Appendix 5. Tables

Table A5.1. Preliminary and enhanced lists of variables for characterizing and monitoring SESs, structured into dimensions across the three components of a SES. The preliminary list contains 77 variables structured into 12 dimensions and was generated through literature review and an initial expert workshop. The improved list contains 149 variables structured into 13 dimensions and was the result of analyzing the preliminary survey results (56 responses) in a second scientific workshop. This improved list was then introduced in the final survey with the aim of using scientist scorings to prioritize the variables.

Component	Dimension	Preliminary list (77 variables in 12 dimensions)	Improved list (149 variables in 13 dimensions)
Social system	Human population dynamics	Population density	Population density
		Population distribution	Population distribution
		Population size	Population size
		Human migrations	Human migrations
		Age structure	Age structure
		Sex Ratio	Sex Ratio
			Population growth rate by natural increase
			Population growth rate by immigration
	Wellbeing and development	Access to drinking water	Access to drinking water
		Water sanitation	Water sanitation
		Electricity access	Electricity access
		Access to internet	Access to internet
		Educational level of the population	Educational level of the population
		Employment	Employment
		Economic level of the population	Economic level of the population
		Social equity	Social equity
		Environmental quality	Environmental quality
		Mortality	Infant mortality rate
		Overcrowding	Average household size
		Life expectancy	Life expectancy
		Institutional diversity	-

		Land protection	-
			Water scarcity
			Poverty
			Access to healthcare and other basic social services
			Total fertility rate
			Subjective wellbeing
			Security
			Social trust
	Governance (not included in 1st survey)		Institutional diversity
			Agenda effectiveness[1]
			Stakeholders participation in decision making[1]
			Internal capacity[1]
			External capacity[1]
			Implementation experience[1]
			Political stability
			Corruption level
			Current conflicts
Ecological system	Organic carbon dynamics (Carbon dynamics in 1st survey)	Net Primary Productivity	Net Primary Productivity
			Gross Primary Productivity
			Respiration
			Secondary productivity
			Organic carbon storage
			Radiation Use Efficiency
			Ecosystem composition by Plant Functional Types
	Water dynamics	Evapotranspiration	Actual evapotranspiration
			Potential evapotranspiration
			Precipitation
			Snow precipitations
			Snow storage
			Horizontal precipitation
			Extra-precipitation water contributions
			Potential water deficit -or excess-

		Actual water deficit -or excess-
		Evaporation - Transpiration ratio
		Soil water infiltration capacity
		Deep drainage
		Groundwater depth
		Actual Soil Water Storage
		Total water yield or "blue water"
		Flows of green water
		Precipitation Use Efficiency
		Vegetation water stress
Surface energy balance (Energy dynamics in 1st survey)	Land surface energy balance	-
	Albedo	Upward shortwave radiation
	Land surface temperature	Sensible heat, land surface temperature
		Net solar radiation
		Downward shortwave radiation
		Upward longwave radiation
		Downward longwave radiation
		Latent heat flux
		Snow heat flux
		Deep ground heat flux
		Air temperature
Nutrient cycling	Nitrogen cycling	-
	Phosphorus cycling	-
		Nitrogen fixation
		Nitrogen deposition
		Phosphorus deposition
		Gross nitrogen mineralization
		Net nitrogen mineralization
		Soil phosphorus availability
		Nitrogen status of plants
		Phosphorus status of plants
Disturbance regime	Drought occurrence	Drought occurrence

		Fire occurrence	Fire occurrence
			Flood occurrence
			Herbivory
			Pest outbreaks occurrence
			Hurricanes/storms occurrence
			Landslides occurrence
			Volcanic eruptions occurrence
Interactions	Ecosystem service supply[2]†	Cropland production (P)	Cropland production (P)
		Livestock production (P)	Livestock production (P)
		Surface and groundwater sources for drinking (P)	Surface and groundwater sources for drinking (P)
		Surface and ground water sources for nondrinking purposes (P)	Surface and ground water sources for nondrinking purposes (P)
		Biomass-based energy sources (P)	Biomass-based energy sources (P)
		Fibres and other materials from plants, algae and animals for direct use or processing (P)	Fibres and other materials from plants, algae and animals for direct use or processing (P)
		Wild plants, algae and their outputs for food (P)	Wild plants, algae and their outputs for food (P)
		Wild animals and their outputs for food (P)	Wild animals and their outputs for food (P)
		Hydrological cycle and water flow maintenance (R)	Hydrological cycle and water flow maintenance (R)
		Global climate regulation (R)	Local climate regulation (R)
		Pollination and seed dispersal (R)	Pollination and seed dispersal (R)
		Pest and disease control (R)	Pest and disease control (R)
		Bioremediation (R)	Bioremediation (R)
		Chemical conditions maintenance of freshwaters and salt waters (R)	Chemical conditions maintenance of freshwaters and salt waters (R)
		Mass stabilisation and control of erosion rates (R)	Mass stabilisation and control of erosion rates (R)
		Ventilation and transpiration (R)	Ventilation (R)

	Weathering, decomposition and fixing rates (for soil formation) (R)	-
	Physical and experiential interactions (C)	Physical and experiential interactions (C)
	Intellectual and representative interacions (C)	Intellectual and representative interacions (C)
	Spiritual and/or emblematic interactions (C)	Spiritual and/or emblematic interactions (C)
Ecosystem disservice supply[3]	Bio-economic	Bio-economic
	Abiotic-economic	Abiotic-economic
	Bio-health	Bio-health
	Abiotic-health	Abiotic-health
	Bio-cultural	Bio-cultural
	Abiotic-cultural	Abiotic-cultural
Ecosystem service demand	Water use level	Water use level
	Energy use level	Energy use level
	Material use level	Material use level
	Human Appropriation of Net Primary Production	Human Appropriation of Net Primary Production
		Water use for irrigated crops
		Appropriation of land for agriculture
		Nature tourism
Human actions on the environment	Land use intensity	Land use intensity
	Isolation	Territorial connectivity
	Carbon dioxide emissions	Anthropogenic carbon dioxide emissions
	Pollution	Pollution
		Land cover/Land use change
		Anthropogenic water management
		Net carbon dioxide flux
		Eutrophication of water bodies
		Soil erosion
		Conservation tillage
		Ecological restoration
		Land protection

	Social-ecological coupling	Local natural capital dependence	Local natural capital dependence
		Import [export] rates	Import [export] rates of crop and livestock products
		Weight in the economy of the non-ecosystem services market	Weight in the economy of the non-ecosystem services market
		Airports [ports] activity	Airports [ports] activity
		Dependence on fossil energies	Dependence on fossil energies
		Renewable energy use	Renewable energy use
		Weight of farming [industry, services] sector in the economy	Weight of sectors in the economy
		Population employed in farming [industry, services] sectors	Population employed by sectors
		Land tenure structure	Land tenure
		Access to natural or semi natural areas	Access to natural or seminatural areas
		Human perception of ecosystem services	Human perception of ecosystem services
		Human population ethnicity	Human population ethnicity
		Local green initiatives	Local green initiatives
		Non-ecosystem services demand	Non-ecosystem services demand
			Weight of traditional (vs. intensive) agricultural sector in the economy
			Population employed in traditional (vs. intensive) agriculture
			Biocapacity
			Cultural attachment to nature

† P = provisioning services; R = regulating services; C = cultural services

[1] Foster, K. A., and W. R. Barnes. 2012. Reframing Regional Governance for Research and Practice. *Urban Affairs Review* 48(2):272–283.

[2] Haines-Young, R., and M. Potschin. 2013. Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. [online] URL: https://www.cices.eu

[3] Shackleton, C. M., S. Ruwanza, G. K. Sinasson Sanni, S. Bennett, P. De Lacy, R. Modipa, N. Mtati, M. Sachikonye, and G. Thondhlana. 2016. Unpacking Pandora's Box: Understanding and Categorising Ecosystem Disservices for Environmental Management and Human Wellbeing. *Ecosystems* 19(4):587–600. [online] URL: https://doi.org/10.1007/s10021-015-9952-z

Table A5.2. List of prioritized variables for characterizing and monitoring SES (extended version with examples and explanations). The list is structured into 13 dimensions across the three components of a SES (Fig. 2 in the paper). Priority level 1 (top priority) includes variables with relevance and consensus above the 90th percentile; level 2 includes variables between the 75th and 90th percentiles; level 3 includes variables with relevance above the 75th percentile but consensus between the 50th and 75th percentiles and vice versa; and finally, level 4 includes variables with relevance and consensus between the 50th and 75th percentiles. The nonpriority category includes variables with relevance and consensus below the 50th percentile.

Component	Dimension	Priority variables (decreasing priority from 1 to 4)				Nonpriority variables
		Level 1	Level 2	Level 3	Level 4	
Social system	Human population dynamics			Population density Population distribution (e.g., % rural population vs. % urban population)		Age structure (e.g., median age, population ageing index, dependency ratio) Human migrations (e.g., ratio of immigration/emigration) Population growth rate by immigration Population growth rate by natural increase Population size Sex Ratio
	Wellbeing and development		Access to drinking water (e.g., distance to drinking water) Educational level (e.g., illiteracy rate, % of population with higher education, school enrolment rate, out	Water sanitation (e.g., % of houses using improved sanitation facilities) Water scarcity		Access to healthcare and other basic social services (e.g., % of population receiving public assistance) Access to internet Average household size (e.g., people per home) Economic level (e.g., household income, income per capita) Electricity access

	of school rate for adolescents) Environmental quality (e.g., air, water and soil pollution levels) Poverty (e.g., % of population with unsatisfied basic needs) Social equity (e.g., wealth distribution, women participation in government, women literacy rate, Gini Index)		Employment (e.g., employment rate, unemployment rate) Infant mortality rate Life expectancy (e.g., life expectancy at birth) Security (e.g., crime rate) Social trust (in government, institutions) Subjective wellbeing (e.g., life satisfaction) Total fertility rate
Governance	Current conflicts (e.g., armed conflicts, political violence)	Corruption level Political stability	Agenda effectiveness (degree in which the agenda is adequately formulated and assessed to achieve specific goals and have a popular understanding)[1] External capacity (skills and reach of the government to connect to - at both the national and international levels- and secure external resources to support regional goals)[1] Implementation experience (level of experience addressing regional goals and degree of institutionalization of these experience in policies and processes)[1] Institutional diversity (degree of polycentrism and nesting level in

					government, with efficient horizontal and vertical coordination) Internal capacity (degree of sufficiency of resources -money, information and expertise, authority and legitimacy- to achieve success on a specific goal) Stakeholders participation in decision making (degree of stakeholder's inclusiveness, with an adequate leadership arrangement and commitment to group and purpose)
Ecological system	Organic carbon dynamics		Net primary productivity (net productivity of organic carbon by plants in an ecosystem, e.g., Net Ecosystem Exchange, Net Carbon Flux, carbon accumulation rate) Organic carbon storage (biomass + litter + soil organic carbon)	Ecosystem composition by plant functional type (plant classification according to their physical, phylogenetic and phenological characteristics)	Gross Primary Productivity (total amount of carbon fixed in the photosynthesis by plants in an ecosystem) Radiation Use Efficiency (organic carbon produced by unit of absorbed solar radiation) Respiration (natural carbon dioxide emissions by ecosystems) Secondary productivity (represents the formation of living mass of a heterotrophic population or group of populations)
	Water dynamics	Precipitation (water + snow)	Actual evapotranspiration Actual water deficit -or excess- (due to climatic and ecohydrological conditions)	Soil water infiltration capacity	Actual Soil Water Storage Deep drainage (to aquifers) Extra-precipitation water contributions (e.g., surface or groundwater inputs by rivers or aquifers, respectively)

Evaporation - Transpiration ratio

Flows of green water (water in and on soils and on vegetation canopy)

Groundwater depth

Horizontal precipitation (e.g., fog, dew, frost)

Potential evapotranspiration

Potential water deficit -or excess- (due to climate conditions)

Precipitation Use Efficiency (organic carbon produced by unit of precipitation or by unit of evapotranspiration)

Snow precipitations

Snow storage

Total water yield or "blue water" (runoff + deep drainage)

Vegetation water stress (e.g., precipitation minus [potential or actual] evapotranspiration)

Surface energy balance		Net solar radiation (insolation)	Land surface temperature (sensitive heat)	Air temperature Deep ground heat flux Downward longwave radiation (thermal infrared [2.5-50 μm]) Downward shortwave radiation (visible [0.4-0.8 μm] + near ultraviolet [0.4-0.3 μm] + near infrared [0.8-2.5 μm]) Latent heat flux (heat spent in water evapotranspiration) Snow heat flux Upward longwave radiation (electromagnetic radiation) Upward shortwave radiation (visible [0.4-0.8 μm] + near ultraviolet [0.4-0.3 μm] + near infrared [0.8-2.5 μm]) (i.e. albedo)
Nutrient cycling	Nitrogen fixation (atmospheric nitrogen fixed by N-fixer organisms, e.g., Rhizobium)	Soil phosphorus availability (e.g., concentrations of non-occluded soil phosphorus)	Nitrogen deposition (wet and dry deposition of ammonium, nitrate and particulate nitrogen)	Gross nitrogen mineralization (e.g., rate of production of ammonium in soils) Net nitrogen mineralization (e.g., net rate of production of plant-available nitrogen) Nitrogen status of plants (e.g., plant tissue nitrogen concentrations) Phosphorus deposition (e.g., aerosols and atmospheric dust, etc.) Phosphorus status of plants (e.g., plant tissue phosphorus concentrations)

	Disturbance regime	Drought occurrence Flood occurrence	Fire occurrence	Hurricanes/storms occurrence Pest outbreaks occurrence		Herbivory (natural, not cattle grazing) Landslides occurrence Volcanic eruptions occurrence
Interactions	Ecosystem service supply[2]†	Cropland production (P) Livestock production (P) Surface and groundwater sources for drinking (P) Hydrological cycle and water flow maintenance (R)		Surface and groundwater sources for nondrinking purposes (P) Local climate regulation (R) Pest and disease control (R) Pollination and seed dispersal (R)	Chemical conditions maintenance of freshwater and saltwater (R)	Biomass-based energy sources (P) Bioremediation (R) Fibres and other materials from plants, algae and animals for direct use or processing (P) Intellectual and representative interactions (scientific, educational, heritage and cultural, entertainment, aesthetic contemplation) (C) Mass stabilisation and control of erosion rates (R) Physical and experiential interactions (with plants, animals, landscapes, seascapes) (C) Spiritual and/or emblematic interactions (symbolic, sacred and/or religious) (C) Ventilation (air renewal) (R) Wild plants, algae and their outputs for food (P) Wild animals and their outputs for food (P)
	Ecosystem disservice supply[3]				Abiotic-economic (e.g., droughts and fires	Abiotic-cultural (e.g., soil erosion rates, mud/landslide scar events,

				occurrence, siltation, leaching of nutrients) Bio-economic (e.g., biological invasions, agricultural and fisheries pests and diseases incidence, red tides)	unpleasant odours from rotting organic matter) Abiotic-health (e.g., flood and storm events occurrence) Bio-cultural (e.g., bird droppings on outdoor sculptures, tree roots cracking pavements) Bio-health (e.g., human diseases incidence from pathogens, allergens)
Ecosystem service demand		Appropriation of land for agriculture Energy use level (e.g., energy consumed per capita and year) Water use level (e.g., water consumed per capita and year) Water use for irrigated crops (e.g., water use per hectare and year)	Material use level (e.g., raw materials consumed per capita and year)	Human Appropriation of Net Primary Production (HANPP) (e.g., Tn C extracted per hectare and year)	Nature tourism (e.g., number of visitors to natural areas)
Human actions on the environment	Land cover/Land use change (e.g., agriculturization, urbanisation, land abandonment)	Eutrophication of water bodies Land protection (e.g., % of the territory declared as natural protected	Anthropogenic water management (e.g., water delivery, drainage and storage systems)	Net CO_2 flux (e.g., CO2 emissions - CO2 sequestration) Territorial connectivity (e.g., distance to main roads, travel time to major cities)	Anthropogenic carbon dioxide emissions (e.g., per capita CO2 emissions, CO2 emissions by sector of economic activity) Conservation tillage (sustainable agricultural practices for soil preservation)

	Land use intensity	area with a management plan) Pollution (toxic emissions and spills) Soil erosion (by anthropogenic practices)			Ecological restoration
Social-ecological coupling	Local natural capital dependence (e.g., % of final ecosystem services consumed by the population that are provided directly by local environment)		Access to natural and semi-natural areas (e.g., distance to a natural or seminatural area) Biocapacity (capacity of ecosystems to meet people's local demand and assimilate waste products)	Import [export] rates of agricultural products Renewable energy use (e.g., % of energy consumed coming from renewable sources)	Airports [ports] activity Cultural attachment to nature Dependence on fossil energies (e.g., % of energy consumed coming from fossil resources) Human perception of ecosystem services (awareness level of the population about services provided by local ecosystems) Human population ethnicity (e.g., % of indigenous population) Land tenure (e.g., % communal lands vs. private lands vs. government lands) Local green initiatives (e.g., in agriculture, cities, touristic activities, local companies) Non-ecosystem services demand (goods and services that do not come

	directly from ecosystems, e.g., socioeconomic services like hospitals, schools or culture, internet, manufactured products, technology)
	Population employed by sectors (agriculture vs. industry vs. services)
	Population employed in traditional (vs. intensive) agriculture
	Weight in the economy of the non-ecosystem services market (goods and services that do not come directly from ecosystems, e.g., socioeconomic services like hospitals, schools or culture, internet, manufactured products, technology)
	Weight of sectors in the economy (agriculture vs. industry vs. services)
	Weight of traditional (vs. intensive) agricultural sector in the economy

† P = provisioning services; R = regulating services; C = cultural services.

[1] Foster, K. A., and W. R. Barnes. 2012. Reframing Regional Governance for Research and Practice. *Urban Affairs Review* 48(2):272–283. [online] URL: https://doi.org/10.1177/1078087411428121

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In this paper, ecosystem disservices are defined as *"the ecosystem generated functions, processes and attributes that result in perceived or actual negative impacts on human wellbeing."*

We based on Shackleton et al. (2016) classification to distinguish among 6 categories of ecosystem disservices, according to their origin (biological or abiotic) and the nature of their impacts on human wellbeing (economic; physical and mental health and safety; aesthetics and culture): bio-economic, abiotic-economic, bio-health, abiotic-health, bio-cultural, abiotic-cultural. Examples of ecosystem disservices for each category are include in the Table above.

Table A5.3. Examples of studies that have used prioritized variables to map SES distribution and dynamics. The specific metrics used to map SESs associated with the priority variables identified in our study are listed. Nonpriority variables (those that obtained the lowest scores in the survey) and additional variables not included in our list are also matched to the metrics used to map SESs.

Component	Variable	Variable priority level	Reference	Metric
Social system	Educational level	2	Castellarini et al. (2014)	Human Development Index
			Hamann et al. (2016)	People with completed secondary schooling or higher
			Martín-López et al. (2017)	Illiterates
				People with university degree
			Rocha et al. (2020)	Literacy rate
			Vallejos et al. (2020)	School density
	Poverty	2	Václavík et al. (2013)	Gross Domestic Product
			Castellarini et al. (2014)	Human Development Index
			Hamann et al. (2016)	Household income
			Vallejos et al. (2020)	Unsatisfied basic needs
	Environmental quality	2	Queiroz et al. (2015)	Standing water quality
				Running water quality
			Dittrich et al. (2017)	Soil quality
	Conflicts	2	Dressel et al. (2018)	Potential for conflict index on moose managers evaluation of moose population
	Population density	3	Ellis and Ramankutty (2008)	Population density
			Asselen and Verburg (2012)	
			Václavík et al. (2013)	
			Hamann et al. (2015)	
			Renard et al. (2015)	
			Dittrich et al. (2017)	
			Martín-López et al. (2017)	
			Spake et al. (2017)	
			Levers et al. (2018)	
			Vallejos et al. (2020)	
			Rocha et al. (2020)	Population density
				Change in population density

Population distribution	3	Ellis and Ramankutty (2008)	Urban and non-urban population
Political stability	3	Václavík et al. (2013)	Political stability index
Population size	nonpriority	Hanspach et al. (2016)	Total population size
Migrations	nonpriority	Hanspach et al. (2016)	Net migration
		Martín-López et al. (2017)	Foreign population
		Rocha et al. (2020)	Inter & intra regional migrations
Age structure	nonpriority	Hanspach et al. (2016)	Proportion of pupils
		Martín-López et al. (2017)	People younger than 20
			People older than 65
		Rocha et al. (2020)	Ratio of children
Sex ratio	nonpriority	Dittrich et al. (2017)	Ratio female/male
		Rocha et al. (2020)	Ratio of woman
Life expectancy	nonpriority	Hamann et al. (2016)	Average age of death
Employment	nonpriority	Hamann et al. (2016)	Unemployed people
			Discouraged work-seeker
		Hanspach et al. (2016)	Unemployment rate
		Dittrich et al. (2017)	Unemployment rate
		Martín-López et al. (2017)	Unemployed inhabitants
		Levers et al. (2018)	Total labour input
		Vallejos et al. (2020)	Permanent workers
Economic level	nonpriority	Václavík et al. (2013)	Gross Domestic Product
		Castellarini et al. (2014)	Human Development Index
		Hamann et al. (2015)	Household income
		Hamann et al. (2016)	Household income
		Martín-López et al. (2017)	Income per capita
		Levers et al. (2018)	Economic activity index
Access to internet	nonpriority	Martín-López et al. (2017)	Number of ADSL lines

	Security	nonpriority	Hamann et al. (2016)	Property ownership (Percentage of households where dwelling is owned and fully paid off)
	Internal capacity of the government	nonpriority	Dittrich et al. (2017)	District debts
	Stakeholders participation in decision making	nonpriority	Dressel et al. (2018)	Proportion of general public that are relevant actors
Ecological system	Precipitation	2	Asselen and Verburg (2012)	Precipitation
			Václavík et al. (2013)	Precipitation
				Precipitation seasonality
			Dittrich et al. (2017)	Mean precipitation vegetation period
			Martín-López et al. (2017)	Mean annual precipitation
				Minimum annual precipitation
				Maximum annual precipitation
			Spake et al. (2017)	Annual precipitation
			Rocha et al. (2020)	Number of months with precipitation >60 mm
	Net Primary Productivity	3	Alessa et al. (2008)	Net Primary Productivity Index
			Ellis and Ramankutty (2008)	Net Primary Productivity (g m^{-2})
			Václavík et al. (2013)	NDVI – mean
				NDVI – seasonality
			Hamann et al. (2015)	Area with high grazing potential
			Spake et al. (2017)	Potential Net Primary Productivity (tC m^{-2} yr)
			Vallejos et al. (2020)	EVI – mean
				EVI – seasonality
	Organic carbon storage	3	Raudsepp-Hearne et al. (2010)	Carbon sequestration (kg C km^{-2})
			Asselen and Verburg (2012)	Soil organic carbon (g C kg^{-1} of soil)
			Václavík et al. (2013)	Soil organic carbon (g C kg^{-1} of soil)
			Renard et al. (2015)	Carbon sequestration (kg C km^{-2})
			Spake et al. (2017)	Carbon stocks from above-ground and below-ground biomass, dead organic matter and soils (tC km^{-2})
			Levers et al. (2018)	Soil organic carbon (tC ha^{-1})
	Actual evapotranspiration	3	Martín-López et al. (2017)	Mean annual evapotranspiration

			Minimum annual evapotranspiration Maximum annual evapotranspiration
Actual water deficit (or excess)	3	Levers et al. (2018)	Ratio of mean annual precipitation & mean annual potential evapotranspiration
		Rocha et al. (2020)	Mean aridity gradient
Net solar radiation	3	Václavík et al. (2013)	Solar radiation (W m^{-2})
		Dittrich et al. (2017)	Mean sunshine duration
Soil phosphorus availability	3	Raudsepp-Hearne et al. (2010) Queiroz et al. (2015)	Soil phosphorus retention
Land surface temperature	4	Asselen and Verburg (2012)	Mean temperature
		Václavík et al. (2013)	Temperature Diurnal temperature range Extreme temperatures
		Dittrich et al. (2017)	Mean temperature vegetation period
		Levers et al. (2018)	Growing degree days (T>0º)
		Rocha et al. (2020)	Mean temperature
Groundwater depth	nonpriority	Dittrich et al. (2017)	Groundwater level
Biodiversity	not in our list	Václavík et al. (2013)	Species richness
		Castellarini et al. (2014)	Distribution of ecoregions
		Hanspach et al. (2016)	Species richness
		Spake et al. (2017)	Species richness
		Levers et al. (2018)	Distribution of ecoregions
Natural capital	not in our list	Vallejos et al. (2020)	Native forest area
Other abiotic conditions	not in our list	Asselen and Verburg (2012)	Soil characteristics Altitude Slope
		Castellarini et al. (2014)	Ecorregions map
		Renard et al. (2015)	Soil capability for agriculture
		Hanspach et al. (2016)	Altitude Terrain ruggedness

				Slope
				Terrain wetness index
				Heatload
			Sinare et al. (2016)	Topography
			Dittrich et al. (2017)	Ruggedness
			Martín-López et al. (2017)	Altitude
				Slope
				Lithology
				Geomorphology
			Spake et al. (2017)	Elevation
			Levers et al. (2018)	Topographic heterogeneity
			Rocha et al. (2020)	Slope
Interactions	Cropland production	1	Raudsepp-Hearne et al. (2010)	Cropland production
			Václavík et al. (2013)	
			Hamann et al. (2015)	
			Queiroz et al. (2015)	
			Renard et al. (2015)	
			Dittrich et al. (2017)	
			Spake et al. (2017)	
			Levers et al. (2018)	
			Rocha et al. (2020)	Variance of crop production
				Kilocalories for diverse crops
			Vallejos et al. (2020)	Annual crops area
	Livestock production	1	Raudsepp-Hearne et al. (2010)	Livestock production
			Asselen and Verburg (2012)	
			Hamann et al. (2015)	
			Queiroz et al. (2015)	
			Renard et al. (2015)	
			Dittrich et al. (2017)	
			Martín-López et al. (2017)	
			Levers et al. (2018)	
			Rocha et al. (2020)	Cattle per km^2
				Small ruminants per capita
			Vallejos et al. (2020)	Forage crops area
				Pregnant cows

Surface and groundwater sources for drinking	1	Raudsepp-Hearne et al. (2010) Dittrich et al. (2017)	Drinking water quality - IQBP indicator (1-5) Clean water - nitrogen concentration in rivers (mg $N\ l^{-1}$)
Hydrological cycle and water flow maintenance	1	Hamann et al. (2015) Renard et al. (2015) Dittrich et al. (2017) Spake et al. (2017) Rocha et al. (2020)	Mean annual runoff Flood control Flood protection (biophysical dependent flood regulation by catchments) Physical water quantity regulation Soil water holding capacity
Land cover/Land use change	1	Ellis and Ramankutty (2008)* Asselen and Verburg (2012)* Václavík et al. (2013) Castellarini et al. (2014)* Hamann et al. (2015)* Hanspach et al. (2016)* Sinare et al. (2016)* Martín-López et al. (2017) * Spake et al. (2017)* Levers et al. (2018) Vallejos et al. (2020)* Dressel et al. (2018)	Multiple categories * (These studies include land cover and land use variables but not address changes directly) Diversity of land cover type
Land use intensity	1	Asselen and Verburg (2012) Václavík et al. (2013) Hanspach et al. (2016) Martín-López et al. (2017) Levers et al. (2018) Vallejos et al. (2020)	Efficiency of agricultural production Multidimensional (N fertilizer, irrigation, soil erosion, yields, HANPP) Landscape heterogeneity Cropland irrigation Greenhouses crops Wood production Fertilizer application rates Yields Stocking density Grassland yields Irrigated area Tractor density Stocking density

Soil erosion	1	Václavík et al. (2013)	Soil erosion
Land protection	1	Martín-López et al. (2017) Spake et al. (2017) Levers et al. (2018)	Surface in the municipality in the protected area Protected area coverage (Natura 2000) Changes in protected areas (Natura 2000)
Local natural capital dependence	1	Hamann et al. (2015)	Demand of ecosystem services provided by the local environment (wood for heating, wood production, crop production, animal production, freshwater, building materials) Female headed households
Water use level	2	Hamann et al. (2015) Martín-López et al. (2017) Rocha et al. (2020)	Use of freshwater from a natural source (a river or spring) Water consumption Dams
Water use for irrigated crops	2	Václavík et al. (2013)	Irrigated surface
Appropriation of land for agriculture	2	Ellis and Ramankutty (2008) Raudsepp-Hearne et al. (2010) Asselen and Verburg (2012) Václavík et al. (2013) Hamann et al. (2015) Renard et al. (2015) Queiroz et al. (2015) Hanspach et al. (2016) Spake et al. (2017) Martín-López et al. (2017) Levers et al. (2018)	Surface dedicated to agriculture
Pollination and seed dispersal	3	Queiroz et al. (2015) Dittrich et al. (2017)	Amount of pollinator habitat within a buffer of 200m from crop production areas Pollination potential (habitat suitable for pollinators)
Bio-economic ecosystem disservices	4	Dressel et al. (2018)	Competition (presence of other ungulate species) Predation (presence of bears)

			Predation (presence of wolves) Fresh browsing damage on Scots pine (Pinus sylvestris)
Human Appropriation of Net Primary Production (HANPP)	4	Václavík et al. (2013) Levers et al. (2018)	HANPP HANPP harvest for arable croplands, permanent crops and grasslands
Territorial connectivity	4	Václavík et al. (2013) Hamann et al. (2015) Renard et al. (2015) Hanspach et al. (2016) Levers et al. (2018) Rocha et al. (2020) Vallejos et al. (2020)	Accessibility (travel time to major cities and market places) Distance to city Distance from main city Remoteness (travel time by car to the next town >20000) Accessibility (travel time to major city >50000) Market access index Transport network connectivity (road density)
Import and export rates of agricultural products	4	Asselen and Verburg (2012)	Market influence Market accessibility
Wild plants, algae and their outputs for food	nonpriority	Raudsepp-Hearne et al. (2010)	Maple syrup
Fibres and other materials from plants, algae and animals for direct use or processing	nonpriority	Dressel et al. (2018) Levers et al. (2018)	Index of moose forage availability Variation in moose forage availability over 10 years Grassland yields Wood production
Wild animals and their outputs for food (P)	nonpriority	Dressel et al. (2018)	Size of moose management area Number of shot moose per square kilometre Ratio of moose to other ungulate species Frequency of moose meat consumption
Biomass-based energy sources	nonpriority	Hamann et al. (2015) Dittrich et al. (2017)	Wood for cooking, wood for heating Energy crops (amount of methane provided by crops for biogas production)

		Spake et al. (2017)	Potential woody biomass supply for stemwood and logging residues
Bioremediation	nonpriority	Dittrich et al. (2017)	Ability of rivers to remove nitrogen
Bio-health ecosystem disservices	nonpriority	Dressel et al. (2018)	Number of moose-car-collisions
Human perceptions of ecosystem services	nonpriority	Sinare et al. (2016)	Use of ecosystem services reported by locals
Nitrogen fertilizer	not in our list	Václavík et al. (2013) Levers et al. (2018)	Fertilized surface Fertilizer application rates [kg ha^{-1}]; <50 kg ha^{-1}, 50-150 kg ha^{-1}, >150 kg ha^{-1}
Urban solid waste	not in our list	Martín-López et al. (2017)	Urban solid waste production (Ton $year^{-1}$ ha^{-1})
Weight of sectors in the economy	nonpriority	Václavík et al. (2013) Martín-López et al. (2017) Levers et al. (2018) Rocha et al. (2020)	GDP in agriculture Capital stock in agriculture Hotel bedroom places Economic size of farms Total monetary inputs in farms Ratio of farmers
Land tenure	nonpriority	Hamann et al. (2015) Dressel et al. (2018) Levers et al. (2018) Vallejos et al. (2020)	Area under traditional authority rule Level of self-organization (geographic coverage of moose management units) Number of sub-units (i.e. license areas) per moose management area Diversity index of forest ownership types Diversity index of agriculture ownership types Property size classes of private forest owners Total utilised agricultural area (owner occupation or rented for >= 1 year) Area with legal type of farmer ‘Physical Person’ Area with land tenure regime ‘Owner’
Ethnicity	nonpriority	Hanspach et al. (2016)	Proportion of the main ethnic groups

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