circa 2000, spherical earth with WGS84 mean radius, with Greenland and several arctic islands added based on fraction of land area in grid cell for crop area and potential vegetation; this is the working grid	Klein Goldewijk et al., 2017; ftp://ftp.pbl.nl/hyde/hyde3.2/2017_beta_release/
Total grid cell area	5 arcmin, km^2, spherical earth with WGS84 mean radius, with Greenland and several arctic islands added based on fraction of land area in grid cell for crop area and potential vegetation; this is the working grid	Klein Goldewijk et al., 2017; ftp://ftp.pbl.nl/hyde/hyde3.2/2017_beta_release/
234 Country boundaries	5 arcmin, from VMAP0 vector data (the source of FAO country boundaries), added East Timor based on a map, and merged some countries to reflect FAO data	VMAP0: http://gis.ess.washington.edu/data/raster/GlobalData/ (last accessed in 2013, now restricted to UW, but these data are currently available in four parts at http://gis-lab.info/qa/vmap0-eng.html);

Original AEZ boundaries	5 arcmin, 1961-1990 data, 160 country boundaries, GTAP Land Use Database, Release 2.1	Lee et al., 2005; Lee et al., 2009; Monfreda et al., 2009; https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1900
Output Geographic Land Unit (GLU) boundaries	5 arcmin, thematic, 235 water basins	Developed for the water module of the Global Change Assessment Model, aggregated from a 1/8-degree global watershed data set; updated 30 Sep 2017
Land cover area data	half-degree, 1800-2016 (decadal up to 2000), 23 land cover types, fraction of grid cell and grid cell area	Produced specifically for Moirai using HYDE 3.2.000 data; http://climate.atmos.uiuc.edu/atuljain/availabledata.html; Previous public version available here: https://www.atmos.illinois.edu/~meiyapp2/datasets.htm (Meiyappan and Jain, 2012)
Soil carbon data – SoilGrids 2.0	250 m, circa 2010, 0-30 cm, MgC/ha, aggregated to 5 arcmin, six carbon states provided based on the aggregation	Hengl, T., Mendes de Jesus, J., Heuvelink, G. B., Ruiperez Gonzalez, M., Kilibarda, M., Blagotić, A., ... & Guevara, M. A. (2017). SoilGrids250m: Global gridded soil information based on machine learning. PLoS one, 12(2), e0169748; https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/ea80098c-bb18-44d8-84dc-a8a1fbadc061; downloaded Ocotber 2020
Soil carbon data - FAO harmonized world soil	30 arcsec, circa 2010, 0-30 cm,	Fischer, G., F. Nachtergaele, S. Prieler, H.T. van Velthuizen, L. Verelst, D. Wiberg, 2008. Global Agro-ecological

database v1.2	MgC/ha, aggregated to 5 arcmin, 6 carbon states provided based on the aggregation	Zones Assessment for Agriculture (GAEZ 2008). IIASA, Laxenburg, Austria and FAO, Rome, Italy; http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/; downloaded October 2020
Vegetation carbon data	300m, circa 2010, above and below ground, MgC/ha, aggregated to 5 arcmin, 6 carbon states provided based on the aggregation	Spawn, S.A., Sullivan, C.C., Lark, T.J. et al. Harmonized global maps of above and belowground biomass carbon density in the year 2010. Sci Data 7, 112 (2020); https://doi.org/10.1038/s41597-020-0444-4; downloaded July 2020
Suitable and protected land area	300m, 6 thematic categories, aggregated to 5 arcmin as fraction of grid cell in each category	Provided Jan 2020 by researchers at U.S. Environmental Protection Agency (EPA) in support of research with the Global Change Analysis Model (GCAM); Contact Aaron Sobel (Sobel.Aaron@epa.gov) for availability, and see .../moirai/docs/third_party_contributions_v31.pdf for original data sources and their citations

Table S2

Table 2. Text inputs as comma separated value files (these have been accessed in June 2018 unless noted otherwise)

Data	Details	Source[a]
87 economic regions	Tabular, GTAP Land Use Database, Release 2.1	Lee et al., 2005; Lee et al., 2009; Monfreda et al., 2009; https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1900
Land rent for 13 use sectors	Tabular, 87 regions by 18 AEZs, GTAP Land Use Database, Release 2.1	Lee et al., 2005; Lee et al., 2009; Monfreda et al., 2009; https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1900
FAO 235 countries	Tabular, with some added countries to match the VMAP0 data, there are two input files containing these data: one maps the countries to the economic regions and the other maps the countries to the raster country data	http://faostat.fao.org/; accessed Aug 2013
Geographic Land Unit (GLU) list	Thematic codes and names for the GLU raster data	Developed for the water module of the Global Change Assessment Model, aggregated from a 1/8-degree global watershed data set
GCAM region list	Names and integer codes for GCAM regions, used in some diagnostics	GCAM
Country to GCAM region mapping	Cross-reference table mapping FAO countries to GCAM regions	FAO country and GCAM region data

HYDE3.2.000 list	Thematic codes and names for HYDE3.2.000 raster data	Klein Goldewijk et al., 2017; ftp://ftp.pbl.nl/hyde/hyde3.2/2017_beta_release/
Land cover to land use mapping	Cross-reference table mapping land cover to potential vegetation and land use	Land cover, land use, and potential vegetation data
GTAP product use list		Lee et al., 2005; Lee et al., 2009; Monfreda et al., 2009; https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1900
175 crop to FAO crop and GTAP use mapping	Cross-reference table mapping 175 crops to FAO crops to GTAP use	175 Crop, FAO crop, and GTAP use data
FAO production data	Tabular, up to 169 crops, 1997-2007	http://faostat.fao.org/faostat/; accessed July 2018
FAO yield data	Tabular, up to 160 crops, 1997-2007, for diagnostics only	http://faostat.fao.org/faostat/; accessed July 2018
FAO harvested area data	Tabular, up to 161 crops, 1997-2007, for year recalibration only	http://faostat.fao.org/faostat/; accessed July 2018
FAO Crop producer prices data	Tabular, up to 205 crops, 1997-2007	http://faostat.fao.org/faostat/; accessed July 2018
USD-year conversion list	Factors to convert input FAO 2005 USD to output 2001 USD	Derived from consumer price index centered at 1982-1984 (https://www.bls.gov/cpi/data.htm)

Potential vegetation list	Thematic codes and names for potential vegetation raster data	Ramankutty and Foley, 1999; http://www.earthstat.org/data-download/

Table S3. New fuel preference elasticities

Subsector	Criteria for share threshold	Share	Fuel preference elasticity
biomass	greater than	0.5	-0.7
gas	lesser than	0.2	0.1
gas	lesser than	0.1	0.3
electricity	lesser than	0.2	0.1
electricity	lesser than	0.1	0.3

Table S4. Bioenergy crop externality cost for expansion

Bioenergy production	Externality cost
0 EJ	0 $/GJ
0-75 EJ	0.01 $/GJ
75-100 EJ	1.5 $/GJ
>100 EJ	3.0 $/GJ

Table S5. Regional breakdown of unmanaged, convertible, and available areas

Region	Land_cover	Cover_area_ha	Unmanaged_area_ha	Convertible_area_ha	Low_avail_area_ha	High_avail_area_ha	Low_avail_percent_convertible	High_avail_percent_convertible	Low_avail_cover_percent_convertible	High_avail_cover_percent_convertible	Other_percent_unmanaged	Unknown_percent_unmanaged
Africa_Eastern	Forest	126458.7692	475889782.3	383969434.3	279748005.6	314912193.5	72.8568424	82.01491196	74.52754512	96.74844548		
Africa_Eastern	Shrubland	56575646	475889782.3	383969434.3	279748005.6	314912193.5	72.8568424	82.01491196	54.60707816	72.76411286		
Africa_Eastern	Grassland	327267329.6	475889782.3	383969434.3	279748005.6	314912193.5	72.8568424	82.01491196	76.01108614	83.60843109		
Africa_Eastern	Other	91444174	475889782.3	383969434.3	279748005.6	314912193.5	72.8568424	82.01491196			19.21541025	
Africa_Eastern	Unknown	476174	475889782.3	383969434.3	279748005.6	314912193.5	72.8568424	82.01491196				0.100059723
Africa_Northern	Forest	0	540243505.6	82232826.6	23249310.44	23623495.07	28.272542	28.72757273				
Africa_Northern	Shrubland	5699983.2	540243505.6	82232826.6	23249310.44	23623495.07	28.272542	28.72757273	44.949075	46.86853119		
Africa_Northern	Grassland	76532843.4	540243505.6	82232826.6	23249310.44	23623495.07	28.272542	28.72757273	27.0305137	27.37647752		
Africa_Northern	Other	457742712	540243505.6	82232826.6	23249310.44	23623495.07	28.272542	28.72757273			84.72896152	
Africa_Northern	Unknown	267967	540243505.6	82232826.6	23249310.44	23623495.07	28.272542	28.72757273				0.049601152
Africa_Southern	Forest	51441146.77	498811459.2	483291209.6	401504639.4	459065331.6	83.07716577	94.98731251	89.95533578	99.47567173		
Africa_Southern	Shrubland	33172531.45	498811459.2	483291209.6	401504639.4	459065331.6	83.07716577	94.98731251	48.36615833	56.88628804		
Africa_Southern	Grassland	398677531.4	498811459.2	483291209.6	401504639.4	459065331.6	83.07716577	94.98731251	85.07785799	97.57843191		
Africa_Southern	Other	15373908.58	498811459.2	483291209.6	401504639.4	459065331.6	83.07716577	94.98731251			3.082108139	
Africa_Southern	Unknown	146341	498811459.2	483291209.6	401504639.4	459065331.6	83.07716577	94.98731251				0.029337939
Africa_Western	Forest	205987790.7	969093523	700405617	609332642.3	665115374.8	86.99710961	94.96145644	90.89550783	98.76065844		
Africa_Western	Shrubland	27654142	969093523	700405617	609332642.3	665115374.8	86.99710961	94.96145644	51.27699257	59.99608523		
Africa_Western	Grassland	466763684.2	969093523	700405617	609332642.3	665115374.8	86.99710961	94.96145644	87.39299891	95.356406		
Africa_Western	Other	267829155	969093523	700405617	609332642.3	665115374.8	86.99710961	94.96145644			27.63708029	
Africa_Western	Unknown	858751	969093523	700405617	609332642.3	665115374.8	86.99710961	94.96145644				0.088613842
Argentina	Forest	13915822.61	218312792.6	202307540.5	112785211.6	119004666.5	55.74938595	58.82364354	77.00040212	85.81905554		
Argentina	Shrubland	17410014.09	218312792.6	202307540.5	112785211.6	119004666.5	55.74938595	58.82364354	89.15160248	92.71069149		
Argentina	Grassland	170981703.8	218312792.6	202307540.5	112785211.6	119004666.5	55.74938595	58.82364354	50.61867072	53.17603725		
Argentina	Other	15963341.02	218312792.6	202307540.5	112785211.6	119004666.5	55.74938595	58.82364354			7.312141826	
Argentina	Unknown	41911	218312792.6	202307540.5	112785211.6	119004666.5	55.74938595	58.82364354				0.019197684
Australia_NZ	Forest	16184171.19	718016319.9	715958658.6	398560662.1	502524579.8	55.66811119	70.18904986	54.68380177	89.90282738		
Australia_NZ	Shrubland	230580800.4	718016319.9	715958658.6	398560662.1	502524579.8	55.66811119	70.18904986	34.45678386	54.72705523		
Australia_NZ	Grassland	469193687	718016319.9	715958658.6	398560662.1	502524579.8	55.66811119	70.18904986	66.12616977	77.10770208		
Australia_NZ	Other	1403492.3	718016319.9	715958658.6	398560662.1	502524579.8	55.66811119	70.18904986			0.195468022	
Australia_NZ	Unknown	654169	718016319.9	715958658.6	398560662.1	502524579.8	55.66811119	70.18904986				0.091107818
Brazil	Forest	392725427.5	695671455.7	694535514.7	558756246.5	673443697.1	80.45034915	96.96317652	73.3673991	97.34662013		
Brazil	Shrubland	56803250.98	695671455.7	694535514.7	558756246.5	673443697.1	80.45034915	96.96317652	86.90584717	95.39111939		
Brazil	Grassland	245006836.2	695671455.7	694535514.7	558756246.5	673443697.1	80.45034915	96.96317652	90.30705906	96.71301982		
Brazil	Other	761083	695671455.7	694535514.7	558756246.5	673443697.1	80.45034915	96.96317652			0.109402649	
Brazil	Unknown	374858	695671455.7	694535514.7	558756246.5	673443697.1	80.45034915	96.96317652				0.053884344
Canada	Forest	386756485.9	842310308.5	601536874.5	175553314.6	192560944.7	29.18413186	32.0114947	36.96518432	40.51126829		
Canada	Shrubland	88410599	842310308.5	601536874.5	175553314.6	192560944.7	29.18413186	32.0114947	1.849705609	2.172362455		
Canada	Grassland	126369789.6	842310308.5	601536874.5	175553314.6	192560944.7	29.18413186	32.0114947	24.49377423	26.87381888		
Canada	Other	239692824	842310308.5	601536874.5	175553314.6	192560944.7	29.18413186	32.0114947			28.45659391	
Canada	Unknown	1080610	842310308.5	601536874.5	175553314.6	192560944.7	29.18413186	32.0114947				0.1282912
Central America and Caribbean	Forest	29018790	50890493.84	49228456.84	37487095.98	46549244.41	76.14924048	94.55759413	70.46199647	94.68394478		
Central America and Caribbean	Shrubland	454910.377	50890493.84	49228456.84	37487095.98	46549244.41	76.14924048	94.55759413	68.2723453	91.41377172		
Central America and Caribbean	Grassland	19754756.46	50890493.84	49228456.84	37487095.98	46549244.41	76.14924048	94.55759413	84.6849175	94.4443867		
Central America and Caribbean	Unknown	1662037	50890493.84	49228456.84	37487095.98	46549244.41	76.14924048	94.55759413				3.265908571
Central Asia	Forest	3067101.194	518886979.1	487027938	162834536.9	169642971	33.43433183	34.83228739	60.19669982	67.32493132		
Central Asia	Shrubland	60313483.1	518886979.1	487027938	162834536.9	169642971	33.43433183	34.83228739	20.79034384	23.39855605		
Central Asia	Grassland	423647353.7	518886979.1	487027938	162834536.9	169642971	33.43433183	34.83228739	35.040668	36.22483694		
Central Asia	Other	31242372.11	518886979.1	487027938	162834536.9	169642971	33.43433183	34.83228739			6.021036058	
Central Asia	Unknown	616669	518886979.1	487027938	162834536.9	169642971	33.43433183	34.83228739				0.11884457
China	Forest	113088620.2	730882290.5	620467200.5	339205974.1	339581356.8	54.66944487	54.72994488	89.5998001	89.67264986		
China	Shrubland	58457148	730882290.5	620467200.5	339205974.1	339581356.8	54.66944487	54.72994488	39.44911229	39.67976755		
China	Grassland	448921432.3	730882290.5	620467200.5	339205974.1	339581356.8	54.66944487	54.72994488	47.85201932	47.8872512		
China	Other	110068271	730882290.5	620467200.5	339205974.1	339581356.8	54.66944487	54.72994488			15.059644	
China	Unknown	346819	730882290.5	620467200.5	339205974.1	339581356.8	54.66944487	54.72994488				0.047452101

Table S5 continued. Regional breakdown of unmanaged, convertible, and available areas

Region	Land_cover	Cover_area_ha	Unmanaged_area_ha	Convertible_area_ha	Low_avail_area_ha	High_avail_area_ha	Low_avail_percent_convertible	High_avail_percent_convertible	Low_avail_cover_percent_convertible	High_avail_cover_percent_convertible	Other_percent_unmanaged	Unknown_percent_unmanaged
Colombia	Forest	58761824	105667616	105036134.5	82875842.87	95579910.64	78.9022209	90.99717073	77.33950349	94.50867895		
Colombia	Shrubland	1440707.7	105667616	105036134.5	82875842.87	95579910.64	78.9022209	90.99717073	60.88694259	77.61243082		
Colombia	Grassland	44833602.8	105667616	105036134.5	82875842.87	95579910.64	78.9022209	90.99717073	81.52933245	86.82487322		
Colombia	Other	542558.5	105667616	105036134.5	82875842.87	95579910.64	78.9022209	90.99717073			0.51345769	
Colombia	Unknown	88923	105667616	105036134.5	82875842.87	95579910.64	78.9022209	90.99717073				0.084153503
EU-12	Forest	24942666.92	57537795.33	57377462.33	47560055.96	53617793.56	82.88978639	93.44748162	80.61685407	92.6643028		
EU-12	Shrubland	425302.89	57537795.33	57377462.33	47560055.96	53617793.56	82.88978639	93.44748162	82.60264139	88.25092794		
EU-12	Grassland	32009492.52	57537795.33	57377462.33	47560055.96	53617793.56	82.88978639	93.44748162	84.66473228	94.12680129		
EU-12	Other	2612	57537795.33	57377462.33	47560055.96	53617793.56	82.88978639	93.44748162			0.004539625	
EU-12	Unknown	157721	57537795.33	57377462.33	47560055.96	53617793.56	82.88978639	93.44748162				0.274117211
EU-15	Forest	59019712.1	404694059.9	191941995.9	136038530	159027479.1	70.87481267	82.85184196	71.57099424	80.74211313		
EU-15	Shrubland	24152899.75	404694059.9	191941995.9	136038530	159027479.1	70.87481267	82.85184196	67.46402495	78.72254872		
EU-15	Grassland	108769384	404694059.9	191941995.9	136038530	159027479.1	70.87481267	82.85184196	71.25444135	84.91354339		
EU-15	Other	210485250	404694059.9	191941995.9	136038530	159027479.1	70.87481267	82.85184196			52.01095615	
EU-15	Unknown	2266814	404694059.9	191941995.9	136038530	159027479.1	70.87481267	82.85184196				0.560130287
Europe_Eastern	Forest	16738339.02	35698944.86	35199406.86	31464274.4	33286760.1	89.38864943	94.56625285	87.49011196	95.05555271		
Europe_Eastern	Shrubland	428708	35698944.86	35199406.86	31464274.4	33286760.1	89.38864943	94.56625285	86.42810451	90.61535553		
Europe_Eastern	Grassland	18032359.84	35698944.86	35199406.86	31464274.4	33286760.1	89.38864943	94.56625285	91.22133098	94.20599576		
Europe_Eastern	Other	474434	35698944.86	35199406.86	31464274.4	33286760.1	89.38864943	94.56625285			1.328986058	
Europe_Eastern	Unknown	25104	35698944.86	35199406.86	31464274.4	33286760.1	89.38864943	94.56625285				0.070321406
Europe_Non_EU	Forest	14890710.94	65977874.79	65495084.79	56463320.09	57064503.76	86.21001145	87.12791798	85.21199763	86.83178324		
Europe_Non_EU	Shrubland	7640102	65977874.79	65495084.79	56463320.09	57064503.76	86.21001145	87.12791798	86.1119907	86.39361506		
Europe_Non_EU	Grassland	42964271.85	65977874.79	65495084.79	56463320.09	57064503.76	86.21001145	87.12791798	86.57333714	87.3611305		
Europe_Non_EU	Other	171252	65977874.79	65495084.79	56463320.09	57064503.76	86.21001145	87.12791798			0.25955974	
Europe_Non_EU	Unknown	311538	65977874.79	65495084.79	56463320.09	57064503.76	86.21001145	87.12791798				0.472185564
European Free Trade Association	Forest	12573977.79	42207971.1	23225934.45	12226818.7	13472204.26	52.64295705	58.00500424	65.91248749	71.6706141		
European Free Trade Association	Shrubland	576672.954	42207971.1	23225934.45	12226818.7	13472204.26	52.64295705	58.00500424	1.704969689	1.966811659		
European Free Trade Association	Grassland	10075283.71	42207971.1	23225934.45	12226818.7	13472204.26	52.64295705	58.00500424	38.99805877	44.15771528		
European Free Trade Association	Other	18465278.65	42207971.1	23225934.45	12226818.7	13472204.26	52.64295705	58.00500424			43.74832092	
European Free Trade Association	Unknown	516758	42207971.1	23225934.45	12226818.7	13472204.26	52.64295705	58.00500424				1.224313765
Global	Forest	2712027093	11043924020	8910848766	5361922933	5981812360	60.17297649	67.12954643	64.84509485	74.86541511		
Global	Shrubland	1181136685	11043924020	8910848766	5361922933	5981812360	60.17297649	67.12954643	36.99808044	44.27473106		
Global	Grassland	5017684988	11043924020	8910848766	5361922933	5981812360	60.17297649	67.12954643	63.10297475	68.32826166		
Global	Other	2107053143	11043924020	8910848766	5361922933	5981812360	60.17297649	67.12954643			19.07884498	
Global	Unknown	26022111	11043924020	8910848766	5361922933	5981812360	60.17297649	67.12954643				0.235623778
India	Forest	42430273.43	119986859.8	106159165.8	89751592.76	94666145.26	84.54436512	89.17378403	88.58385369	92.9279943		
India	Shrubland	20952723	119986859.8	106159165.8	89751592.76	94666145.26	84.54436512	89.17378403	81.200283	84.62758554		
India	Grassland	42776169.39	119986859.8	106159165.8	89751592.76	94666145.26	84.54436512	89.17378403	82.1755467	87.67676055		
India	Other	13104289	119986859.8	106159165.8	89751592.76	94666145.26	84.54436512	89.17378403			10.92143675	
India	Unknown	723405	119986859.8	106159165.8	89751592.76	94666145.26	84.54436512	89.17378403				0.602903519
Indonesia	Forest	102277536.3	133926893.8	131102915.8	106594283.8	120390792.1	81.3058071	91.82922545	83.19110719	93.85251286		
Indonesia	Grassland	28825379.54	133926893.8	131102915.8	106594283.8	120390792.1	81.3058071	91.82922545	74.6164295	84.65024451		
Indonesia	Unknown	2823978	133926893.8	131102915.8	106594283.8	120390792.1	81.3058071	91.82922545				2.108596653
Japan	Forest	22680635.17	33080904.04	30816372.14	20396178.2	25235286.55	66.18617567	81.88921927	67.83953701	83.30502683		
Japan	Shrubland	3187946.97	33080904.04	30816372.14	20396178.2	25235286.55	66.18617567	81.88921927	57.40971839	76.31653028		
Japan	Grassland	4947790	33080904.04	30816372.14	20396178.2	25235286.55	66.18617567	81.88921927	64.26200247	78.98974741		
Japan	Other	11151.9	33080904.04	30816372.14	20396178.2	25235286.55	66.18617567	81.88921927			0.033710989	
Japan	Unknown	2253380	33080904.04	30816372.14	20396178.2	25235286.55	66.18617567	81.88921927				6.811724363
Mexico	Forest	39146475.06	155813114.7	155521259.6	123924943.9	135374402.1	79.68360351	87.04559267	84.47809222	95.74046666		
Mexico	Shrubland	29213232.1	155813114.7	155521259.6	123924943.9	135374402.1	79.68360351	87.04559267	72.05200934	80.97127052		
Mexico	Grassland	87161552.43	155813114.7	155521259.6	123924943.9	135374402.1	79.68360351	87.04559267	80.08809607	85.1763845		
Mexico	Other	59040.11	155813114.7	155521259.6	123924943.9	135374402.1	79.68360351	87.04559267			0.037891618	
Mexico	Unknown	232815	155813114.7	155521259.6	123924943.9	135374402.1	79.68360351	87.04559267				0.149419386

Table S5 continued. Regional breakdown of unmanaged, convertible, and available areas

Region	Land_cover	Cover_area_ha	Unmanaged_area_ha	Convertible_area_ha	Low_avail_area_ha	High_avail_area_ha	Low_avail_percent_convertible	High_avail_percent_convertible	Low_avail_cover_percent_convertible	High_avail_cover_percent_convertible	Other_percent_unmanaged	Unknown_percent_unmanaged
Middle East	Forest	780275.3131	475646524.8	303532022.8	126787733.4	132127944.4	41.77079316	43.53014987	61.44052953	66.749431		
Middle East	Shrubland	84839259.08	475646524.8	303532022.8	126787733.4	132127944.4	41.77079316	43.53014987	39.09500623	41.32970799		
Middle East	Grassland	217912488.4	475646524.8	303532022.8	126787733.4	132127944.4	41.77079316	43.53014987	42.74211873	44.30370088		
Middle East	Other	171656038.1	475646524.8	303532022.8	126787733.4	132127944.4	41.77079316	43.53014987			36.08899237	
Middle East	Unknown	458464	475646524.8	303532022.8	126787733.4	132127944.4	41.77079316	43.53014987				0.096387543
Pakistan	Forest	15288.774	56714850.91	25948323.9	19571069.27	20846932.6	75.42325024	80.34018955	95.61118127	96.29110393		
Pakistan	Shrubland	24166164.1	56714850.91	25948323.9	19571069.27	20846932.6	75.42325024	80.34018955	76.35717208	81.49019934		
Pakistan	Grassland	1766871.022	56714850.91	25948323.9	19571069.27	20846932.6	75.42325024	80.34018955	62.47496096	64.47304651		
Pakistan	Other	30688673.01	56714850.91	25948323.9	19571069.27	20846932.6	75.42325024	80.34018955			54.1104711	
Pakistan	Unknown	77854	56714850.91	25948323.9	19571069.27	20846932.6	75.42325024	80.34018955				0.137272687
Russia	Forest	496144096.1	1484265133	1167553544	329665311.6	350877340.9	28.23556258	30.05235543	32.48770422	34.90796741		
Russia	Shrubland	206694751	1484265133	1167553544	329665311.6	350877340.9	28.23556258	30.05235543	8.405789675	8.830760867		
Russia	Grassland	464714696.9	1484265133	1167553544	329665311.6	350877340.9	28.23556258	30.05235543	32.5156833	34.30724343		
Russia	Other	315729690	1484265133	1167553544	329665311.6	350877340.9	28.23556258	30.05235543			21.27178514	
Russia	Unknown	981899	1484265133	1167553544	329665311.6	350877340.9	28.23556258	30.05235543				0.066153882
South Africa	Forest	727730.522	102023693.5	101597084.5	74638337.43	74717553.34	73.46503867	73.54300932	94.78823249	94.94082107		
South Africa	Shrubland	5711291	102023693.5	101597084.5	74638337.43	74717553.34	73.46503867	73.54300932	67.20890938	67.92400414		
South Africa	Grassland	95158063	102023693.5	101597084.5	74638337.43	74717553.34	73.46503867	73.54300932	73.67745405	73.7166145		
South Africa	Other	354781	102023693.5	101597084.5	74638337.43	74717553.34	73.46503867	73.54300932			0.347743733	
South Africa	Unknown	71828	102023693.5	101597084.5	74638337.43	74717553.34	73.46503867	73.54300932				0.070403254
South America_Northern	Forest	89949737.7	127767759.7	126577581.5	77485195.16	108179123.1	61.21557563	85.46467848	54.06252901	82.53392881		
South America_Northern	Shrubland	873404.1	127767759.7	126577581.5	77485195.16	108179123.1	61.21557563	85.46467848	53.92768174	76.82745291		
South America_Northern	Grassland	35754439.73	127767759.7	126577581.5	77485195.16	108179123.1	61.21557563	85.46467848	79.38898149	93.0487423		
South America_Northern	Other	865778.204	127767759.7	126577581.5	77485195.16	108179123.1	61.21557563	85.46467848			0.677618678	
South America_Northern	Unknown	324400	127767759.7	126577581.5	77485195.16	108179123.1	61.21557563	85.46467848				0.253898167
South America_Southern	Forest	135078428	357428079.7	305618844.7	242522355.4	263991261	79.35451612	86.37924841	84.85335746	96.35869703		
South America_Southern	Shrubland	15146965	357428079.7	305618844.7	242522355.4	263991261	79.35451612	86.37924841	79.11509932	84.65510881		
South America_Southern	Grassland	155393451.6	357428079.7	305618844.7	242522355.4	263991261	79.35451612	86.37924841	74.59789093	77.87250159		
South America_Southern	Other	51048930	357428079.7	305618844.7	242522355.4	263991261	79.35451612	86.37924841			14.28229423	
South America_Southern	Unknown	760305	357428079.7	305618844.7	242522355.4	263991261	79.35451612	86.37924841				0.21271552
South Asia	Forest	11095665.02	74809658.86	65752983.76	33021361.29	35439374.5	50.22032371	53.89774345	66.46034192	81.12134211		
South Asia	Shrubland	15534259	74809658.86	65752983.76	33021361.29	35439374.5	50.22032371	53.89774345	51.68089796	52.39936882		
South Asia	Grassland	39123059.74	74809658.86	65752983.76	33021361.29	35439374.5	50.22032371	53.89774345	45.03456518	46.7718235		
South Asia	Other	8965211.1	74809658.86	65752983.76	33021361.29	35439374.5	50.22032371	53.89774345			11.98402885	
South Asia	Unknown	91464	74809658.86	65752983.76	33021361.29	35439374.5	50.22032371	53.89774345				0.122262287
South Korea	Forest	2621100	7993863.618	7668444.618	5884465.398	6604673.908	76.73610088	86.12794689	77.31987437	86.58530191		
South Korea	Shrubland	4079767	7993863.618	7668444.618	5884465.398	6604673.908	76.73610088	86.12794689	77.068687	86.68515762		
South Korea	Grassland	967577.618	7993863.618	7668444.618	5884465.398	6604673.908	76.73610088	86.12794689	73.75235824	82.53953893		
South Korea	Unknown	325419	7993863.618	7668444.618	5884465.398	6604673.908	76.73610088	86.12794689				4.070860044
Southeast Asia	Forest	179932099.8	231726736.5	225681034.5	186347626	212119323.9	82.5712388	93.99076194	82.42727465	94.63167629		
Southeast Asia	Shrubland	1492761.79	231726736.5	225681034.5	186347626	212119323.9	82.5712388	93.99076194	72.89723603	87.68340656		
Southeast Asia	Grassland	44256172.98	231726736.5	225681034.5	186347626	212119323.9	82.5712388	93.99076194	83.48285745	91.59774695		
Southeast Asia	Other	227491.98	231726736.5	225681034.5	186347626	212119323.9	82.5712388	93.99076194			0.098172521	
Southeast Asia	Unknown	5818210	231726736.5	225681034.5	186347626	212119323.9	82.5712388	93.99076194				2.510806516
Taiwan	Forest	1778716.72	3136861.139	3120991.139	1893536.036	2134433.522	60.67098402	68.3896053	50.49504103	62.50446182		
Taiwan	Shrubland	366528.848	3136861.139	3120991.139	1893536.036	2134433.522	60.67098402	68.3896053	74.06199021	74.06199021		
Taiwan	Grassland	975745.5714	3136861.139	3120991.139	1893536.036	2134433.522	60.67098402	68.3896053	74.19083004	76.98704162		
Taiwan	Unknown	15870	3136861.139	3120991.139	1893536.036	2134433.522	60.67098402	68.3896053				0.505919749

Table S5 continued. Regional breakdown of unmanaged, convertible, and available areas

Region	Land_cover	Cover_area_ha	Unmanaged_area_ha	Convertible_area_ha	Low_avail_area_ha	High_avail_area_ha	Low_avail_percent_convtertible	High_avail_percent_convtertible	Low_avail_cover_percent_convtertible	High_avail_cover_percent_convtertible	Other_percent_unmanaged	Unknown_percent_unmanaged
USA	Forest	188129989.5	708803278.9	654960906.9	425563234.6	453306357.4	64.97536419	69.21120827	70.41599085	77.55947591		
USA	Shrubland	98680730	708803278.9	654960906.9	425563234.6	453306357.4	64.97536419	69.21120827	29.07271697	32.41352467		
USA	Grassland	368150187.5	708803278.9	654960906.9	425563234.6	453306357.4	64.97536419	69.21120827	71.81864306	74.808551		
USA	Other	52672716	708803278.9	654960906.9	425563234.6	453306357.4	64.97536419	69.21120827			7.43121788	
USA	Unknown	1169656	708803278.9	654960906.9	425563234.6	453306357.4	64.97536419	69.21120827				0.165018424

Table S6. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
Africa_Eastern	2050	CORE	Biomass	342.1885043	72.8568424	20.25246544	52.60437696	-13.14984061	-11.726
Africa_Eastern	2050	CORE	Crops	8617.473012	72.8568424	20.25246544	52.60437696	-59.21630761	-7.394
Africa_Eastern	2050	CORE	Forests (Harvested)	1912.020431	72.8568424	20.25246544	52.60437696	-10.59463487	-4.048
Africa_Eastern	2050	CORE	Forests (Unmanaged)	14.11578309	74.52754512	20.25246544	54.27507968	0.038092698	4.195
Africa_Eastern	2050	CORE	Grassland	37721.41595	76.01108614	20.25246544	55.7586207	107.6366169	4.105
Africa_Eastern	2050	CORE	Grazed Pasture	3466.156167	72.8568424	20.25246544	52.60437696	-37.9696579	-6.643
Africa_Eastern	2050	CORE	Shrubland	6692.83803	54.60707816	20.25246544	34.35461273	7.257319499	1.375
Africa_Northern	2050	CORE	Biomass	12.00258334	28.272542	117.6411023	-89.3685603	-2.366652163	-40.66
Africa_Northern	2050	CORE	Crops	3544.654878	28.272542	117.6411023	-89.3685603	-186.0357533	-61.498
Africa_Northern	2050	CORE	Forests (Harvested)	401.6333615	28.272542	117.6411023	-89.3685603	-14.97181746	-34.583
Africa_Northern	2050	CORE	Forests (Unmanaged)	0	0	117.6411023	-117.6411023	0	
Africa_Northern	2050	CORE	Grassland	9034.939096	27.0305137	117.6411023	-90.61058861	243.8349176	33.756
Africa_Northern	2050	CORE	Grazed Pasture	401.50772	28.272542	117.6411023	-89.3685603	-54.50750367	-122.086
Africa_Northern	2050	CORE	Shrubland	677.9884517	44.949075	117.6411023	-72.6920273	12.83829958	23.728
Africa_Southern	2050	CORE	Biomass	283.8798555	83.07716577	8.395678437	74.68148734	0.835643	0.953
Africa_Southern	2050	CORE	Crops	5862.671055	83.07716577	8.395678437	74.68148734	-3.293412895	-0.59
Africa_Southern	2050	CORE	Forests (Harvested)	845.0923362	83.07716577	8.395678437	74.68148734	-0.321455326	-0.279
Africa_Southern	2050	CORE	Forests (Unmanaged)	6086.064943	89.95533578	8.395678437	81.55965735	0.371042964	0.078
Africa_Southern	2050	CORE	Grassland	47218.86553	85.07785799	8.395678437	76.68217955	3.143947622	0.084
Africa_Southern	2050	CORE	Grazed Pasture	892.5757131	83.07716577	8.395678437	74.68148734	-0.718396941	-0.529
Africa_Southern	2050	CORE	Shrubland	3967.030283	48.36615833	8.395678437	39.9704799	-0.310846718	-0.095
Africa_Western	2050	CORE	Biomass	1008.222696	86.99710961	20.42040282	66.57670679	-21.74748289	-6.986
Africa_Western	2050	CORE	Crops	16705.58547	86.99710961	20.42040282	66.57670679	-48.93788267	-3.012
Africa_Western	2050	CORE	Forests (Harvested)	2521.794228	86.99710961	20.42040282	66.57670679	-4.632885194	-1.249
Africa_Western	2050	CORE	Forests (Unmanaged)	24169.62155	90.89550783	20.42040282	70.47510501	5.241918757	0.284
Africa_Western	2050	CORE	Grassland	54105.89803	87.39299891	20.42040282	66.97259609	76.40563315	1.959
Africa_Western	2050	CORE	Grazed Pasture	1733.874486	86.99710961	20.42040282	66.57670679	-13.08663991	-4.137
Africa_Western	2050	CORE	Shrubland	3240.907714	51.27699257	20.42040282	30.85658975	17.74563138	6.962
Argentina	2050	CORE	Biomass	67.84482609	55.74938595	18.08097072	37.66841523	-1.103371703	-3.769
Argentina	2050	CORE	Crops	5752.918329	55.74938595	18.08097072	37.66841523	-16.00539318	-3.134
Argentina	2050	CORE	Forests (Harvested)	121.676307	55.74938595	18.08097072	37.66841523	-0.158216785	-1.305
Argentina	2050	CORE	Forests (Unmanaged)	1648.681499	77.00040212	18.08097072	58.9194314	0.45229066	0.343
Argentina	2050	CORE	Grassland	20236.76122	50.61867072	18.08097072	32.5377	21.32436102	1.321
Argentina	2050	CORE	Grazed Pasture	1272.38919	55.74938595	18.08097072	37.66841523	-2.499997288	-1.883
Argentina	2050	CORE	Shrubland	2066.590832	89.15160248	18.08097072	71.07063176	0.396583411	0.239
Australia_NZ	2050	CORE	Biomass	125.3161234	55.66811119	0.935757773	54.73235342	-0.026768344	-0.059
Australia_NZ	2050	CORE	Crops	6293.392762	55.66811119	0.935757773	54.73235342	-0.849727056	-0.154
Australia_NZ	2050	CORE	Forests (Harvested)	636.5589141	55.66811119	0.935757773	54.73235342	-0.010850111	-0.016
Australia_NZ	2050	CORE	Forests (Unmanaged)	1909.071942	54.68380177	0.935757773	53.748044	0.068970551	0.045
Australia_NZ	2050	CORE	Grassland	55676.84294	66.12616977	0.935757773	65.190412	0.450499993	0.01

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
Australia_NZ	2050	CORE	Grazed Pasture	2600.801788	55.66811119	0.935757773	54.73235342	0.196433897	0.065
Australia_NZ	2050	CORE	Shrubland	27572.01056	34.45678386	0.935757773	33.52102609	-0.1816216	-0.008
Brazil	2050	CORE	Biomass	189.866062	80.45034915	6.994999107	73.45535004	-0.342117453	-0.565
Brazil	2050	CORE	Crops	10897.51472	80.45034915	6.994999107	73.45535004	-4.274818765	-0.437
Brazil	2050	CORE	Forests (Harvested)	1670.092971	80.45034915	6.994999107	73.45535004	-0.137130055	-0.085
Brazil	2050	CORE	Forests (Unmanaged)	46820.98514	73.3673991	6.994999107	66.37239999	-0.369356007	-0.01
Brazil	2050	CORE	Grassland	28731.91025	90.30705906	6.994999107	83.31205995	5.057248818	0.228
Brazil	2050	CORE	Grazed Pasture	5687.045962	80.45034915	6.994999107	73.45535004	-2.127741203	-0.359
Brazil	2050	CORE	Shrubland	6756.593634	86.90584717	6.994999107	79.91084806	0.016318379	0.003
Canada	2050	CORE	Biomass	299.4386572	29.18413186	14.86344407	14.32068779	-38.87008916	-38.767
Canada	2050	CORE	Crops	5903.445188	29.18413186	14.86344407	14.32068779	-68.09004091	-13.382
Canada	2050	CORE	Forests (Harvested)	2527.245777	29.18413186	14.86344407	14.32068779	-10.27905606	-4.002
Canada	2050	CORE	Forests (Unmanaged)	45898.0307	36.96518432	14.86344407	22.10174024	44.61562927	1.205
Canada	2050	CORE	Grassland	15009.87087	24.49377423	14.86344407	9.630330162	43.53842565	3.56
Canada	2050	CORE	Grazed Pasture	307.6020063	29.18413186	14.86344407	14.32068779	0.087310807	0.25
Canada	2050	CORE	Shrubland	10567.22658	1.849705609	14.86344407	-13.01373846	20.17920279	2.287
Central America and Caribbean	2050	CORE	Biomass	36.76216781	76.14924048	7.391868867	68.75737161	0.000149275	0.001
Central America and Caribbean	2050	CORE	Crops	1686.864404	76.14924048	7.391868867	68.75737161	-1.046062751	-0.742
Central America and Caribbean	2050	CORE	Forests (Harvested)	363.572111	76.14924048	7.391868867	68.75737161	-0.084478721	-0.223
Central America and Caribbean	2050	CORE	Forests (Unmanaged)	3430.734667	70.46199647	7.391868867	63.07012761	0.763549765	0.281
Central America and Caribbean	2050	CORE	Grassland	2316.086127	84.6849175	7.391868867	77.29304863	0.692677568	0.396
Central America and Caribbean	2050	CORE	Grazed Pasture	411.0713399	76.14924048	7.391868867	68.75737161	-0.333921999	-0.748
Central America and Caribbean	2050	CORE	Shrubland	53.97057289	68.2723453	7.391868867	60.88047644	0.010124495	0.234
Central Asia	2050	CORE	Biomass	85.03496232	33.43433183	15.59598061	17.83835122	-2.71167261	-6.43
Central Asia	2050	CORE	Crops	4432.862393	33.43433183	15.59598061	17.83835122	-37.56758062	-9.783
Central Asia	2050	CORE	Forests (Harvested)	84.44813373	33.43433183	15.59598061	17.83835122	-0.422030799	-5.041
Central Asia	2050	CORE	Forests (Unmanaged)	363.528349	60.19669982	15.59598061	44.60071921	0.152148813	0.518
Central Asia	2050	CORE	Grassland	50500.44651	35.040668	15.59598061	19.44468738	30.5846756	0.739
Central Asia	2050	CORE	Grazed Pasture	862.9541039	33.43433183	15.59598061	17.83835122	0.612707529	0.639
Central Asia	2050	CORE	Shrubland	7227.84614	20.79034384	15.59598061	5.194363226	29.62575491	4.932
China	2050	CORE	Biomass	31.15726203	54.66944487	29.77707251	24.89237236	-2.140708977	-10.126
China	2050	CORE	Crops	14954.39678	54.66944487	29.77707251	24.89237236	-32.55221678	-2.707
China	2050	CORE	Forests (Harvested)	3619.783824	54.66944487	29.77707251	24.89237236	-9.490375884	-2.964

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
China	2050	CORE	Forests (Unmanaged)	13229.73172	89.5998001	29.77707251	59.8227276	2.065741352	0.191
China	2050	CORE	Grassland	52385.83261	47.85201932	29.77707251	18.07494682	133.6498663	3.082
China	2050	CORE	Grazed Pasture	6450.981615	54.66944487	29.77707251	24.89237236	-41.19615179	-6.95
China	2050	CORE	Shrubland	6919.137473	39.44911229	29.77707251	9.672039782	19.54442567	3.394
Colombia	2050	CORE	Biomass	4.343355059	78.9022209	7.276852115	71.62536879	-0.007187083	-0.402
Colombia	2050	CORE	Crops	436.2841601	78.9022209	7.276852115	71.62536879	-0.018006767	-0.043
Colombia	2050	CORE	Forests (Harvested)	87.724325	78.9022209	7.276852115	71.62536879	-0.006322129	-0.067
Colombia	2050	CORE	Forests (Unmanaged)	7011.885498	77.33950349	7.276852115	70.06265138	-0.074049247	-0.013
Colombia	2050	CORE	Grassland	5294.021602	81.52933245	7.276852115	74.25248034	0.167839096	0.04
Colombia	2050	CORE	Grazed Pasture	543.6413	78.9022209	7.276852115	71.62536879	-0.069421169	-0.107
Colombia	2050	CORE	Shrubland	171.731998	60.88694259	7.276852115	53.61009048	-0.001944528	-0.014
EU-12	2050	CORE	Biomass	175.7927582	82.88978639	21.98227345	60.90751293	-2.741744596	-5.21
EU-12	2050	CORE	Crops	4389.585804	82.88978639	21.98227345	60.90751293	-7.528253578	-1.98
EU-12	2050	CORE	Forests (Harvested)	1408.40351	82.88978639	21.98227345	60.90751293	-1.459482427	-1.164
EU-12	2050	CORE	Forests (Unmanaged)	2873.3044	80.61685407	21.98227345	58.63458062	5.849136678	2.766
EU-12	2050	CORE	Grassland	3712.018612	84.66473228	21.98227345	62.68245883	6.163859089	2.236
EU-12	2050	CORE	Grazed Pasture	89.59960977	82.88978639	21.98227345	60.90751293	-0.158560832	-1.771
EU-12	2050	CORE	Shrubland	50.06095873	82.60264139	21.98227345	60.62036794	0.045611921	1.164
EU-15	2050	CORE	Biomass	1132.815861	70.87481267	-11.38230383	82.2571165	0.521992065	0.232
EU-15	2050	CORE	Crops	9269.149488	70.87481267	-11.38230383	82.2571165	0.093053869	0.012
EU-15	2050	CORE	Forests (Harvested)	4356.346727	70.87481267	-11.38230383	82.2571165	0.071138545	0.018
EU-15	2050	CORE	Forests (Unmanaged)	6525.454631	71.57099424	-11.38230383	82.95329807	-0.140621101	-0.031
EU-15	2050	CORE	Grassland	12587.14849	71.25444135	-11.38230383	82.63674518	-0.082153544	-0.009
EU-15	2050	CORE	Grazed Pasture	0	70.87481267	-11.38230383	82.2571165		
EU-15	2050	CORE	Shrubland	2857.697168	67.46402495	-11.38230383	78.84632879	-0.021737904	-0.009
Europe_Eastern	2050	CORE	Biomass	79.42599711	89.38864943	39.37647592	50.01217352	-2.50591466	-6.535
Europe_Eastern	2050	CORE	Crops	4932.642187	89.38864943	39.37647592	50.01217352	-7.602347985	-1.856
Europe_Eastern	2050	CORE	Forests (Harvested)	405.6137283	89.38864943	39.37647592	50.01217352	0.150774488	0.412
Europe_Eastern	2050	CORE	Forests (Unmanaged)	1962.590896	87.49011196	39.37647592	48.11363605	4.682438997	3.203
Europe_Eastern	2050	CORE	Grassland	2111.79642	91.22133098	39.37647592	51.84485506	5.264679595	3.357
Europe_Eastern	2050	CORE	Grazed Pasture	207.9816327	89.38864943	39.37647592	50.01217352	-0.157926037	-0.753
Europe_Eastern	2050	CORE	Shrubland	50.63264616	86.42810451	39.37647592	47.05162859	0.122326244	3.109
Europe_Non_EU	2050	CORE	Biomass	70.95225269	86.21001145	29.97778316	56.23222829	-1.814734931	-6.212
Europe_Non_EU	2050	CORE	Crops	3651.132733	86.21001145	29.97778316	56.23222829	-8.768330203	-2.746
Europe_Non_EU	2050	CORE	Forests (Harvested)	508.495687	86.21001145	29.97778316	56.23222829	-0.669069601	-1.33
Europe_Non_EU	2050	CORE	Forests (Unmanaged)	1733.450909	85.21199763	29.97778316	55.23421447	3.542041208	2.742
Europe_Non_EU	2050	CORE	Grassland	5033.965693	86.57333714	29.97778316	56.59555398	7.793965886	2.016
Europe_Non_EU	2050	CORE	Grazed Pasture	323.4355339	86.21001145	29.97778316	56.23222829	-0.949626836	-2.927
Europe_Non_EU	2050	CORE	Shrubland	902.2834541	86.1119907	29.97778316	56.13420754	0.870174395	1.217

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
European Free Trade Association	2050	CORE	Biomass	168.6186534	52.64295705	5.528594304	47.11436275	-1.878544195	-4.576
European Free Trade Association	2050	CORE	Crops	158.7645426	52.64295705	5.528594304	47.11436275	-0.459644661	-3.811
European Free Trade Association	2050	CORE	Forests (Harvested)	269.0015091	52.64295705	5.528594304	47.11436275	-0.368783217	-1.49
European Free Trade Association	2050	CORE	Forests (Unmanaged)	1392.359913	65.91248749	5.528594304	60.38389318	1.166557724	1.264
European Free Trade Association	2050	CORE	Grassland	1150.47864	38.99805877	5.528594304	33.46946447	1.895385854	2.135
European Free Trade Association	2050	CORE	Grazed Pasture	134.298519	52.64295705	5.528594304	47.11436275	-0.148822072	-1.09
European Free Trade Association	2050	CORE	Shrubland	66.40881607	1.704969689	5.528594304	-3.823624615	0.203793434	3.549
Global	2050	CORE	Biomass	6127.554764	60.17297748	15.74962665	44.42335082	-193.6125414	-10.448
Global	2050	CORE	Crops	192984.6056	60.17297748	15.74962665	44.42335082	-545.0970199	-3.21
Global	2050	CORE	Forests (Harvested)	37367.38171	60.17297748	15.74962665	44.42335082	-64.75111933	-1.679
Global	2050	CORE	Forests (Unmanaged)	319988.8364	64.84509485	15.74962665	49.0954682	199.8467592	0.782
Global	2050	CORE	Grassland	590634.0966	63.10297475	15.74962665	47.3533481	557.6419697	1.201
Global	2050	CORE	Grazed Pasture	33220.64189	60.17297748	15.74962665	44.42335082	-137.5146602	-3.515
Global	2050	CORE	Shrubland	140548.459	36.99808044	15.74962665	21.24845379	169.930421	1.478
India	2050	CORE	Biomass	147.918312	84.54436512	47.92787331	36.61649181	-9.715417885	-20.612
India	2050	CORE	Crops	20631.68554	84.54436512	47.92787331	36.61649181	-156.8485077	-8.615
India	2050	CORE	Forests (Harvested)	3058.672734	84.54436512	47.92787331	36.61649181	-31.19021415	-9.184
India	2050	CORE	Forests (Unmanaged)	4610.050756	88.58385369	47.92787331	40.65598037	85.37295805	30.73
India	2050	CORE	Grassland	4732.95147	82.1755467	47.92787331	34.24767339	80.93229095	26.234
India	2050	CORE	Grazed Pasture	180.2415884	84.54436512	47.92787331	36.61649181	-3.826757706	-17.9
India	2050	CORE	Shrubland	2355.807439	81.200283	47.92787331	33.27240969	33.79662126	20.936
Indonesia	2050	CORE	Biomass	40.44372533	81.3058071	15.26796788	66.03783922	-0.323947675	-1.355
Indonesia	2050	CORE	Crops	5615.69505	81.3058071	15.26796788	66.03783922	-5.611300656	-1.172
Indonesia	2050	CORE	Forests (Harvested)	858.353027	81.3058071	15.26796788	66.03783922	-0.343524779	-0.384
Indonesia	2050	CORE	Forests (Unmanaged)	12043.95187	83.19110719	15.26796788	67.92313931	4.052467378	0.423
Indonesia	2050	CORE	Grassland	3360.937354	74.6164295	15.26796788	59.34846162	3.162966872	1.207
Indonesia	2050	CORE	Grazed Pasture	338.5750171	81.3058071	15.26796788	66.03783922	-0.768234965	-1.831
Japan	2050	CORE	Biomass	59.4635291	66.18617567	-4.509871848	70.69604752	0.5073148	3.349
Japan	2050	CORE	Crops	499.5116793	66.18617567	-4.509871848	70.69604752	-0.018117478	-0.047
Japan	2050	CORE	Forests (Harvested)	210.066557	66.18617567	-4.509871848	70.69604752	-0.014748821	-0.087
Japan	2050	CORE	Forests (Unmanaged)	2681.447819	67.83953701	-4.509871848	72.34940886	-0.008757029	-0.004
Japan	2050	CORE	Grassland	588.442031	64.26200247	-4.509871848	68.77187432	-0.004990388	-0.01
Japan	2050	CORE	Grazed Pasture	0	66.18617567	-4.509871848	70.69604752		

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
Japan	2050	CORE	Shrubland	379.1770583	57.40971839	-4.509871848	61.91959023	-0.004994004	-0.016
Mexico	2050	CORE	Biomass	93.87897252	79.68360351	12.98376149	66.69984203	-0.014423392	-0.033
Mexico	2050	CORE	Crops	2825.863713	79.68360351	12.98376149	66.69984203	-3.218255388	-1.321
Mexico	2050	CORE	Forests (Harvested)	347.2903536	79.68360351	12.98376149	66.69984203	-0.141000584	-0.397
Mexico	2050	CORE	Forests (Unmanaged)	4640.750189	84.47809222	12.98376149	71.49433074	0.66623491	0.181
Mexico	2050	CORE	Grassland	10262.24303	80.08809607	12.98376149	67.10433458	3.259294379	0.411
Mexico	2050	CORE	Grazed Pasture	1406.469486	79.68360351	12.98376149	66.69984203	-0.904607657	-0.585
Mexico	2050	CORE	Shrubland	3474.524035	72.05200934	12.98376149	59.06824785	0.202305617	0.072
Middle East	2050	CORE	Biomass	25.7431949	41.76786743	23.88253077	17.88533665	-4.281907487	-19.555
Middle East	2050	CORE	Crops	4265.858014	41.76786743	23.88253077	17.88533665	-44.63541462	-11.521
Middle East	2050	CORE	Forests (Harvested)	27.5454093	41.76786743	23.88253077	17.88533665	-0.28618132	-9.127
Middle East	2050	CORE	Forests (Unmanaged)	92.05426255	61.44052953	23.88253077	37.55799876	0.217255463	2.983
Middle East	2050	CORE	Grassland	25984.07797	42.74211873	23.88253077	18.85958796	36.63709348	1.742
Middle East	2050	CORE	Grazed Pasture	427.5920323	41.76786743	23.88253077	17.88533665	0.752239781	1.397
Middle East	2050	CORE	Shrubland	10189.21995	39.09500623	23.88253077	15.21247546	7.999050556	0.952
Pakistan	2050	CORE	Biomass	8.227450179	75.42325024	53.01547446	22.40777579	-0.210681867	-7.171
Pakistan	2050	CORE	Crops	2608.8611	75.42325024	53.01547446	22.40777579	-31.25073718	-15.531
Pakistan	2050	CORE	Forests (Harvested)	304.1259	75.42325024	53.01547446	22.40777579	-3.13693559	-8.742
Pakistan	2050	CORE	Forests (Unmanaged)	1.657473931	95.61118127	53.01547446	42.59570681	0.020910528	26.457
Pakistan	2050	CORE	Grassland	199.2656999	62.47496096	53.01547446	9.459486498	5.191858589	36.433
Pakistan	2050	CORE	Grazed Pasture	777.664064	75.42325024	53.01547446	22.40777579	-26.53135324	-22.533
Pakistan	2050	CORE	Shrubland	2765.525212	76.35717208	53.01547446	23.34169763	56.12203718	30.612
Russia	2050	CORE	Biomass	1145.497398	28.23556258	17.65766227	10.57790031	-134.6168623	-46.466
Russia	2050	CORE	Crops	14246.2105	28.23556258	17.65766227	10.57790031	-279.9948695	-24.171
Russia	2050	CORE	Forests (Harvested)	3126.436651	28.23556258	17.65766227	10.57790031	12.99325605	4.765
Russia	2050	CORE	Forests (Unmanaged)	58802.37916	32.48770422	17.65766227	14.83004195	179.6107127	3.737
Russia	2050	CORE	Grassland	55406.76124	32.5156833	17.65766227	14.85802103	114.6457533	2.531
Russia	2050	CORE	Grazed Pasture	500.9602013	28.23556258	17.65766227	10.57790031	3.368355096	7.214
Russia	2050	CORE	Shrubland	24703.7691	8.405789675	17.65766227	-9.251872595	142.4492521	6.927
South Africa	2050	CORE	Biomass	10.53739403	73.46503867	23.89639737	49.5686413	0.091795995	2.131
South Africa	2050	CORE	Crops	1177.246655	73.46503867	23.89639737	49.5686413	-2.927233295	-2.719
South Africa	2050	CORE	Forests (Harvested)	181.575503	73.46503867	23.89639737	49.5686413	-0.158505252	-0.862
South Africa	2050	CORE	Forests (Unmanaged)	85.58751983	94.78823249	23.89639737	70.89183512	0.053920017	0.833
South Africa	2050	CORE	Grassland	11280.40782	73.67745405	23.89639737	49.78105668	5.753717947	0.644
South Africa	2050	CORE	Grazed Pasture	1085.92055	73.46503867	23.89639737	49.5686413	-2.821474666	-2.296
South Africa	2050	CORE	Shrubland	682.3744586	67.20890938	23.89639737	43.31251201	-0.099766735	-0.179
South America_Northern	2050	CORE	Biomass	6.796375813	61.21557563	-12.39195159	73.60752722	1.119550477	36.452
South America_Northern	2050	CORE	Crops	465.7202489	61.21557563	-12.39195159	73.60752722	-0.005091632	-0.013

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
South America_Northern	2050	CORE	Forests (Harvested)	41.97719618	61.21557563	-12.39195159	73.60752722	-0.026086005	-0.588
South America_Northern	2050	CORE	Forests (Unmanaged)	10809.42024	54.06252901	-12.39195159	66.45448059	0.000229023	0
South America_Northern	2050	CORE	Grassland	4317.956378	79.38898149	-12.39195159	91.78093308	-1.93E-05	0
South America_Northern	2050	CORE	Grazed Pasture	257.9830861	61.21557563	-12.39195159	73.60752722	-0.057379099	-0.187
South America_Northern	2050	CORE	Shrubland	105.3135129	53.92768174	-12.39195159	66.31963333	-0.000254913	-0.003
South America_Southern	2050	CORE	Biomass	32.65078629	79.35451612	14.83480946	64.51970666	-0.05701067	-0.385
South America_Southern	2050	CORE	Crops	2805.897709	79.35451612	14.83480946	64.51970666	-0.595504959	-0.234
South America_Southern	2050	CORE	Forests (Harvested)	704.5153323	79.35451612	14.83480946	64.51970666	-0.124297422	-0.172
South America_Southern	2050	CORE	Forests (Unmanaged)	16106.59353	84.85335746	14.83480946	70.018548	-0.011948951	-0.001
South America_Southern	2050	CORE	Grassland	18459.90557	74.59789093	14.83480946	59.76308148	1.059711809	0.071
South America_Southern	2050	CORE	Grazed Pasture	872.9317476	79.35451612	14.83480946	64.51970666	-0.087628817	-0.091
South America_Southern	2050	CORE	Shrubland	1808.04095	79.11509932	14.83480946	64.28028987	-0.030585327	-0.021
South Asia	2050	CORE	Biomass	5.1029123	50.22032371	21.70020588	28.52011783	-0.950958721	-28.529
South Asia	2050	CORE	Crops	2412.95475	50.22032371	21.70020588	28.52011783	-32.48635028	-15.89
South Asia	2050	CORE	Forests (Harvested)	457.5320871	50.22032371	21.70020588	28.52011783	-3.822387081	-7.231
South Asia	2050	CORE	Forests (Unmanaged)	1260.774695	66.46034192	21.70020588	44.76013605	6.781195438	7.501
South Asia	2050	CORE	Grassland	4393.253064	45.03456518	21.70020588	23.3343593	60.19355499	18.036
South Asia	2050	CORE	Grazed Pasture	883.4319077	50.22032371	21.70020588	28.52011783	-31.55615894	-28.703
South Asia	2050	CORE	Shrubland	1791.783447	51.68089796	21.70020588	29.98069208	8.611394582	6.195
South Korea	2050	CORE	Biomass	0.651472477	76.73610088	12.23215769	64.50394319	-0.005345996	-1.949
South Korea	2050	CORE	Crops	197.2450446	76.73610088	12.23215769	64.50394319	0.046802615	0.299
South Korea	2050	CORE	Forests (Harvested)	58.61572	76.73610088	12.23215769	64.50394319	0.020965033	0.409
South Korea	2050	CORE	Forests (Unmanaged)	311.8569761	77.31987437	12.23215769	65.08771669	-0.021062147	-0.081
South Korea	2050	CORE	Grassland	115.4659624	73.75235824	12.23215769	61.52020055	-0.009962461	-0.103
South Korea	2050	CORE	Grazed Pasture	6.49263	76.73610088	12.23215769	64.50394319	0.008002276	1.301
South Korea	2050	CORE	Shrubland	486.8976122	77.068687	12.23215769	64.83652931	-0.039380045	-0.097
Southeast Asia	2050	CORE	Biomass	91.67215662	82.5712388	15.39575541	67.17548338	-1.04337864	-3.135
Southeast Asia	2050	CORE	Crops	9142.444553	82.5712388	15.39575541	67.17548338	-5.960039523	-0.745

Table S6 continued. Regional and land type breakdown of available areas and 2050 changes needed to meet protection goal, based on marginal changes in land allocation in 2050 due to decreases in availability

region	year	policy	agg.land	hist_value_thkm2	low_avail_percent_conv	needed_percent_conv	final_avail_percent_conv	area_change_via_protection_thkm2	percent_change_via_protection
Southeast Asia	2050	CORE	Forests (Harvested)	1483.620706	82.5712388	15.39575541	67.17548338	-0.626832001	-0.406
Southeast Asia	2050	CORE	Forests (Unmanaged)	21095.55106	82.42727465	15.39575541	67.03151924	7.28460886	0.435
Southeast Asia	2050	CORE	Grassland	5199.72297	83.48285745	15.39575541	68.08710204	1.741248439	0.42
Southeast Asia	2050	CORE	Grazed Pasture	513.3643974	82.5712388	15.39575541	67.17548338	-1.518334364	-3.005
Southeast Asia	2050	CORE	Shrubland	174.964261	72.89723603	15.39575541	57.50148062	0.110891799	0.792
Taiwan	2050	CORE	Biomass	0.123298934	58.51755737	1.089323667	57.4282337	8.42E-05	0.06
Taiwan	2050	CORE	Crops	57.58224798	58.51755737	1.089323667	57.4282337	0.001787946	0.038
Taiwan	2050	CORE	Forests (Harvested)	10.08519219	58.51755737	1.089323667	57.4282337	0.000513385	0.057
Taiwan	2050	CORE	Forests (Unmanaged)	213.4164368	50.49504103	1.089323667	49.40571736	-0.002693776	-0.015
Taiwan	2050	CORE	Grassland	108.3758071	74.19083004	1.089323667	73.10150637	-0.001045144	-0.012
Taiwan	2050	CORE	Grazed Pasture	7.090474927	58.51755737	1.089323667	57.4282337	0.001663082	0.242
Taiwan	2050	CORE	Shrubland	0.844816016	74.06199021	1.089323667	72.97266655	-4.08E-06	-0.006
USA	2050	CORE	Biomass	345.1852079	64.97536419	11.11069666	53.86466753	-3.366928763	-2.626
USA	2050	CORE	Crops	18542.49093	64.97536419	11.11069666	53.86466753	-28.95678144	-1.713
USA	2050	CORE	Forests (Harvested)	4757.465461	64.97536419	11.11069666	53.86466753	-2.006360466	-0.432
USA	2050	CORE	Forests (Unmanaged)	22163.73186	70.41599085	11.11069666	59.30529419	7.905149919	0.454
USA	2050	CORE	Grassland	43396.03158	71.81864306	11.11069666	60.7079464	18.61646666	0.547
USA	2050	CORE	Grazed Pasture	576.0080174	64.97536419	11.11069666	53.86466753	0.192724901	0.323
USA	2050	CORE	Shrubland	11789.26186	29.07271697	11.11069666	17.96202031	6.772031983	0.692