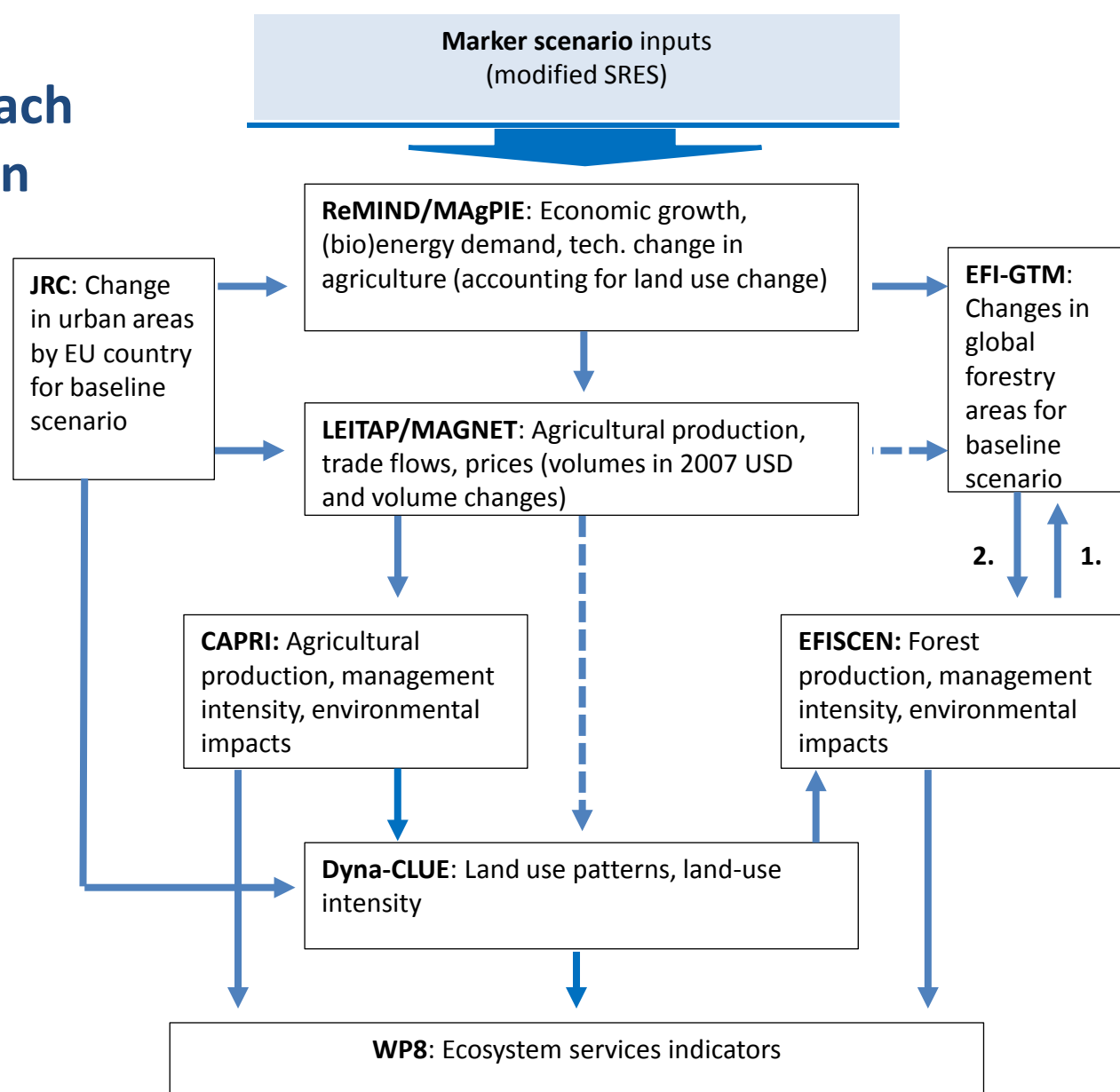# VISIONS OF LAND USE TRANSITIONS IN EUROPE

Integrated Assessment Modelling of Land use transitions

H. Lotze-Campen, P. Verburg, A. Popp, A. Tabeau, J. Helming, M. Lindner, E. v.d. Zanden, H. Verkerk, C. Lavalle, et al.

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VOLANTE Top-Down Modelling (WP7): Objectives

- Enable integrative land system change assessment by integrating land use models across different sectors and spatial scales (from global to sub-national)

- Integrate impacts of policy parameters such as taxes, land use regulations and international trade policies on land system change

- Understand and explore the interactions between land-use relevant sectors

- Integrate land management information in spatial land allocation models for Europe.

WP7: modelling approach and model interaction

Marker scenario inputs
(modified SRES)

ReMIND/MAgPIE: Economic growth, (bio)energy demand, tech. change in agriculture (accounting for land use change)

JRC: Change in urban areas by EU country for baseline scenario

EFI-GTM: Changes in global forestry areas for baseline scenario

LEITAP/MAGNET: Agricultural production, trade flows, prices (volumes in 2007 USD and volume changes)

2.   **1.**

CAPRI: Agricultural production, management intensity, environmental impacts

EFISCEN: Forest production, management intensity, environmental impacts

Dyna-CLUE: Land use patterns, land-use intensity

WP8: Ecosystem services indicators

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Modified SRES scenario narratives for VOLANTE

- **V-A1**: A globalised world with strong economic growth, high growth of food and feed demand, weak regulation on land use change, declining tropical forest areas, fully liberalized CAP, phased-out bioenergy mandates.

- **V-A2**: A fragmented world with modest economic growth, high population growth, high growth of food and feed demand, weak regulation on land use change, declining tropical forest areas, no change in CAP, phased-out bioenergy mandates.

- **V-B1**: A sustainable world with modest economic growth, slow growth of food and feed demand, strong regulation on land use change, protected tropical forest areas, liberalized CAP, modest bioenergy demand.

- **V-B2**: A fragmented world with modest economic growth, modest growth of food and feed demand, some regulation on land use change, some protection of tropical forest areas, no change in CAP, modest bioenergy demand.

Modified SRES scenario framework for VOLANTE

Global

Less Intervention

More Intervention

Local

|	V-A1	V-A2	V-B1	V-B2
Population	9 billion people in 2050, 7 billion in 2100	15 billion people in 2100	9 billion people in 2050, 7 billion in 2100	10 billion people in 2100
Trade	Trade liberalisation	Continuous trade patterns	Trade liberalisation	Highly regionally self-sufficient
Food Demand	Increasing demand per capita for calories & livestock products (linked to income growth)	Increasing demand per capita for calories & livestock products (linked to income growth)	Equal per capita consumption around the world, sustainable diet ("contraction and convergence")	Increasing demand per capita for calories & livestock products (related to income growth)
Land-Use	Weak regulation, e.g. declining intact forest area	Weak regulation, e.g. declining intact forest area	Global land use regulation for climate mitigation, forest protection & biodiversity conservation (constant intact forest area)	Regionally specific land use regulation for climate mitigation, forest protection & biodiversity conservation (constant/declining intact forest area)
Bioenergy	Bioenergy (global supply) for baseline use [no global agreement on CC mitigation]; biofuel targets phased out	Bioenergy (regional supply) for baseline use [no global agreement on CC mitigation]; biofuel targets phased out	Bioenergy (global supply) for CC mitigation [global agreement on CC mitigation]; medium bioenergy shares	Bioenergy (regional supply) for baseline [regional agreements on CC mitigation]; medium bioenergy shares
Climate Change	Medium level of emissions (CC: ca. +3C in 2100); medium climate impacts	High level of emissions (CC: GMT ca. +4C in 2100); medium climate impacts	Low Level of Emisions (CC: ca. +2C in 2100); medium climate impacts	Low to medium level of emissions; medium climate impacts
CAP reform	Fully liberalized: full abolition of Pillar 1 and 2. CAP budget will be zero.	No change. CAP budget constant.	Abolition Pillar 1, 33% of the reduced Pillar 1 budget shift to pillar 2 (linked to environmental and social targets)	33% of Pillar 1 budget will be shifted to pillar 2 (linked to environmental and social targets)

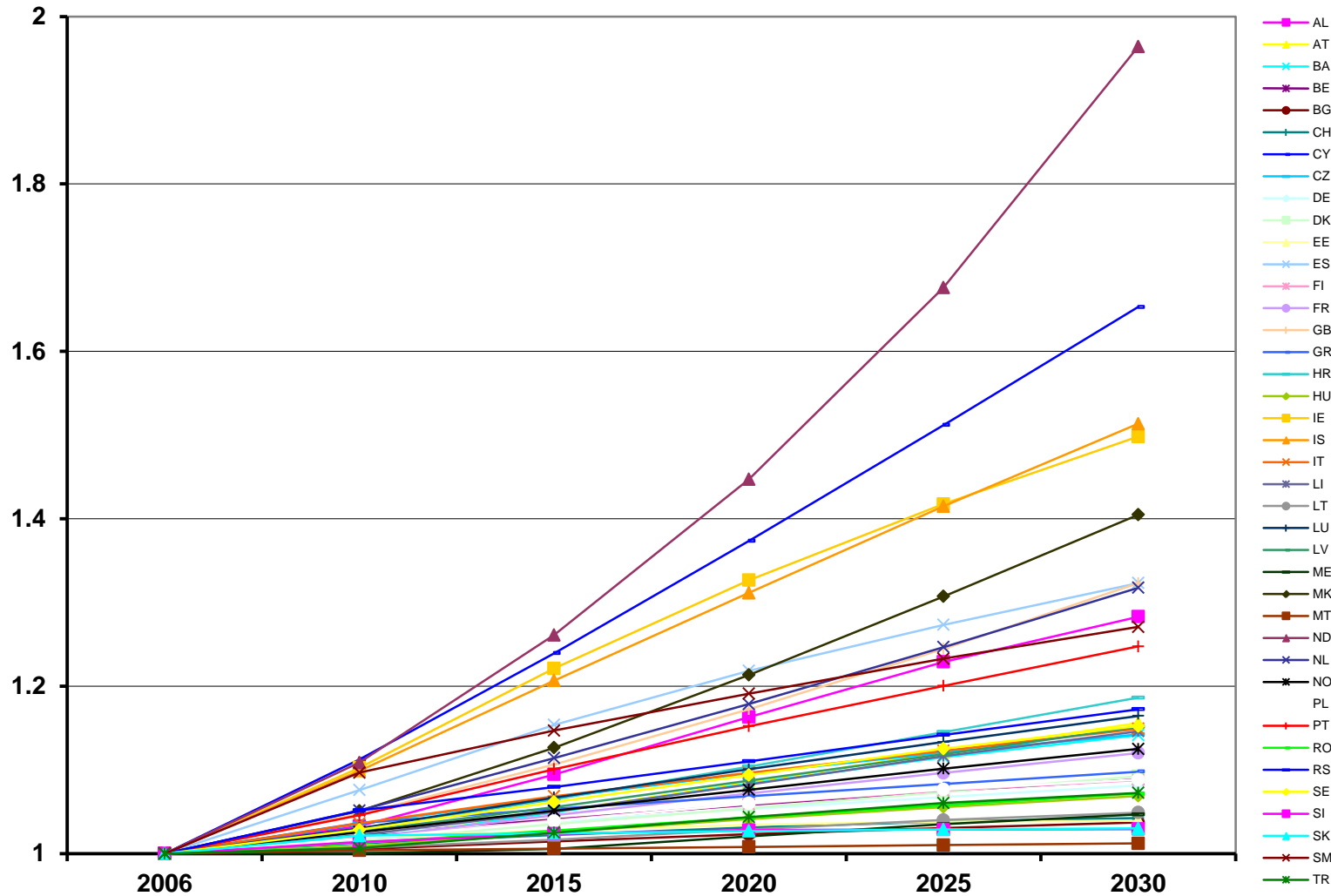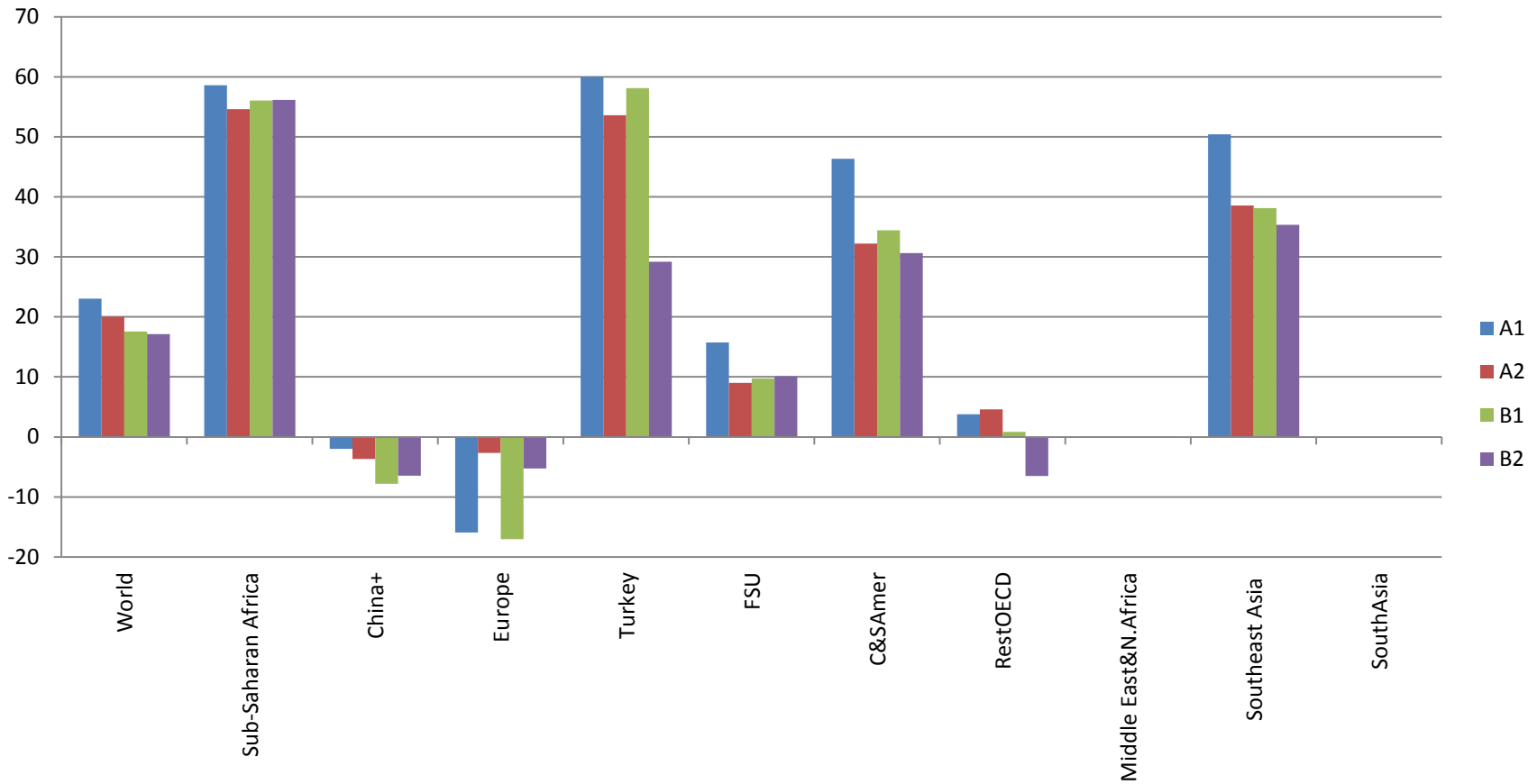# Marker scenario results for VOLANTE

Exogenous driver: Population (PIK)
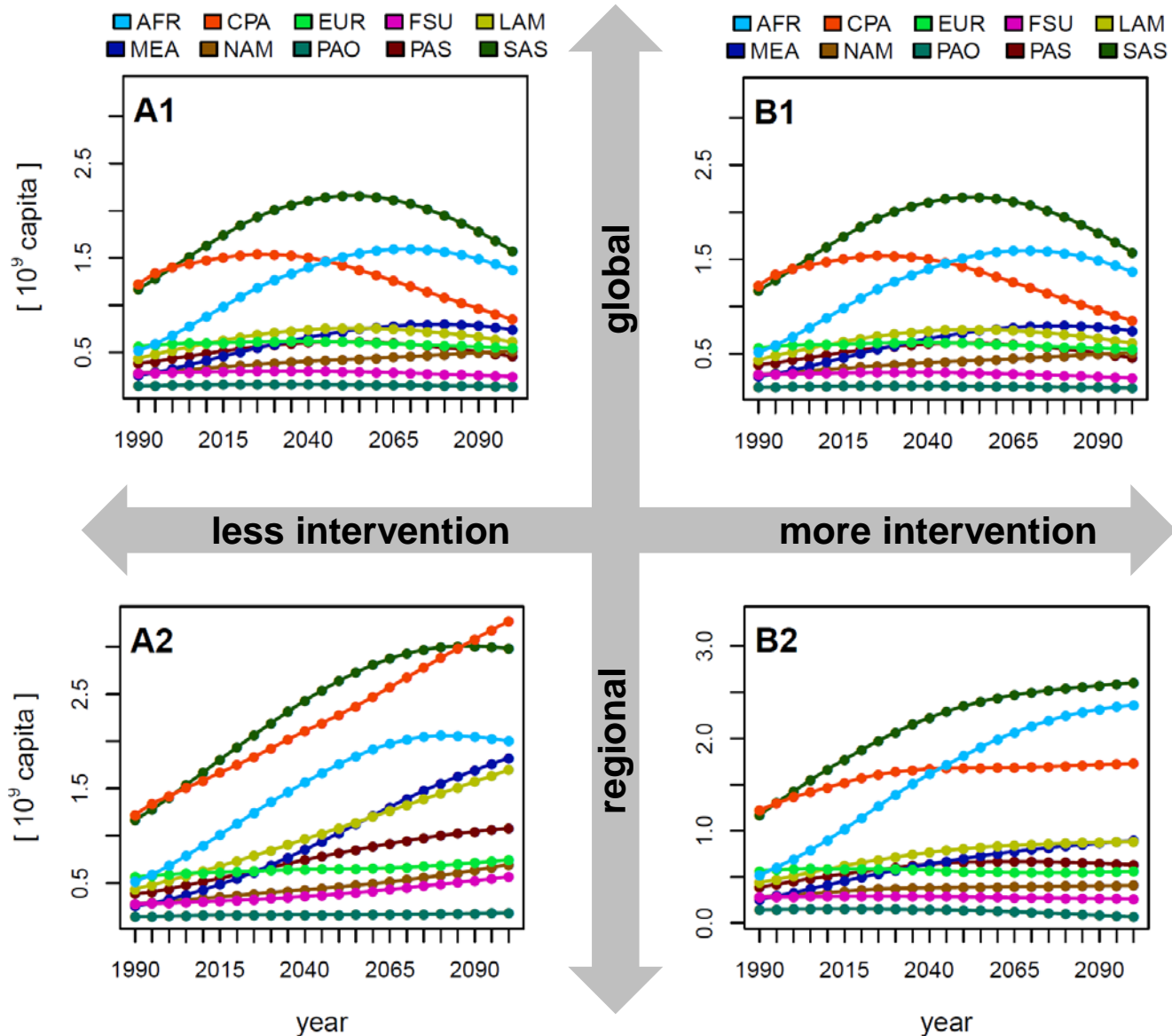
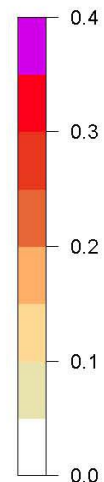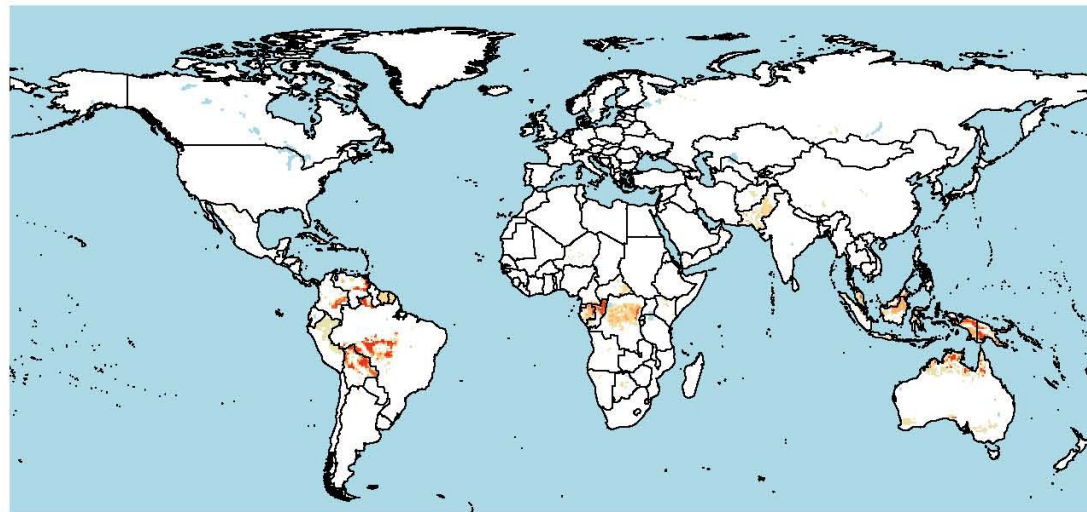# GDP projections (ReMIND/MAgPIE, PIK)
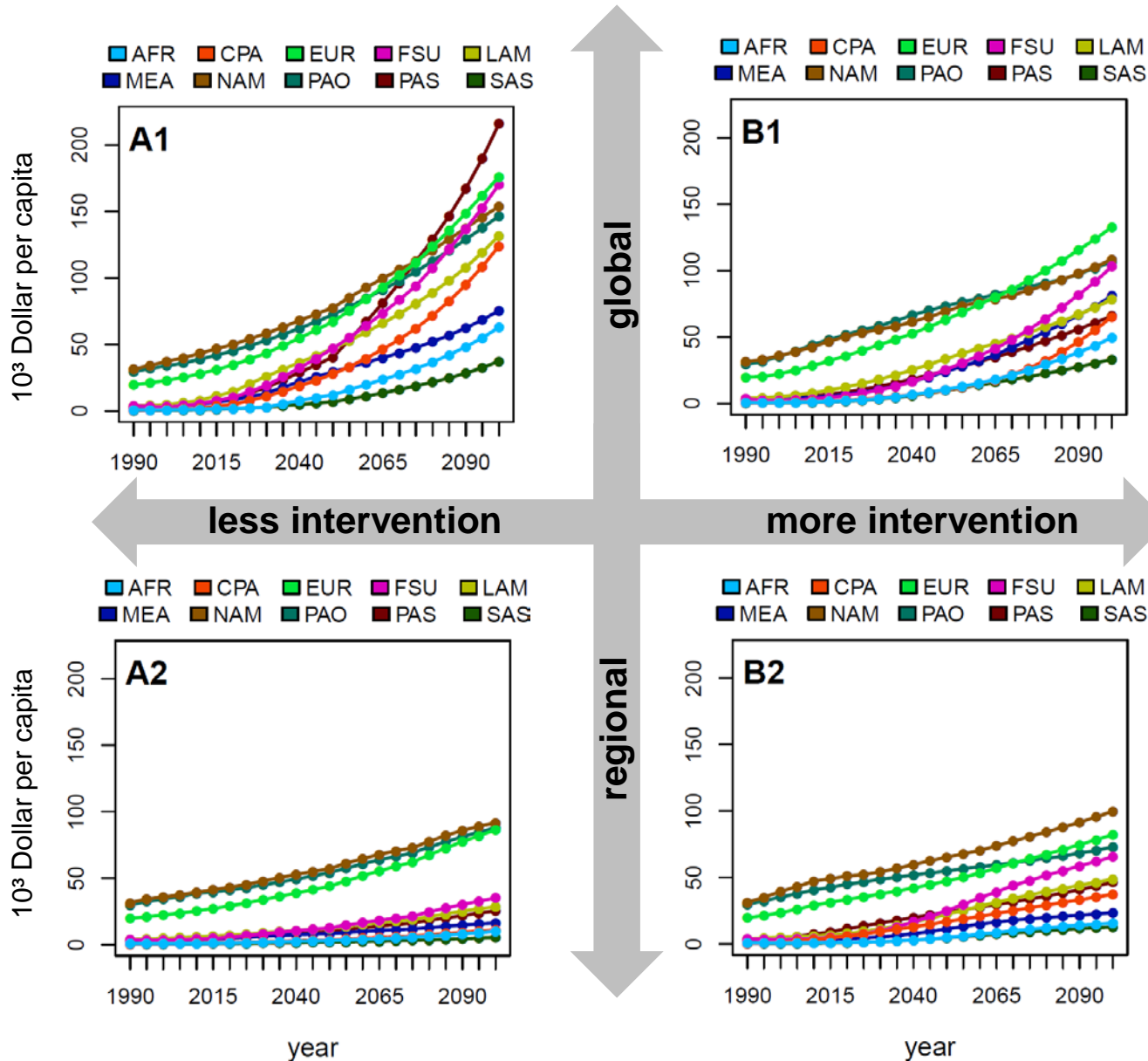
Demand for built-up area in Europe (JRC)

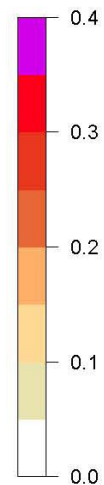# Agricultural land changes (%, 2010-2040)
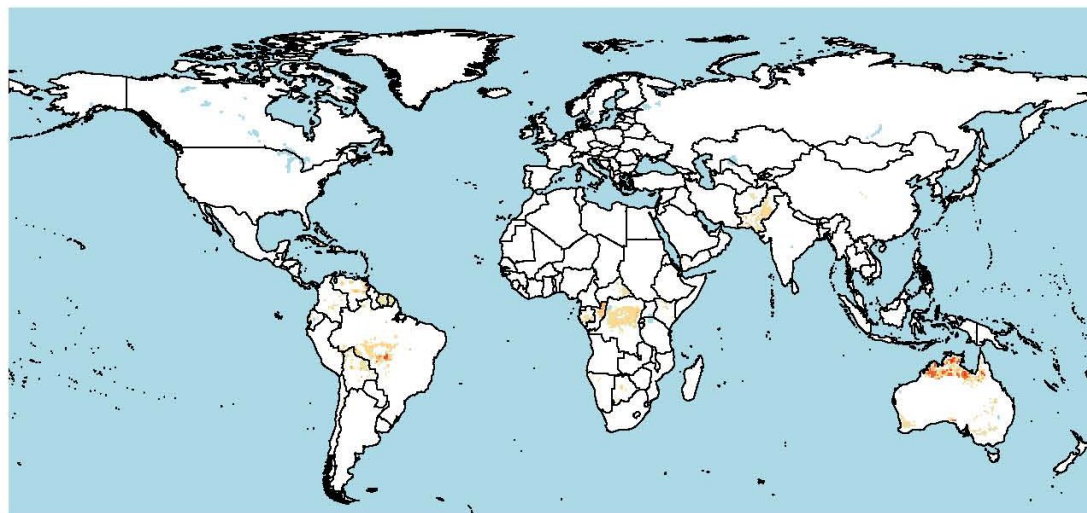# (LEITAP/MAGNET, WUR)

Scenario A2

Scenario B1

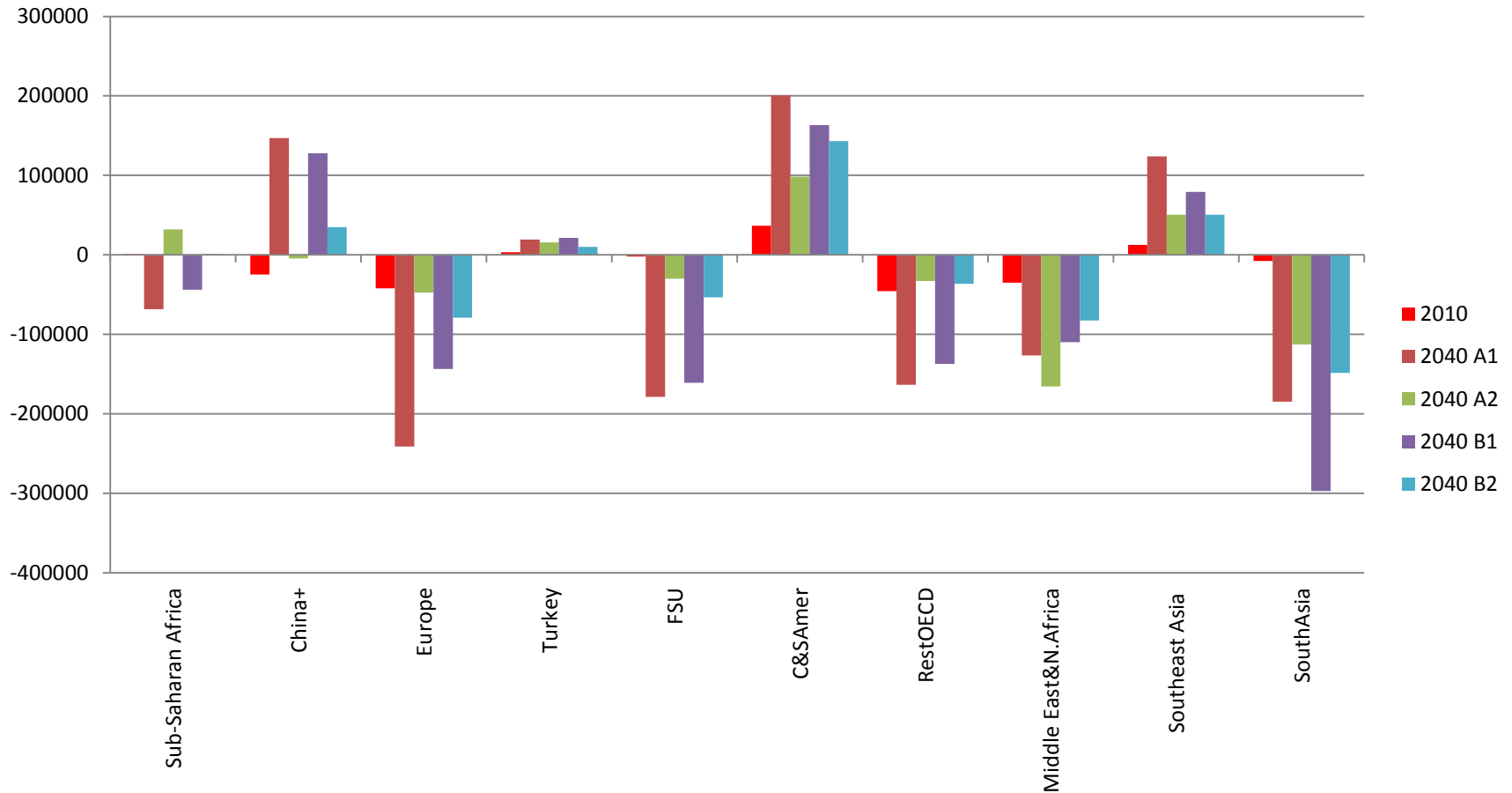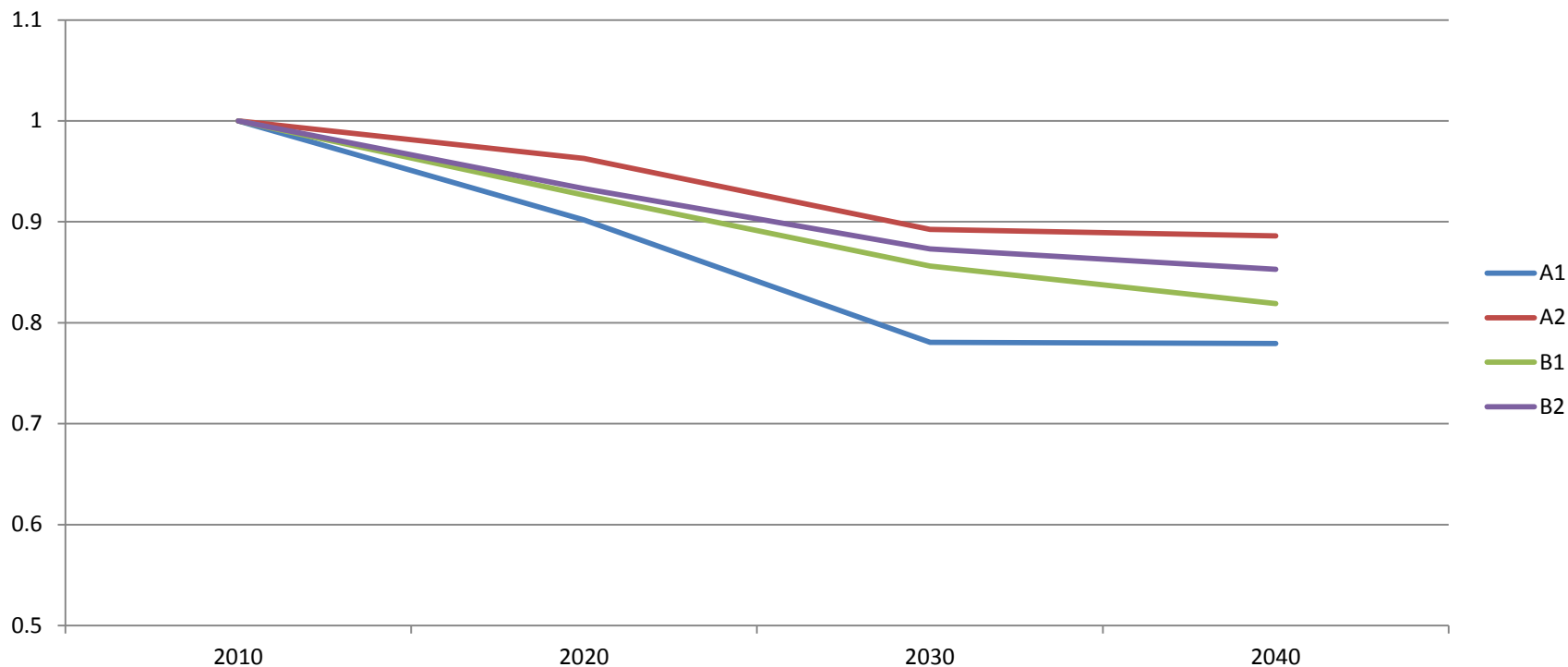**Cropland expansion outside Europe (MAgPIE, PIK)**

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# Regional net exports (million US$, 2010 -2040) (LEITAP/MAGNET, WUR)

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Development of **real** world prices for agri-food commodities (2010 = 1) (LEITAP/MAGNET, WUR)

World agri-food prices decreases because (1) yields are growing much faster than population (2) production input saving technological progress (1.3% - 3.5% pa depending on scenario)
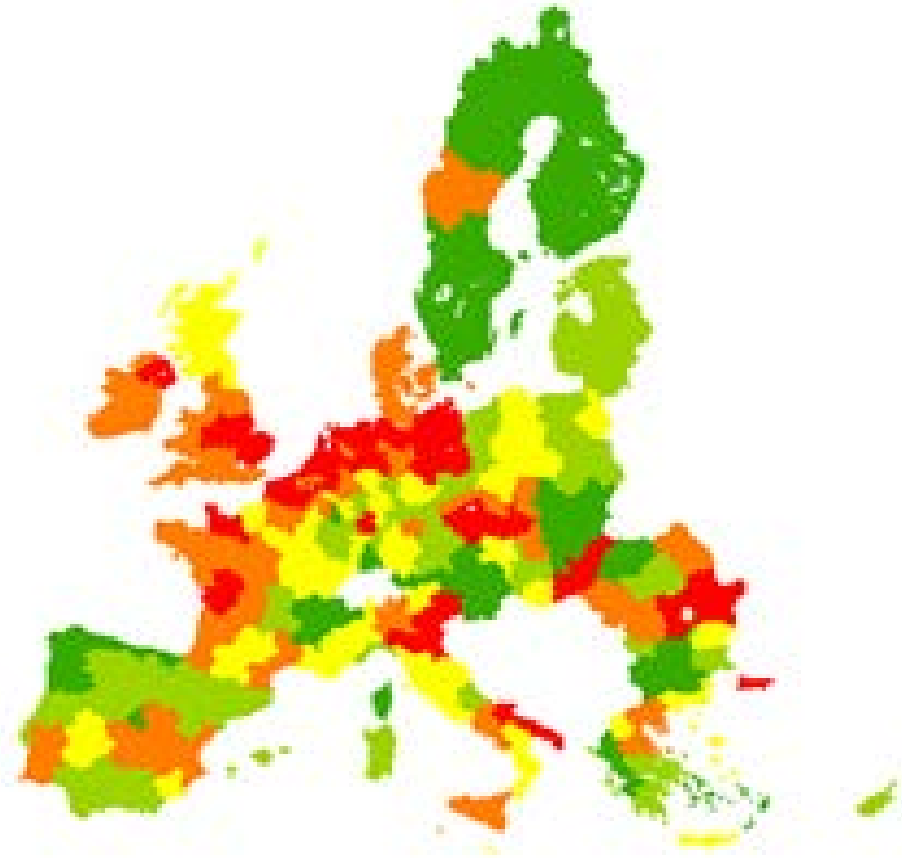
Development of nominal agricultural prices in Europe (2010 = 1) (LEITAP/MAGNET, WUR)
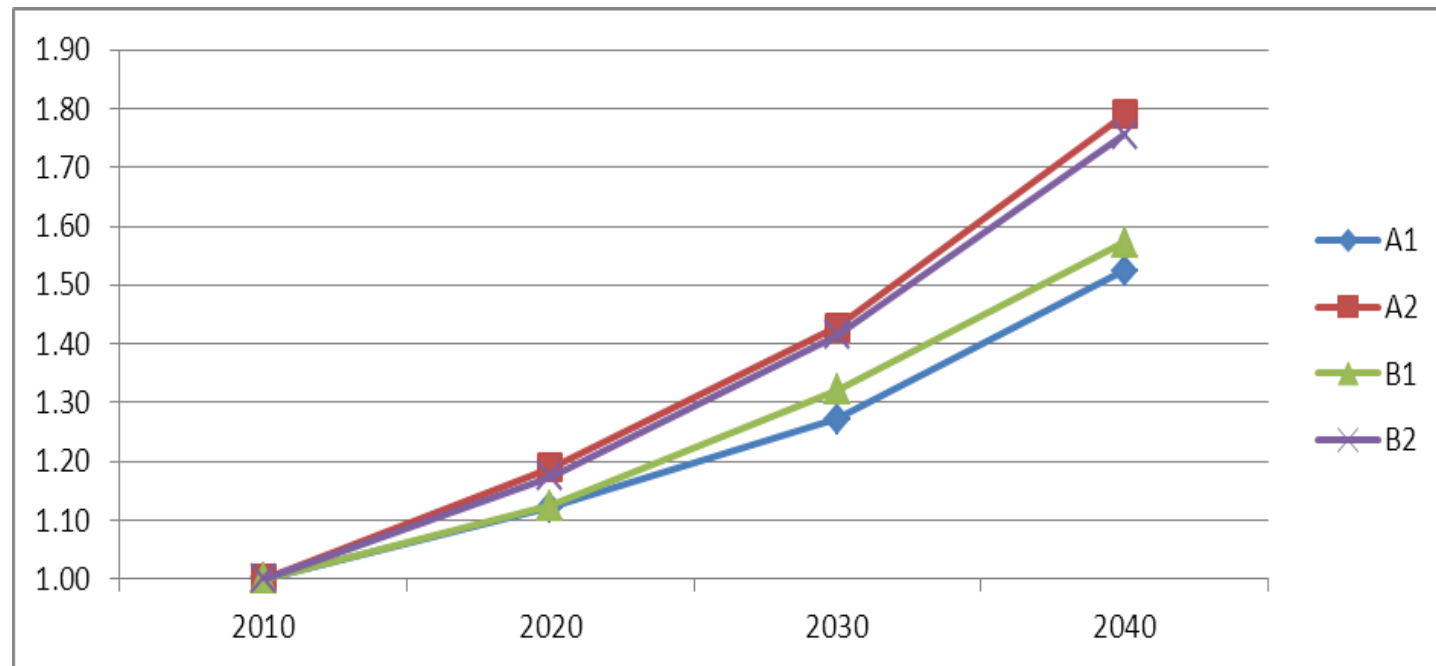
Percentage change in agricultural area in 2020 (A2 vs. A1) (CAPRI, WUR)

Strong increase of agricultural land use in areas with high share of CAP subsidies in income
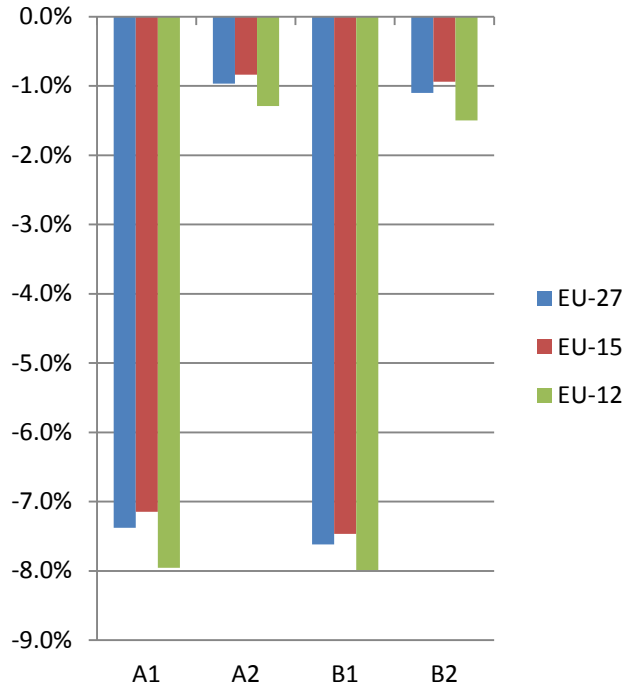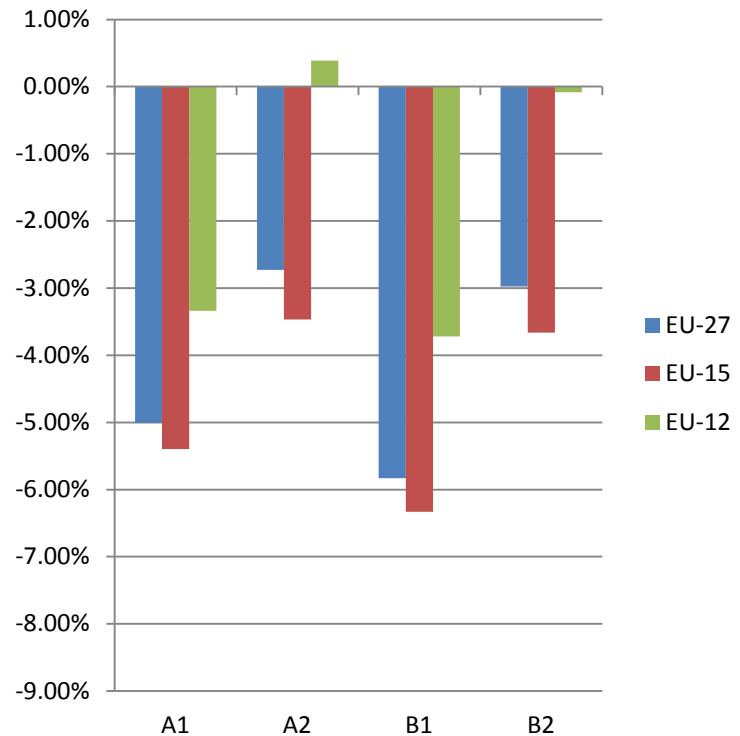
<4%	🟥
<6%	🟧
<7.5%	🟨
<10%	🟩
>10%	🟩

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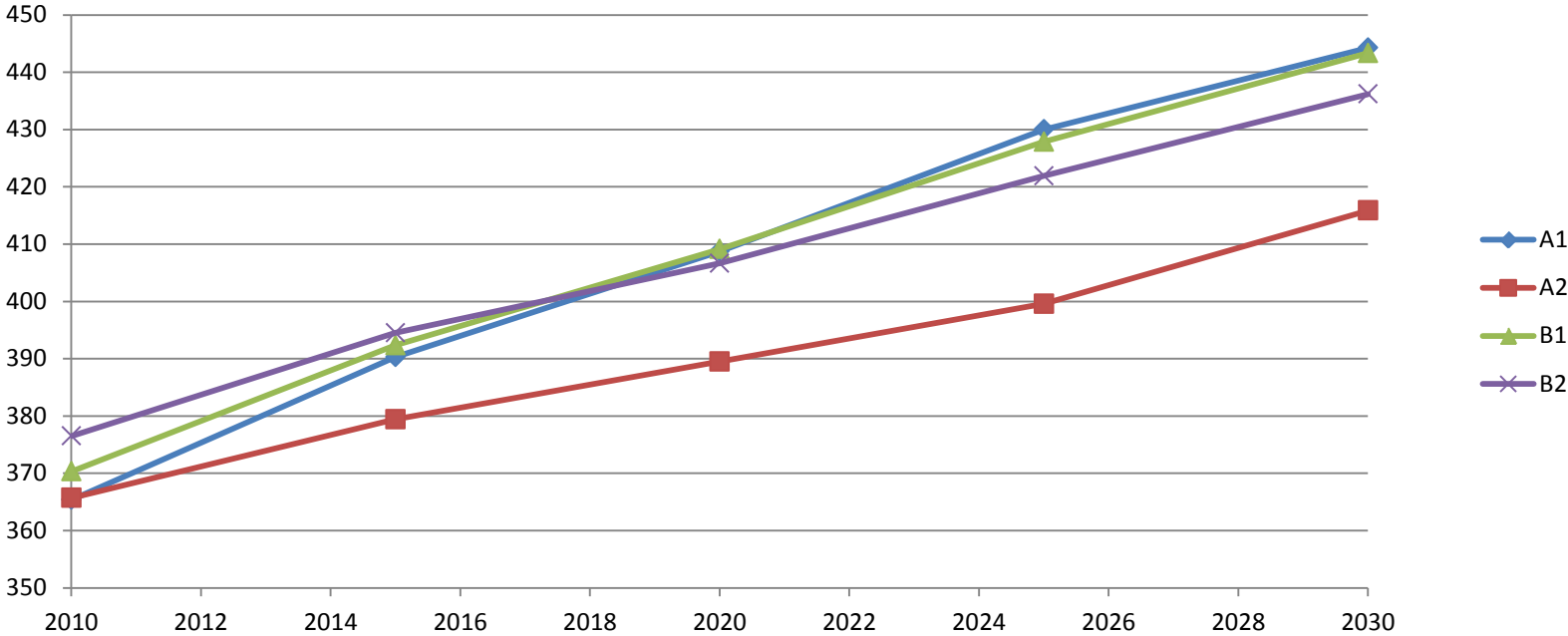COOPERATION

Agricultural area

Nitrogen surplus at soil level
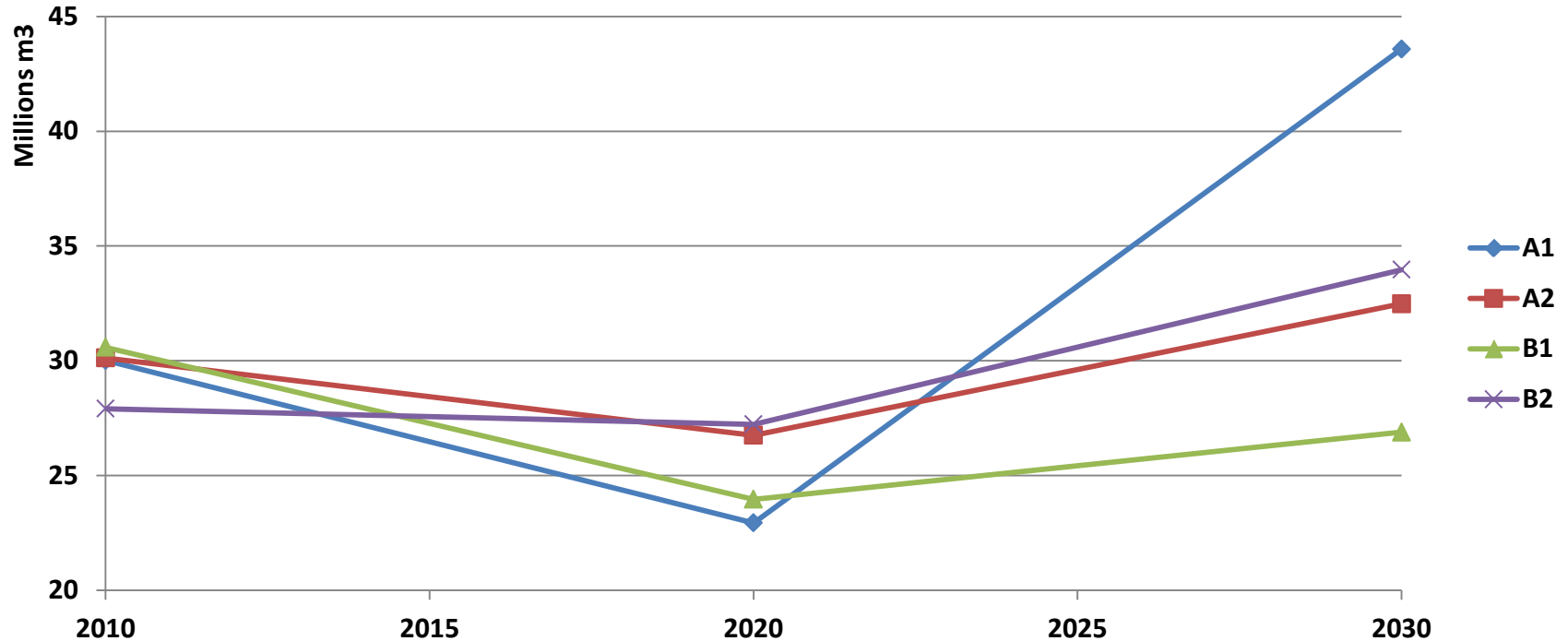## (% changes, 2020 vs. 2010) (CAPRI, WUR)

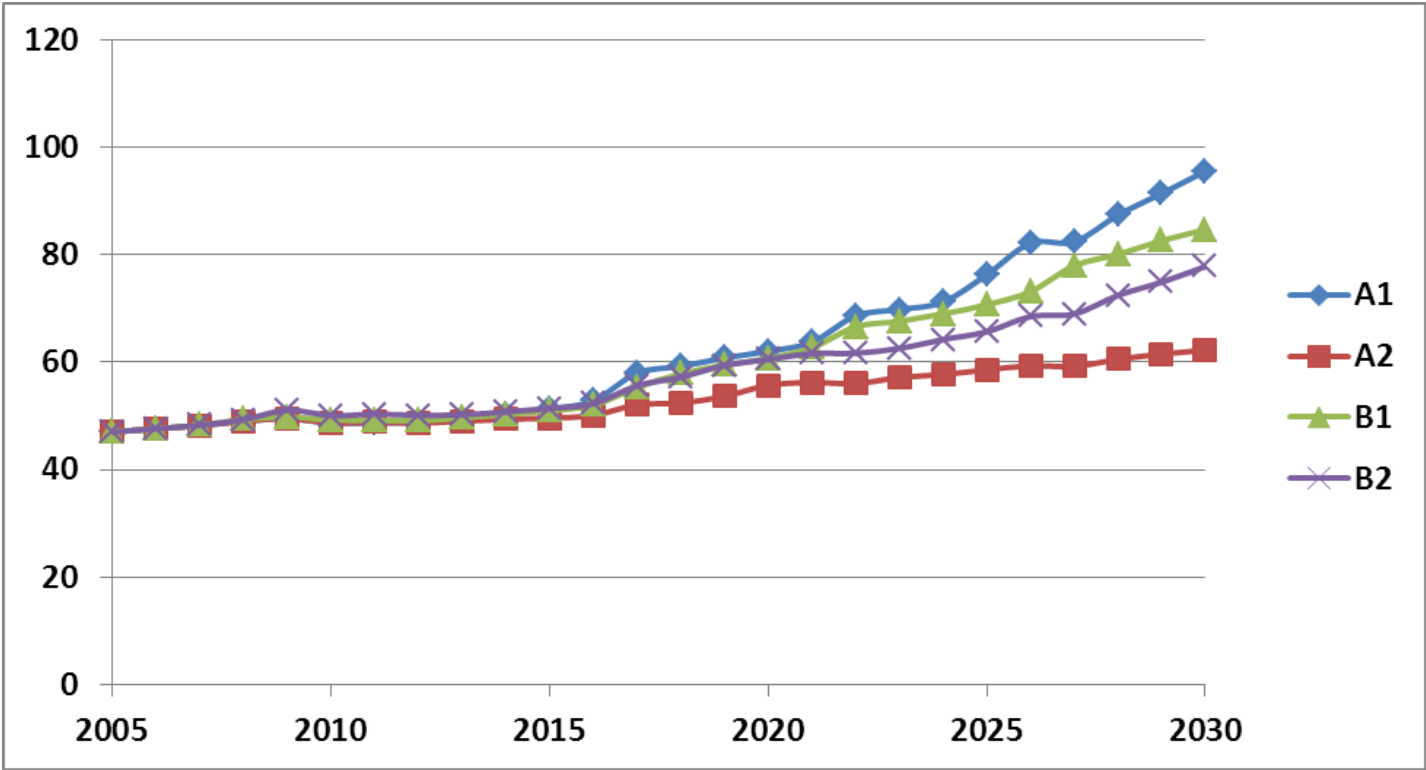# EU industrial round wood harvest (million m³) (EFI-GTM)

EU harvest is the lowest in A2 due to low global economic growth and high availability of wood supply from plantations in Asia & Latin America. However, EU harvest is higher under B1&B2 due to restricted wood supply in Asia & Latin America.
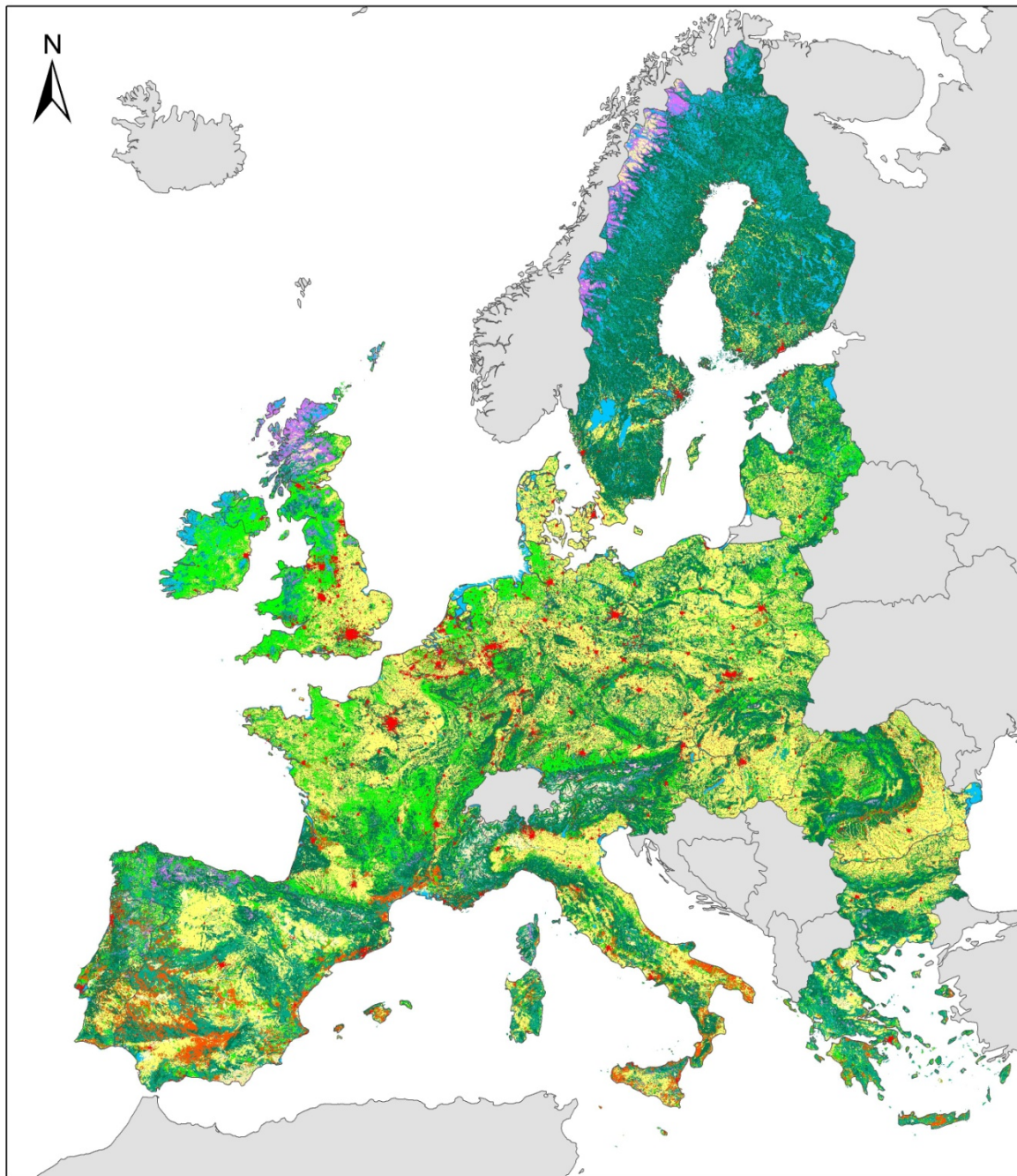
Import of industrial wood into EU (EFI-GTM)

EU is the second largest industrial wood importer (after Asia). EU's B2 round wood imports are somewhat higher due to lower wood pulp imports.

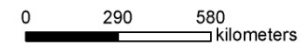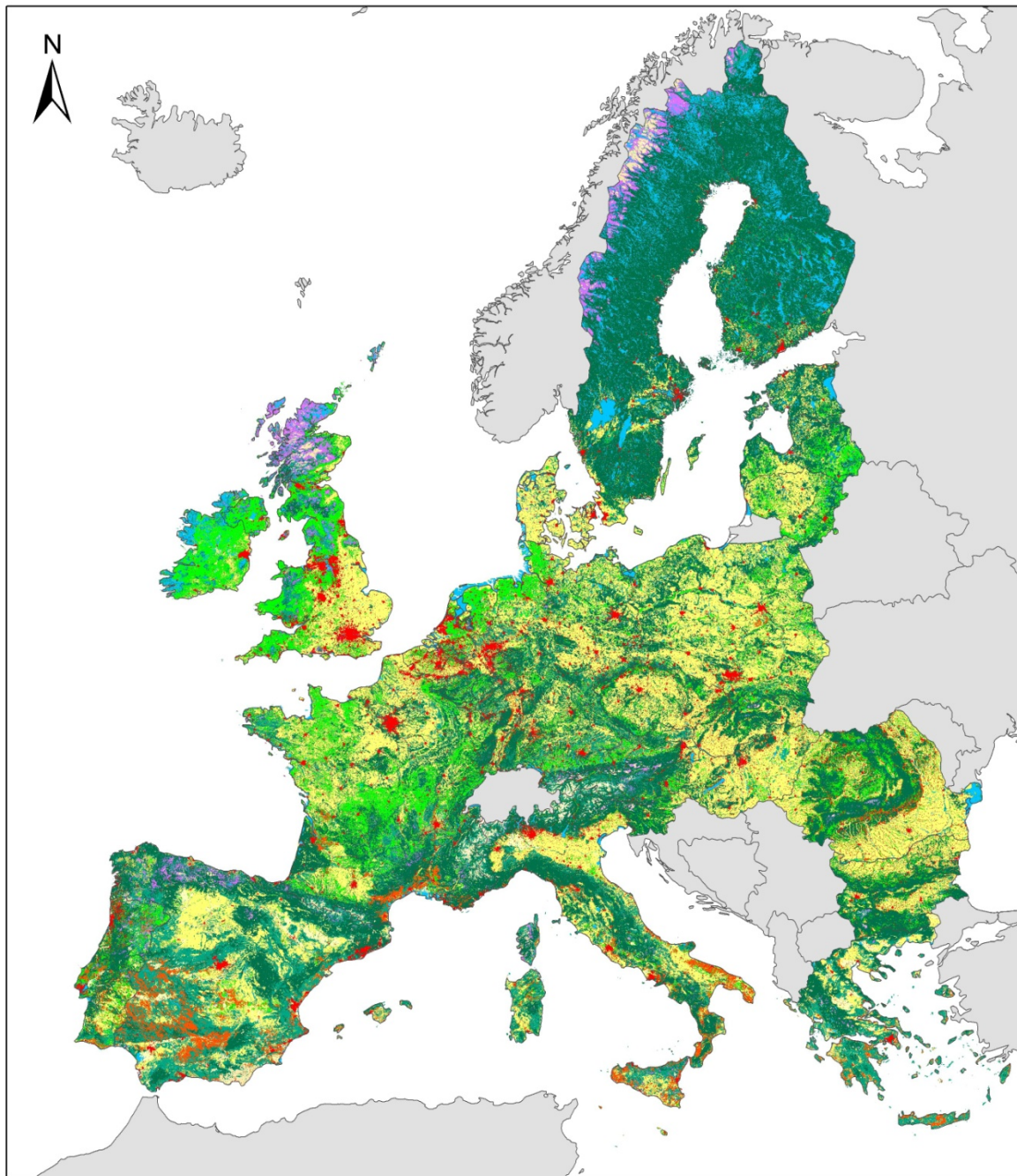# EU non-coniferous industrial wood price (in 2005 US$)(EFI-GTM)

B1 - 2005

- <all other values>
- built-up land
- arable land (non-irrigated)
- grassland
- (semi) natural vegetation
- inland wetlands
- glaciers and snow
- irrigated arable land
- abandoned arable
- permanent crops
- forest
- sparcely vegetated areas
- beaches, dunes and sands
- salines
- water and coastal flats
- moors and heathland
- abandoned grassland

Dyna-CLUE (VU)

0   290   580
kilometers

B1 - 2040

red	built-up land
pale yellow	arable land (non-irrigated)
green	grassland
teal	(semi) natural vegetation
light blue	inland wetlands
white	glaciers and snow
cream	irrigated arable land
olive	abandoned arable
orange	permanent crops
dark green	forest
tan	sparsely vegetated areas
yellow	beaches, dunes and sands
grey	salines
cyan	water and coastal flats
purple	moors and heathland
olive-khaki	abandoned grassland

Dyna-CLUE (VU)
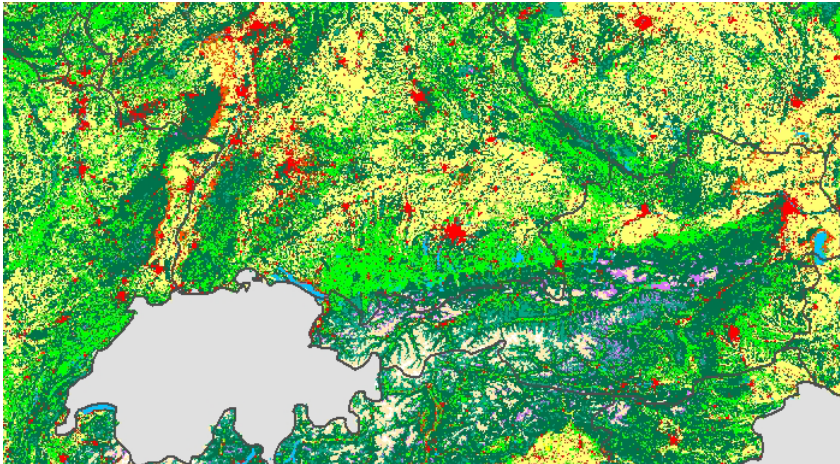
0   290   580
kilometers

Urbanisation (Dyna-CLUE, VU)
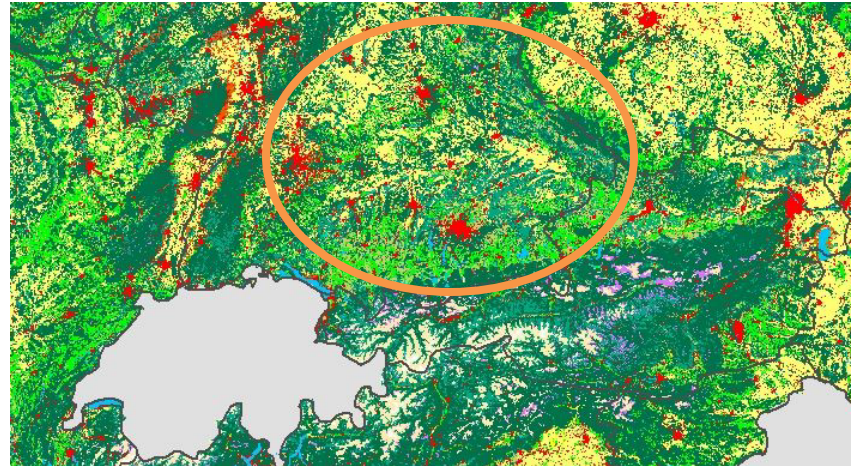

2005

2020
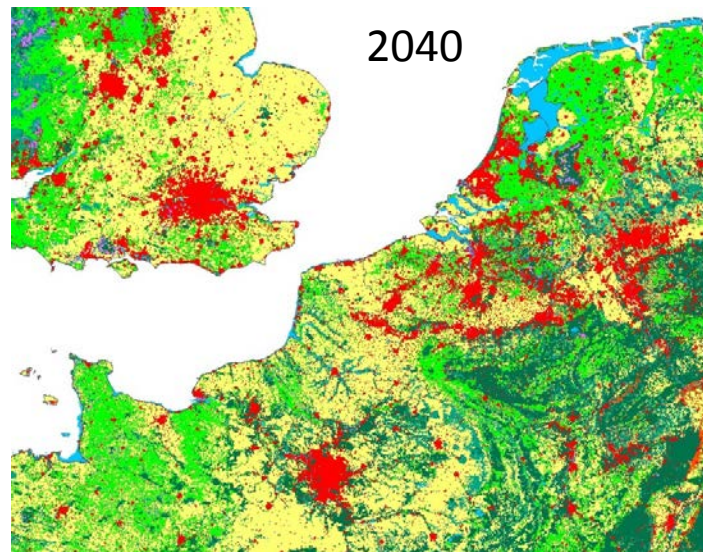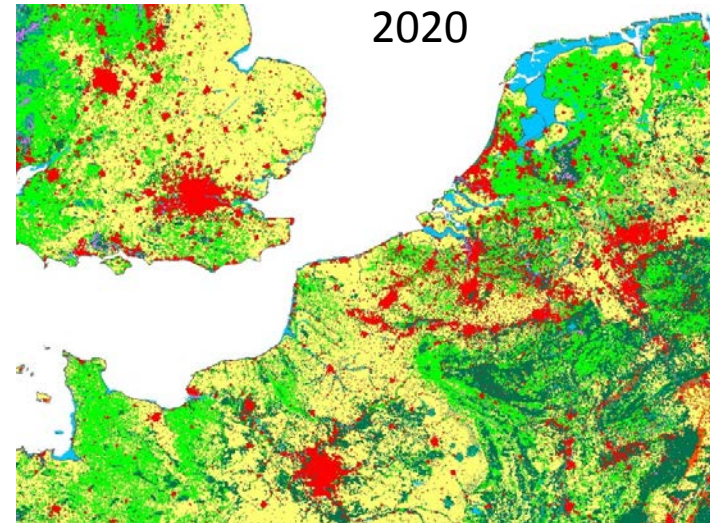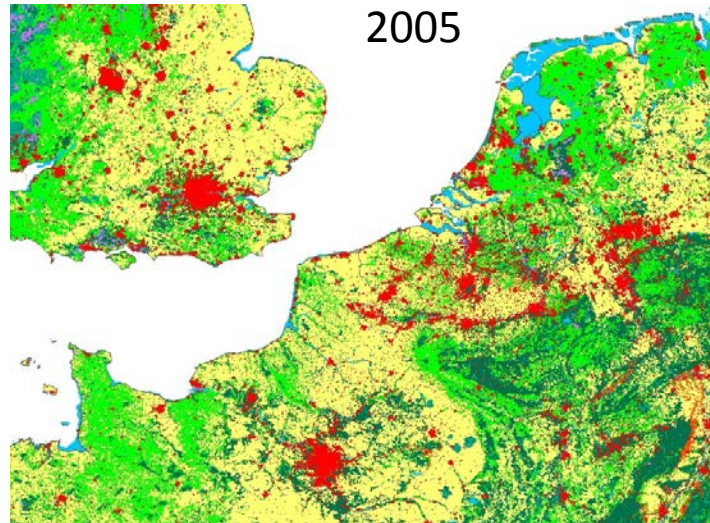
2040

Land abandonment (Dyna-CLUE, VU)

- Large abandonment trends

- Abandonment in concentrated areas
  - Bretagne
  - Dutch borders
  - Borders of the Alps

2005   2040

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Selected policy scenario results for VOLANTE

VOLANTE Policy Scenarios (VPS) – overview

1. Increased nature protection
2. Nitrogen policies / Water quality policies
3. Measures to improve agricultural technologies and increase yields
4. Measures to induce bio-based economy and bioenergy use
5. PES: Payment for carbon sequestration
6. PES: Payment for recreational services
7. Use Common Agricultural Policy (CAP) to increase rural employment
8. Encourage compact cities through zoning etc.
9. Climate change impacts and adaptation, e.g. improve flood protection
10. Climate mitigation in agriculture (Emission taxes on CH4 and N2O)
11. Stongly increased trade barriers (to increase food, feed, and bioenergy self-sufficiency)

VPS3: Improved agricultural technologies
Changes in agricultural area in Europe (MAGNET)
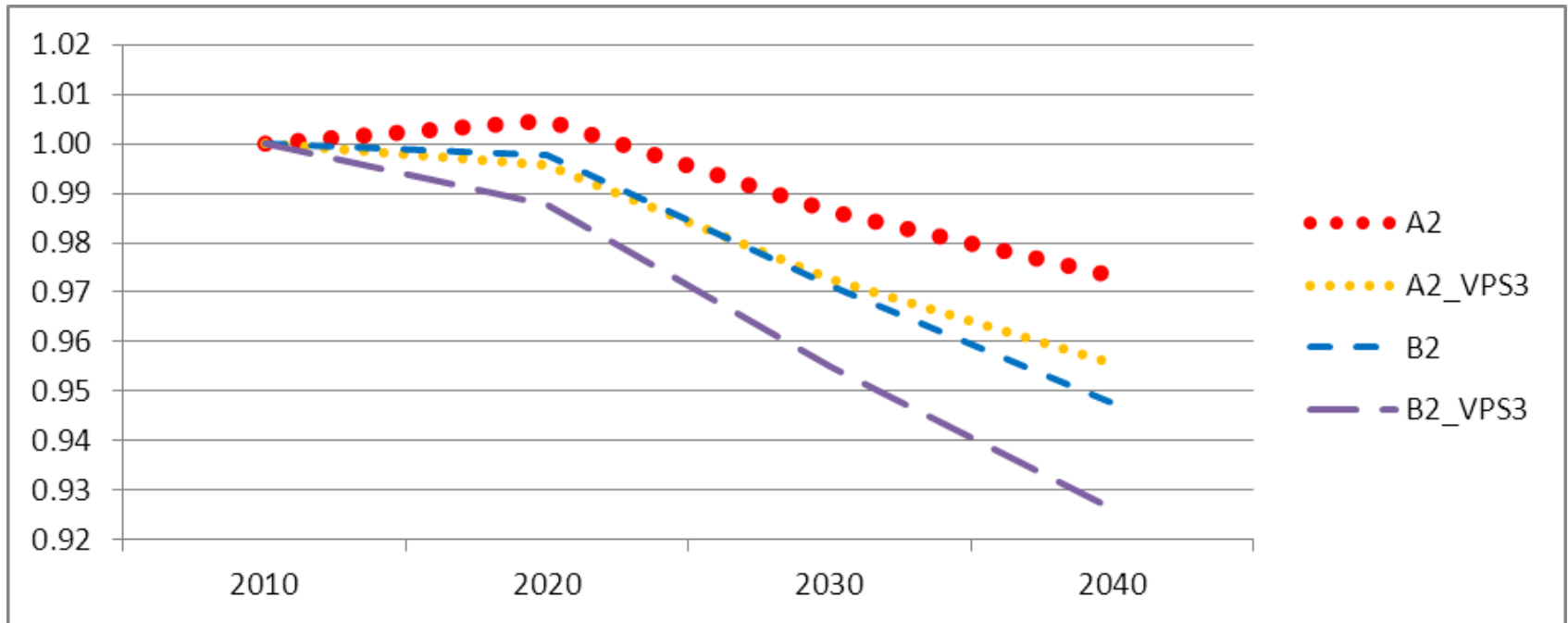
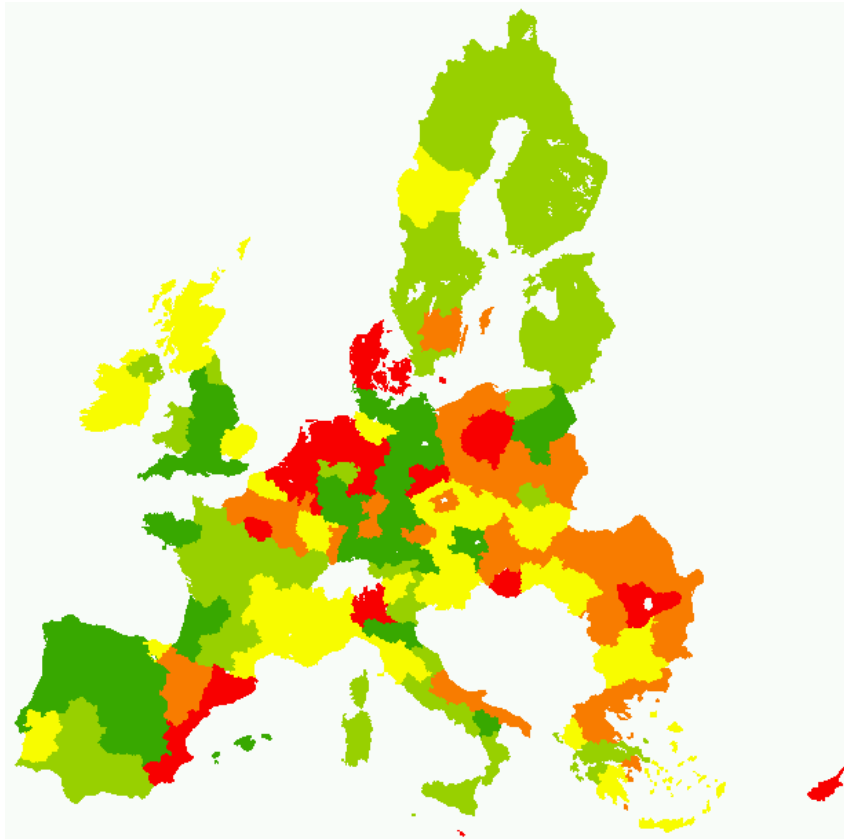# VPS11: Increased trade barriers
Changes in agricultural area in Europe (MAGNET)
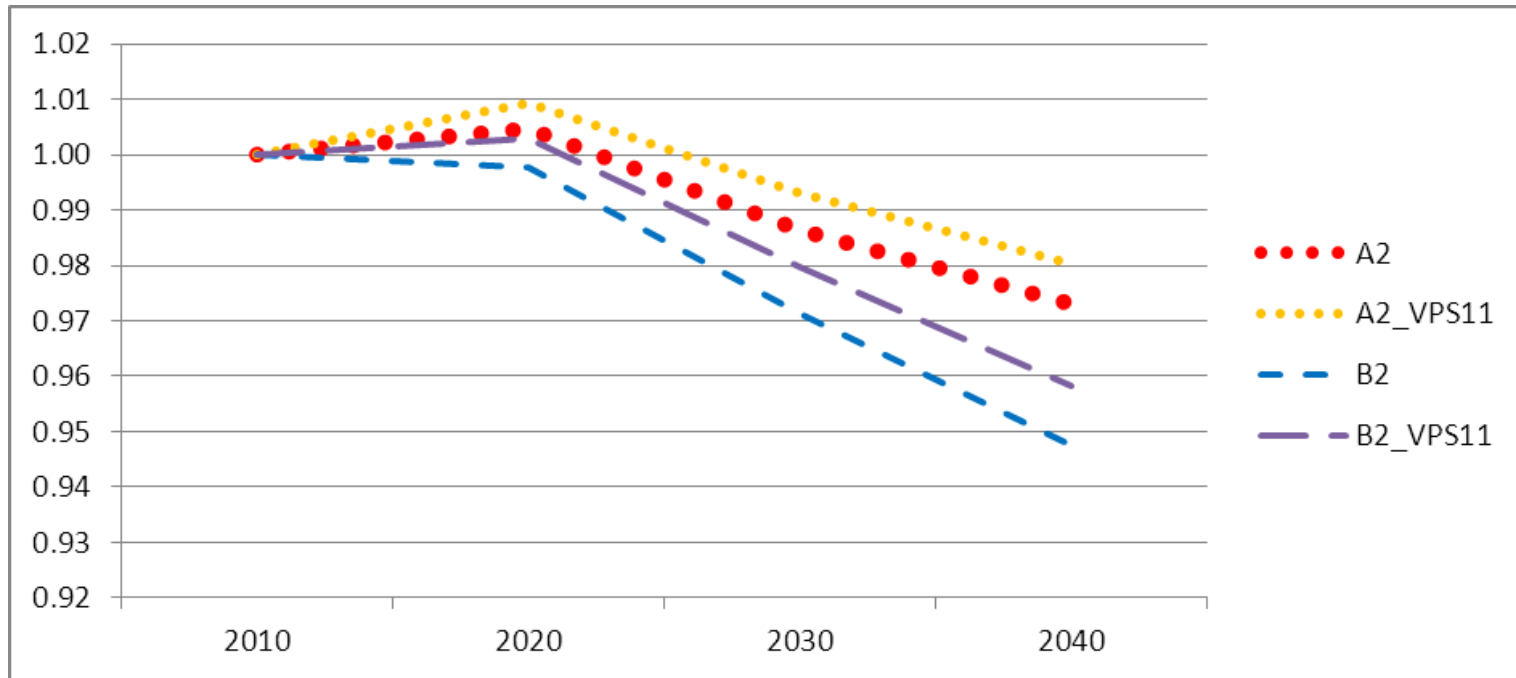
VPS2: Nitrogen policies
Changes in grassland area (CAPRI)

> 3%	<3%	<0.75%	<0%	<-0.5%

VPS6: Payment for recreational services
Changes in total premiums (CAPRI)
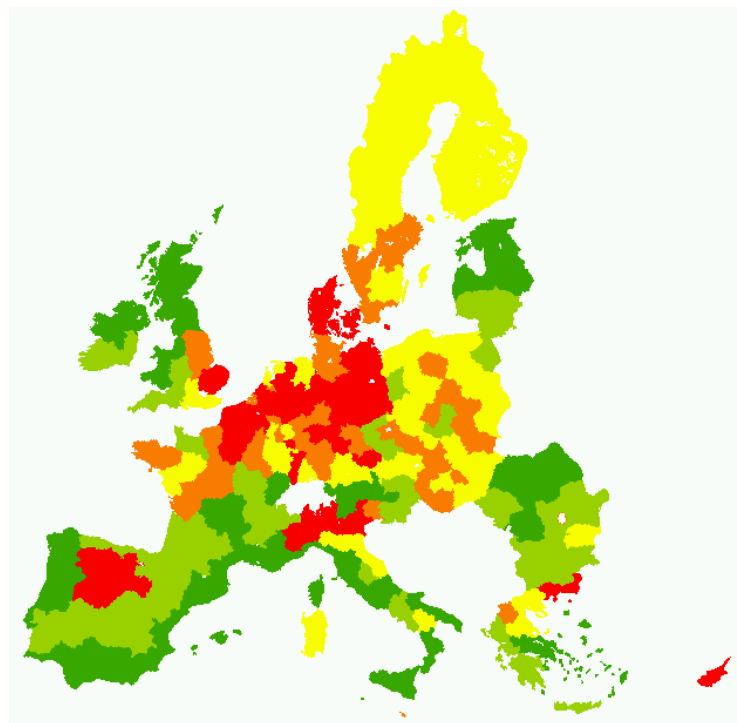
< -12%	< -7.6%	<-1.8%	<11.9%	>11.9%
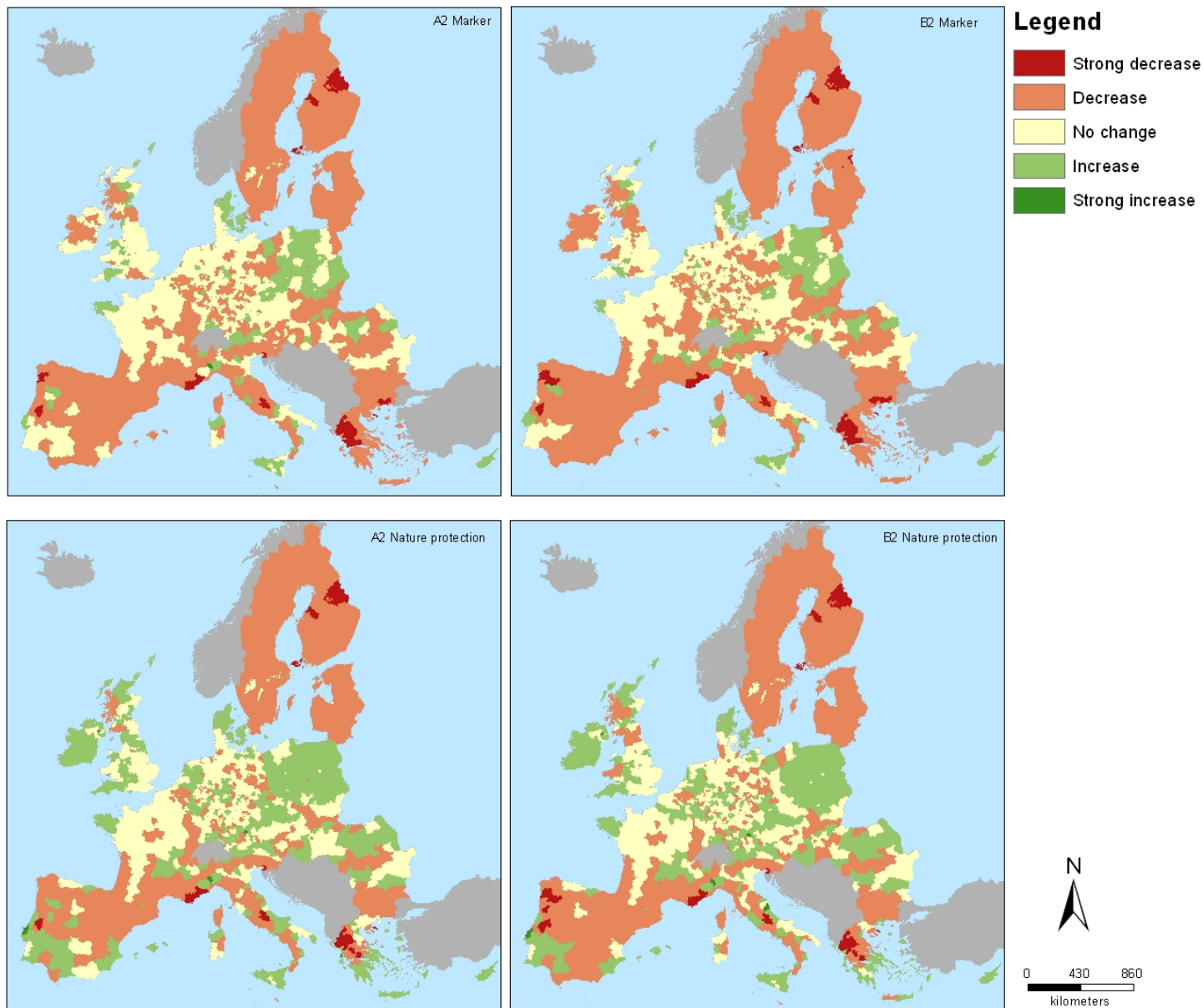
VPS1: Increased nature protection (CLUE)

Figure 1. Change in total natural area (forest and semi-natural) for Marker scenarios (top) and the Nature protection alternative (bottom). Indicator is calculated at Nuts3 level by Eu-Clue-Scanner by comparing the change in land use from 2000 to that simulated for 2040. An increase or decrease is between 1% and 20% change and a strong increase or decrease is more than 20% change.

Land use 2000
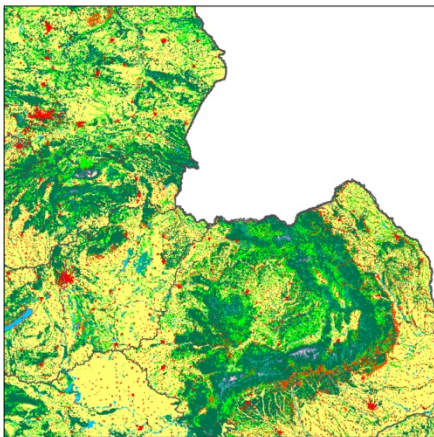
Nature protection areas

VPS1 results

Legend

Nature protection

- Natura2000
- Natura2000 expansion
- Ecological corridor

A2 Marker

B2 Marker

Land use

- built-up land
- arable land (non-irrigated)
- grassland
- (semi) natural vegetation
- inland wetlands
- glaciers and snow
- irrigated arable land
- abandoned arable
- permanent crops
- forest
- sparsely vegetated areas
- beaches, dunes and sands
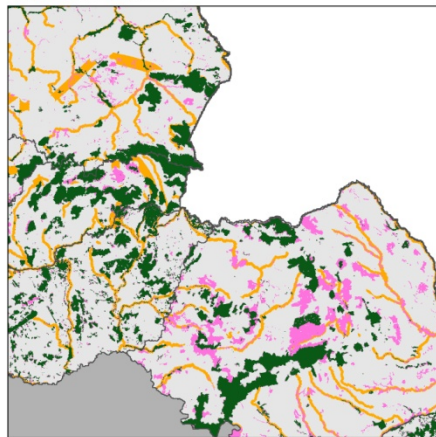- salines
- water and coastal flats
- moors and heathland
- abandoned grassland
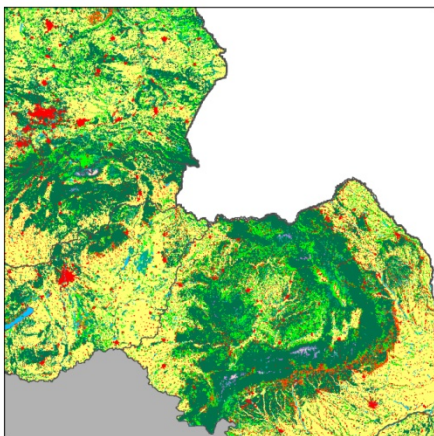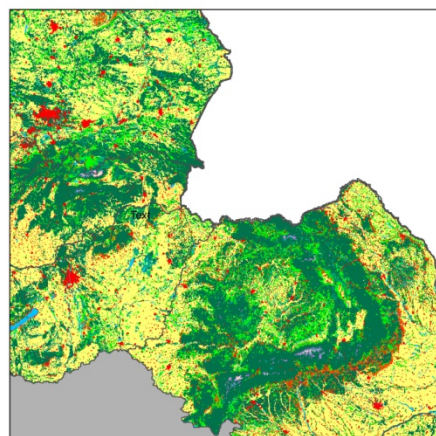
A2 VPS1 Nature protection

B2 VPS1 Nature protection

N

0   100 200   400
Kilometers
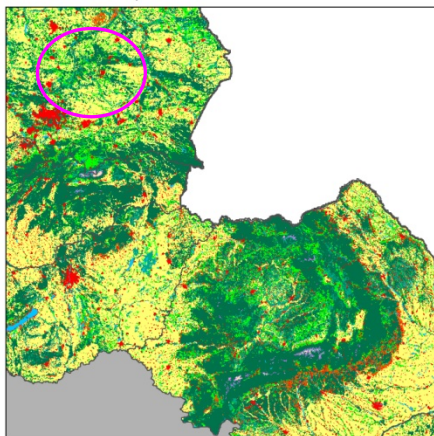
VPS1: Increased nature protection (CLUE)
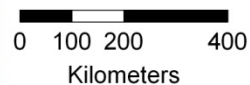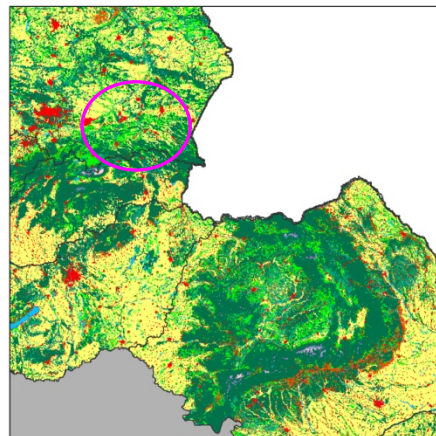
VPS8: Compact cities (CLUE)

Legend
- No change
- Small increase
- Increase
- Strong increase

A2 Marker

E2 Marker

A2 Compact cities

E2 Compact cities

Figure 3. Change in degree of urbanisation between 2000 and 2040. Calculated by Eu-Clue-Scanner per Nuts2. No change is less than 0.1%; small increase between 0.1% and 2.5%; increase between 2.5% and 5% and a strong increase is more than 5% change.

WP8: Bundles of Ecosystem Services (CNRS)

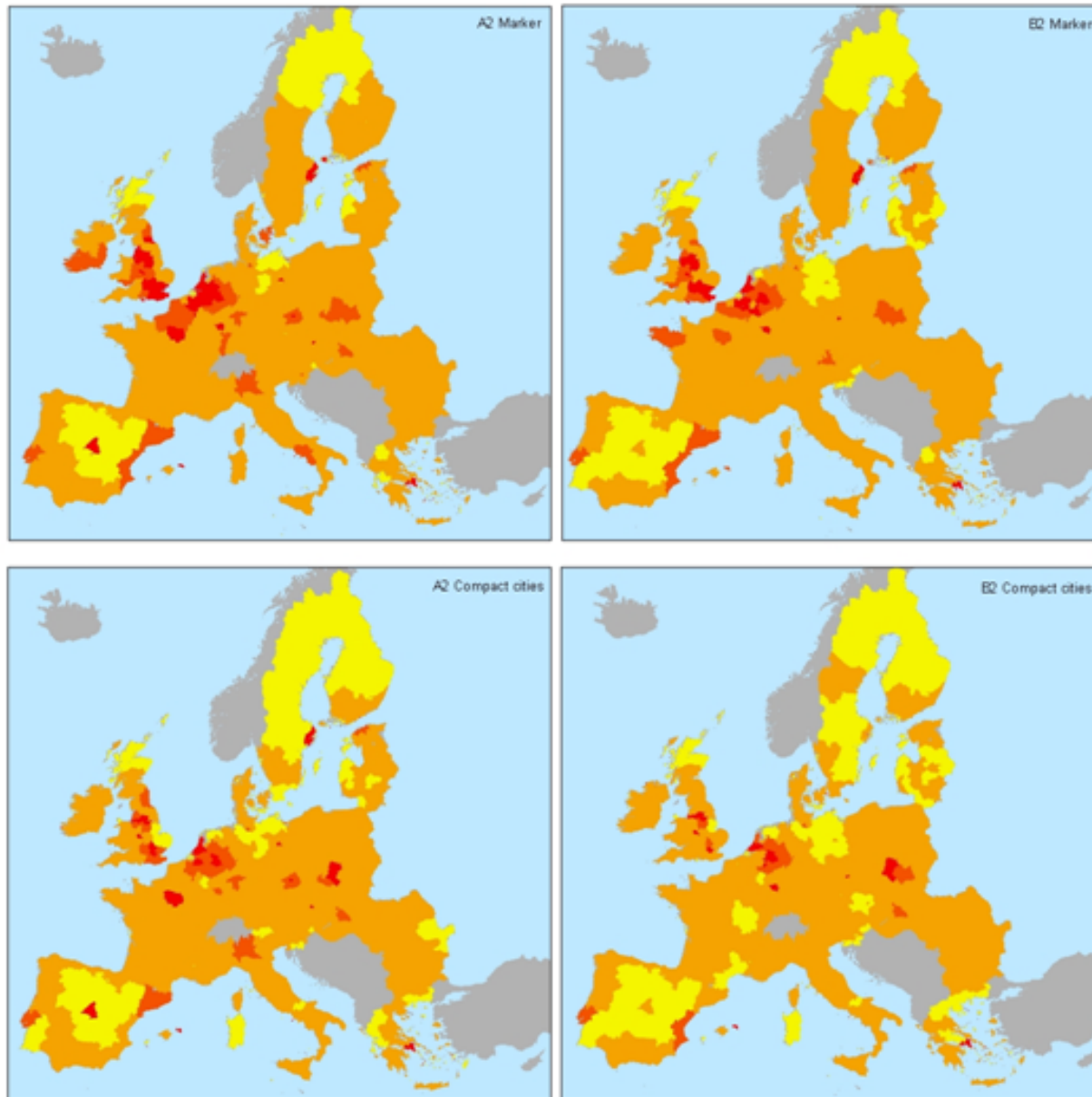| Service category	Ecosystem service	Indicator name	Inputs	Partner	Expected by
CULTURAL	Recreation	Territorial capital of rural tourism	PDO, Protected regions, CLU/CLC, travel time to urban location, leader sites, camping sites, ski resorts, DEM, precipitation, temperature, UNESCO and UN sites	IVM VU	*Ready*
		Recreation potential index - Availability of the ES to citizen	CLC, water quality, N input (CAPRI), livestock density (CAPRI), forest, protected areas (NATURA2000, Protected areas), road network, population density	JRC	Not before the send of summer 2012
		Recreation value of EU forests	Age structure by tree sp, Recreation scores (expert-based)	EFI	*Not before November*
PROVISIONING	Food-feed-fibre	To be defined	CAPRI outputs	JRC/IVM VU	?
	Raw material	Wood (roundwood and harvest residues)	Round wood from thinning, Round wood from final felling, Harvest residues from thinning, Harvest residues from final felling	EFI	*Not before November*
REGULATING	Climate regulation	Carbon sequestration in biomass and soil of European forests	Carbon stocks in forest biomass - Carbon stocks in forest soil	IVM VU	*Ready*
		Carbon sink and cumulative carbon sink	LU18, Soil organic carbon, Age of land use, Emission factors, Forest biomass content	IVM VU	*Ready*
	Moderation of extreme events	Forest fire risk	Sensibility scores, EFISCEN outputs	EFI	*Ready*
		Fire risk level	EFI's vulnerability index, FWI, topography, CLC, climate	LECA	
		Flood regulation	Land use, DEM, Temperature, Precipitation, Soil types	IVM VU	*By the end of oct 2012*
	Pollination	Relative pollinators abundance	CLC, crops (CAPRI), forest, farmland presence, road network, rivers, floral availability and nesting suitability by crops/CLC class	JRC (IVM VU?)	February 2012
DIS-SERVICE	Invasive species	Alien threat score	Daisie outputs	LECA	*Validation required*
PRIMARY PRODUCTION	HANPP	Human appropriation of NPP	Based on outputs from LPJ, CORINE, CAPRI, EFISCEN, FAO stat and FRA	UNIKLU	*Downscaling at 1Km in progress*
	NPPact	NPP of the actual veg			
	NPPh	NPP harvested			
	NPP0	NPP of the potential veg			
HABITAT SERVICE	Maintenance of genetic diversity	Dead wood	Standing deadwood - Downed deadwood - Residues remaining in forest - Forest area	EFI	*Not before November*

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WP7: modelling approach and model interaction

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(modified SRES)

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CAPRI: Agricultural production, management intensity, environmental impacts

EFISCEN: Forest production, management intensity, environmental impacts

Dyna-CLUE: Land use patterns, land-use intensity

WP8: Ecosystem services indicators

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