SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

The Evaluation of Ecosystem Services - Development of the Methodology in Serbia

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The **sustainability** of the natural resources and environmental protection is the primary task of our community.

Successful ecosystems management

- show their services monetarily -

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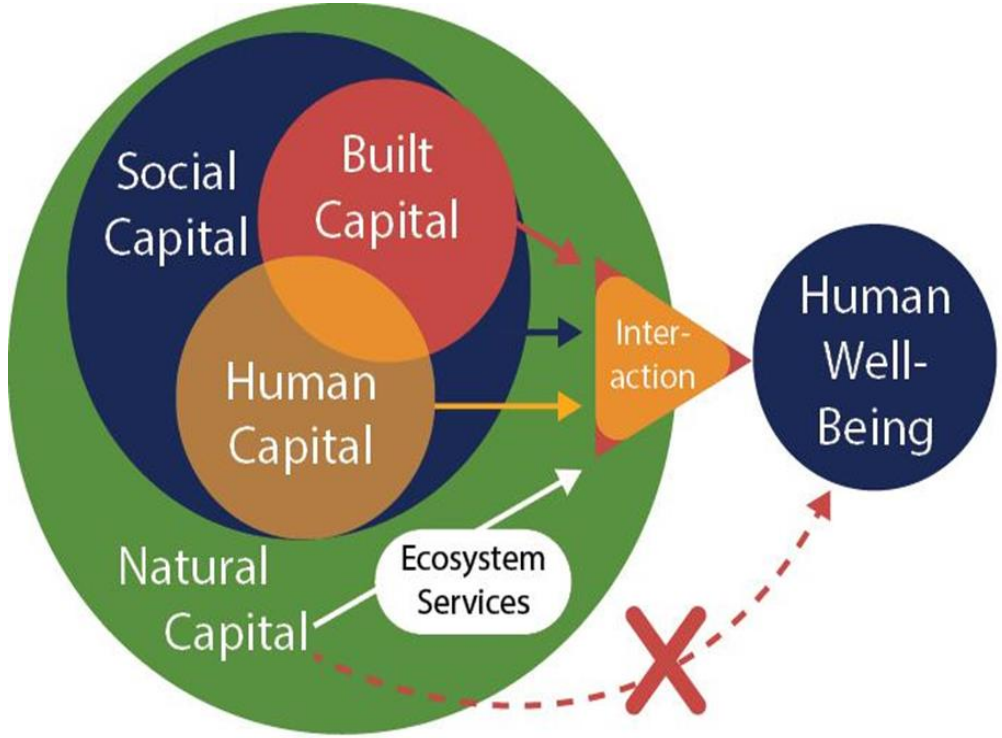
Ecosystems, if properly managed - benefit a flow of services that are vital to humanity:

- the production of goods (food);
- life support processes (water purification);
- life fulfilling conditions (beauty, recreation opportunities);
- conservation of options (genetic diversity for future use).

Ecosystem services:

"The benefits that people obtain from ecosystems "

-*The Millennium Ecosystem Assessment*, 2005



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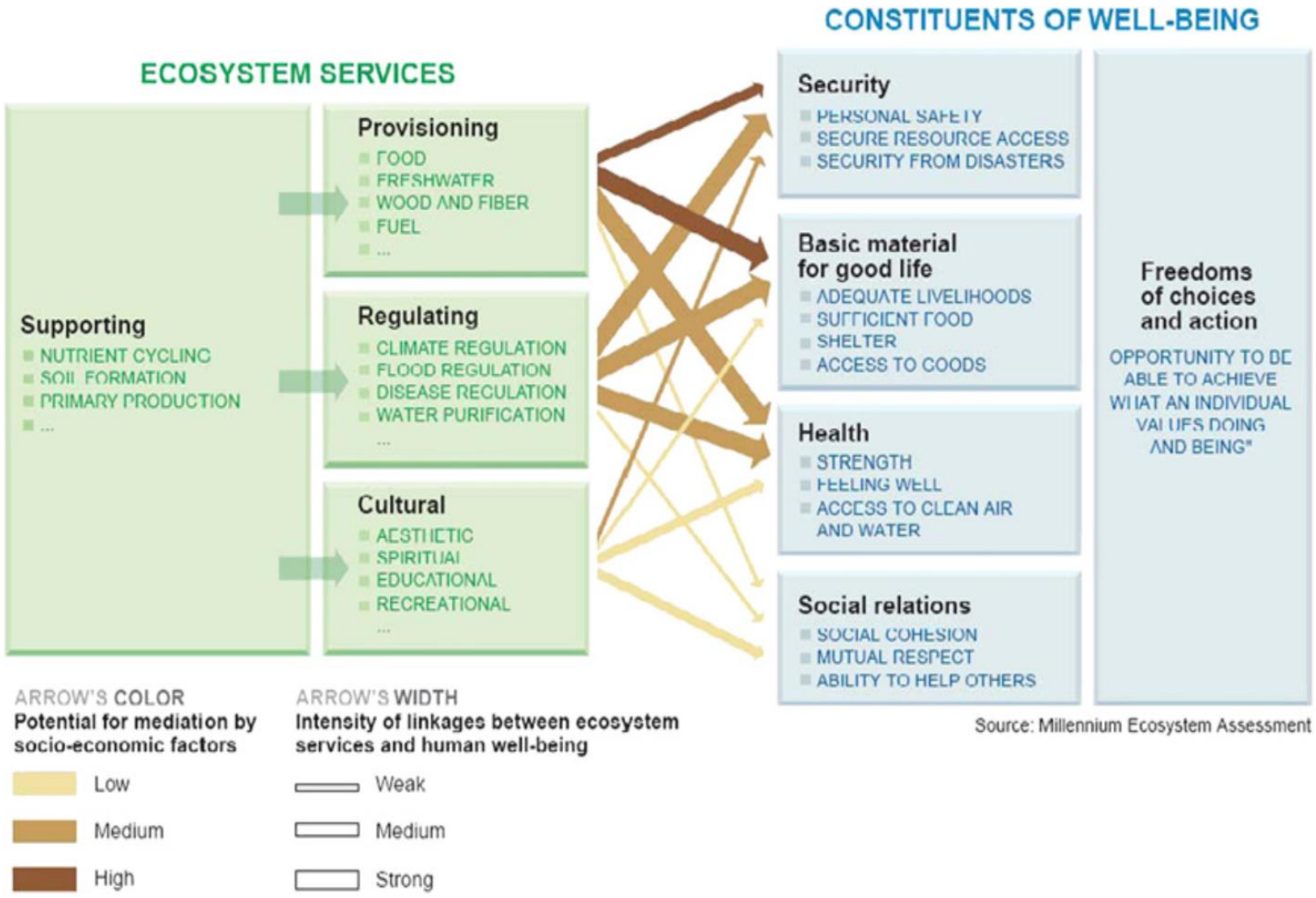
Millennium ecosystem assessment (MA) overview diagram



Source: Millennium Ecosystem Assessment

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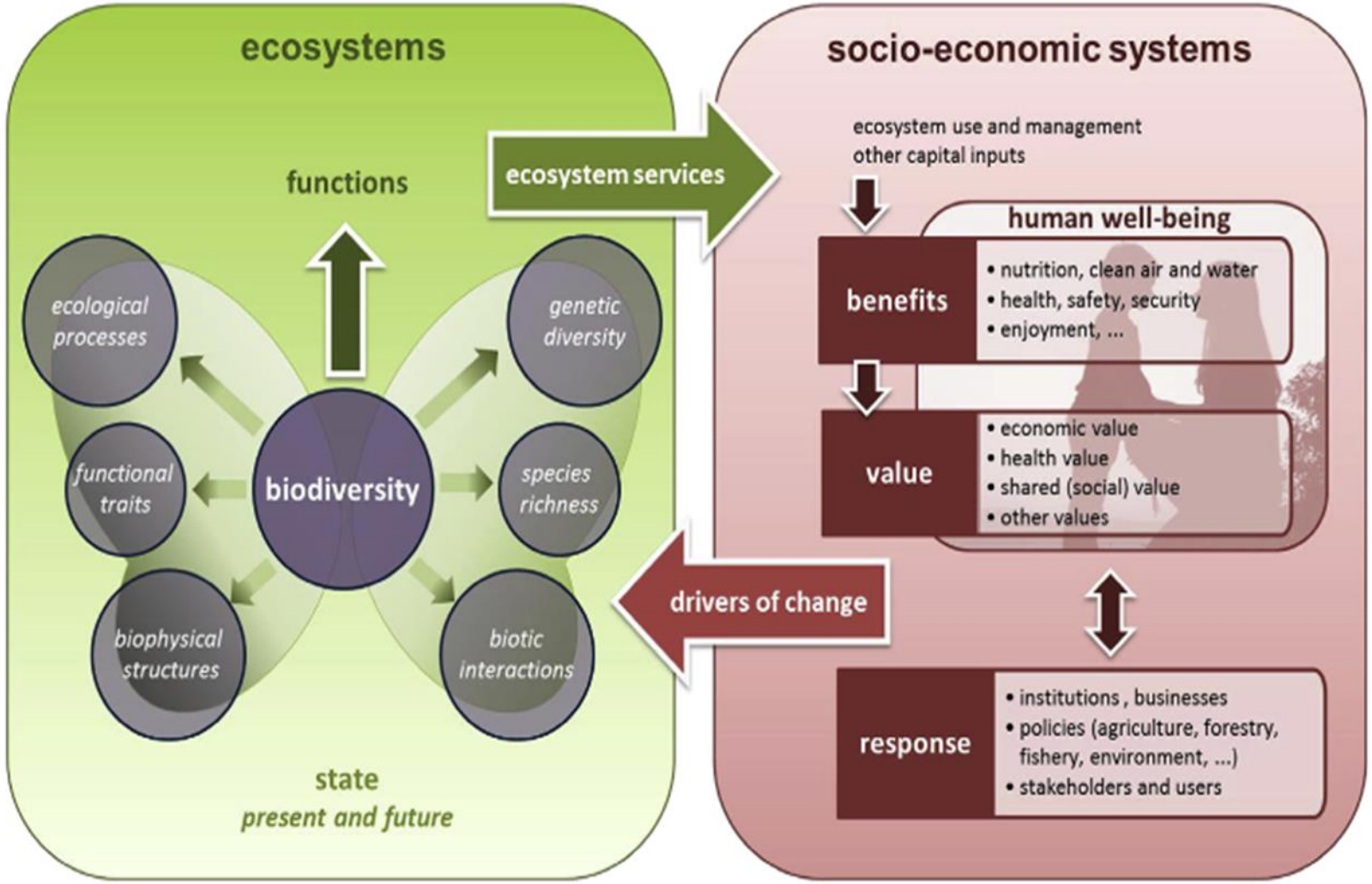
Conceptual framework for EU and national ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020



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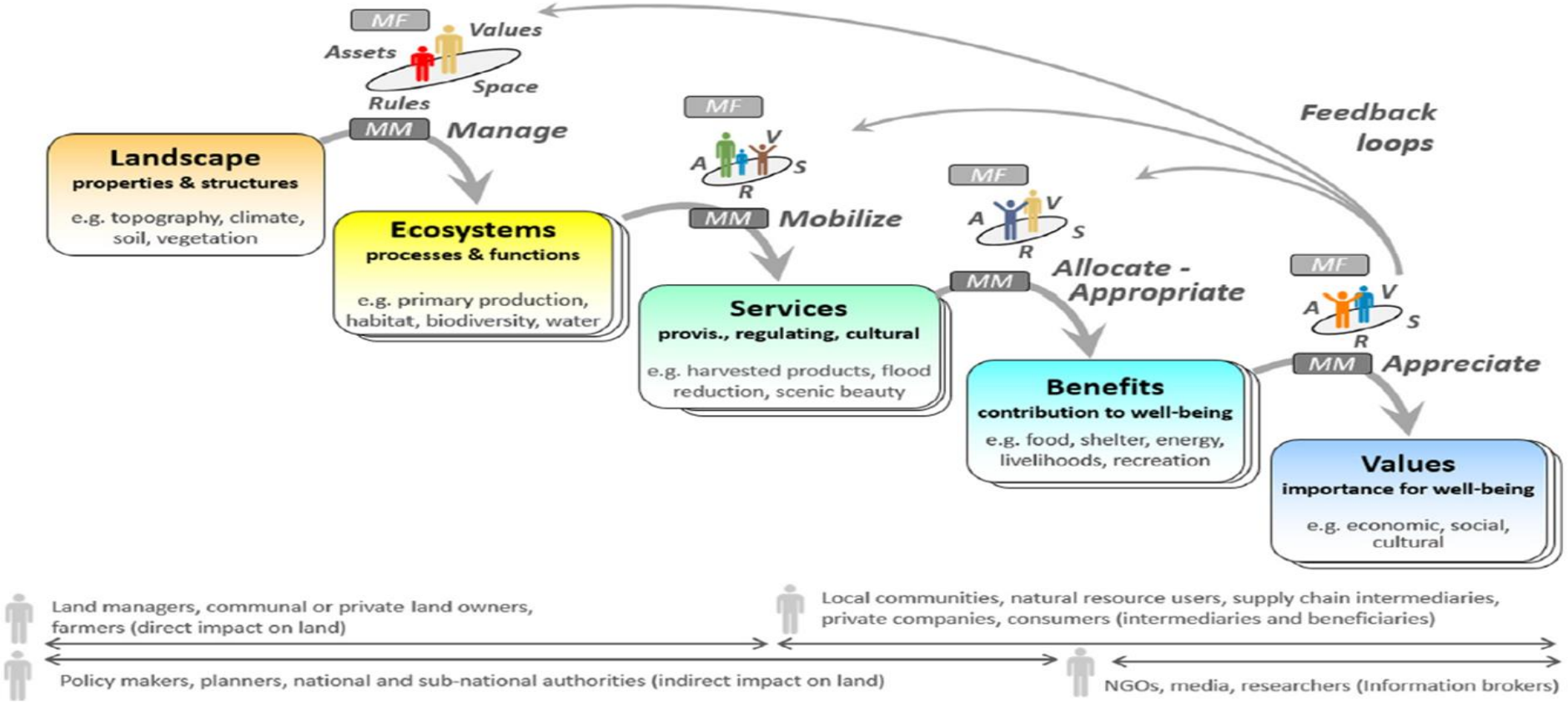
Cascade framework - The framework on mediating mechanisms and factors in ecosystem service delivery



Mediating mechanisms (MM) control ES flows along the cascade (rightward arrows). Mediating factors (MF) influence mediating mechanisms depending on the diversity of stakeholders involved (examples at the bottom). Feedbacks (leftward arrows) are created by the influence of ES appreciation on mediating mehanisms (Haines-Young and Potschin, 2010; Spangenberg et al., 2014a).

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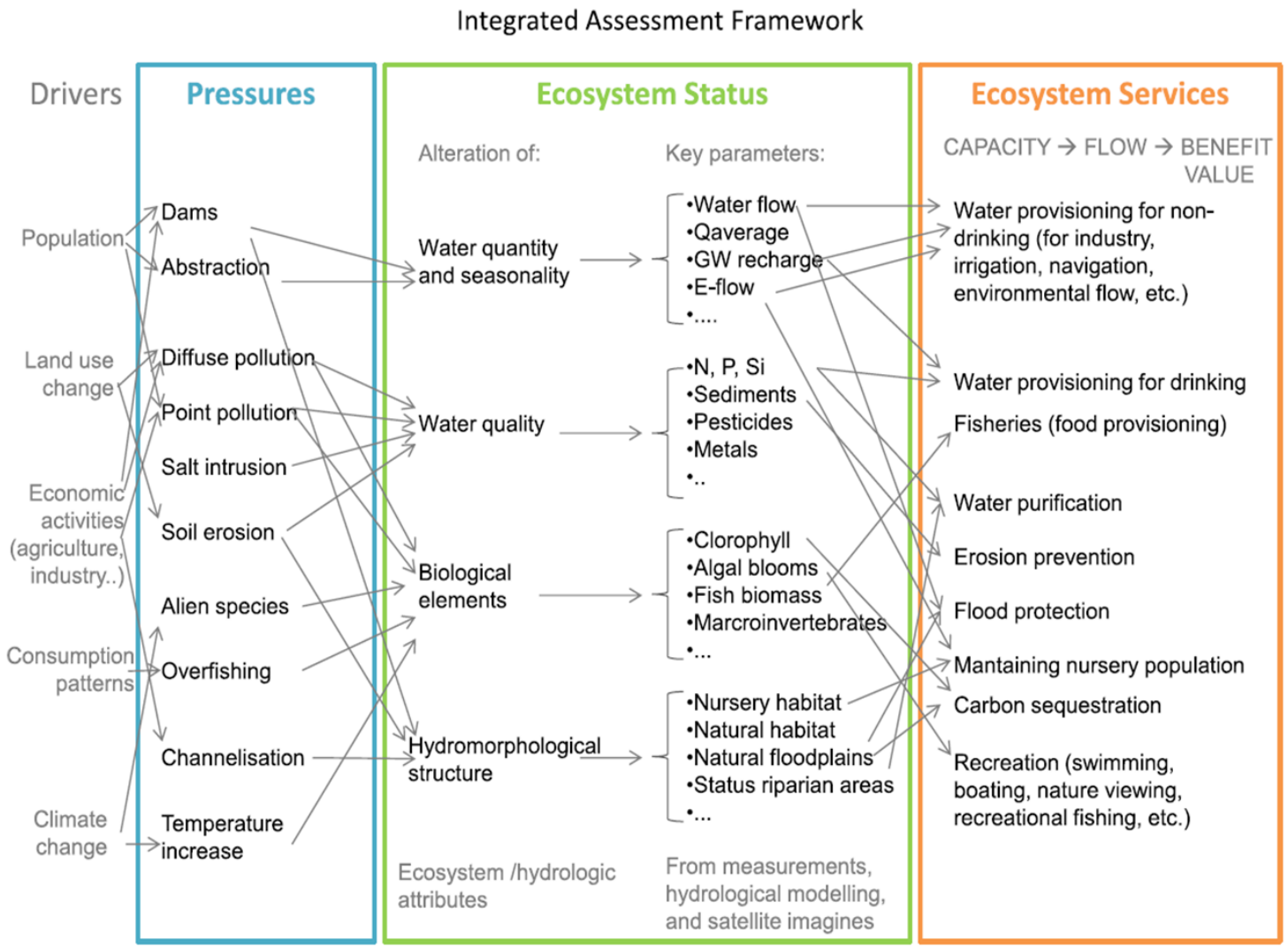
Links between pressures, ecosystem status and ecosystem services



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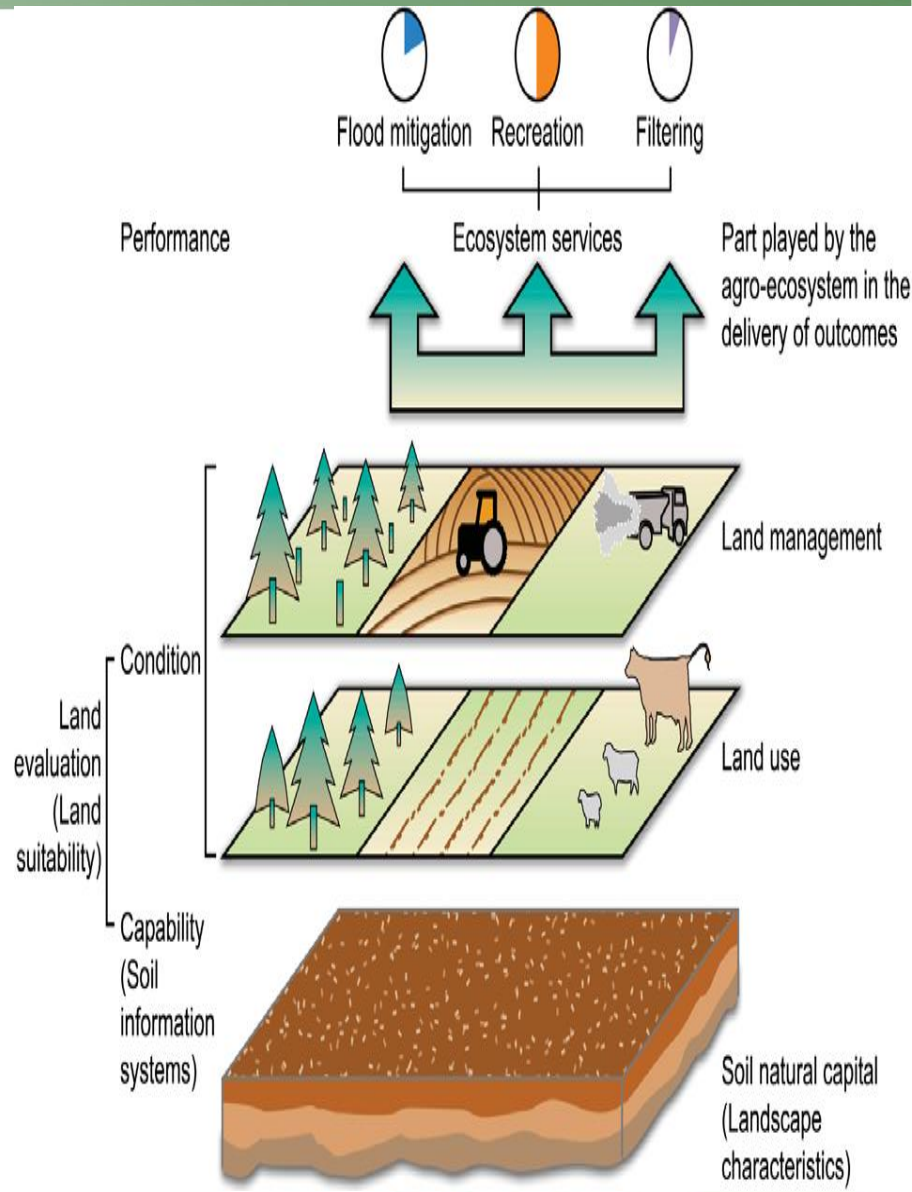
Soil-use and soil management decisions have major impacts on ecosystems as well as the benefits and services they provide to people.

Ecosystem services include:
- ***carbon sequestration*** (positive impact on climate regulation);
- nutrient retention (positive impact on water quality);
- water flow timing (has a role in flood and drought mitigation)
- inputs to the production of agricultural crops (soil productivity, pollination).

Changes in soil management (agricultural practices, forestry practices, intensity of development) can cause changes in the provision and value of ecosystem services.



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Cultural ecosystem services such as recreation that are provided by natural environments are known to be very important (Daniel et al., 2012), but quantification has been elusive and subjective (Burkhard et al., 2012) and their values are often overlooked.

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The assessment of the impact of ecosystem services is a very ***sensitive and complex issue.***

Long-term and extensive research is needed to fully monitor and evaluate ecosystem services.

The risk is related to the validity of the collected data (background), as well as the difficulties in the availability, harmonization and validation of the data, also valid methodology, market price and ect.

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Biodiversity and ecosystem services are a natural capital that is necessary to adequately **protect** and **evaluate**.

The loss of biodiversity makes the economic prosperity of the society decrease.

The purpose of the ecosystem valuation is to:

- unravel the complexities of socio-ecological relationships,
- define how human decisions would affect ecosystem service values
- express these value changes in units (monetary) that allow for their incorporation in public decision-making processes.

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- Based on the IUCN (World Conservation Union) report, the monetary value of ecosystem products and services in the United States is estimated to reach **33 trillion $/year**
- The United States GDP for the whole of 2008 was only 14.4 trillion $.
- For the European Union in the same year, GDP was 14.94 trillion $.

- In Serbia in the special nature reserve "Zasavica“, the natural capital is estimated at around 261 mil. €.

- The total value of the inflow from forests in 2006 was 394 mil. € (forest products from wood, hunting, recreation, erosion, carbon sequestration, forest preservation), while the maximum estimated value is 564 mil. €.

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	TOTAL ECONOMIC VALUE (TEV)				
	USE VALUE		NON-USE VALUE		
TEV CATE-GORIES	Direct use value	Indirect use valuet	Option value	Existence value	Bequest value
COMMONLY USED VALUATION METHODS	Market based, revealed preference, cost-based and state preference approaches	Change in productivity, cost-based and state preference approaches	Change in productivity, cost-based and state preference approaches	State preference approaches	State preference approaches

Decreasing ease of valuation

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- InVEST model - Integrated Valuation of Ecosystem Services and Tradeoffs (Tallis et al. 2008, http://invest.ecoinformatics.org/)
- Calculate the provision and value of ecosystem services.
- The aim is to align economic forces with conservation.
- InVEST uses maps and tabular data of soil use or other kind of ecosystem services in conjunction with environmental information (soil, topography and climate) to generate spatially explicit predictions.
- InVEST provides a powerful tool for simultaneously quantifying and valuing multiple ecosystem services.
- The output from InVEST can provide information useful to managers and policy-makers.

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- InVEST is designed to inform the decision makers on how changes in ecosystems are likely to lead to changes in the flows of benefits to people.

- InVEST often employs a production function approach to quantifying and valuing ecosystem services.

  A production function specifies the output of ecosystem services provided by the environment given its condition and processes.

- Once a production function is specified, we can quantify the impact of changes on the soil or in the water on the level of ecosystem service output.

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The data requirements and outputs summary table (Example)

InVEST Data and Model Inventory				
	Step	**Data requirements**	**Process**	**Outputs**
Biodiversity: Habitat Quality and Rarity (Tier 0)				
Required	**Supply**	Current Land use/land cover Threat impact distance Relative threat impact weights Form of threat decay function Threat maps Habitat suitability (optional: by species group) Habitat sensitivity to threats Half saturation constant	Calculate habitat quality and degradation based on threat intensity and sensitivity	Habitat degradation index; Habitat quality index
Optional	**Supply**	Protected status	Calculates rarity of current and/or future habitat types relative to baseline; calculates quality and degradation of baseline based on threat intensity and sensitivity	Relative habitat rarity index for current and/or future land use/land cover; Degradation and quality for baseline
		Baseline land use/land cover		
		Future land use/land cover	Calculates quality and degradation of future scenario based on threat intensity and sensitivity; optionally calculates habitat rarity relative to baseline	Habitat degradation, quality and optionally rarity for future scenario
Carbon Storage and Sequestration				
Required	**Service**	Land use/land cover Carbon in aboveground biomass Carbon in belowground biomass Carbon in dead organic matter Carbon in soil	Looks up carbon stock(s) per pixel	Total carbon stock (Mg/pixel)
Optional	**Service**	Carbon removed via timber harvest First year of timber harvest Harvest frequency Half life of harvested wood products Carbon density in harvested wood Biomass conversion expansion factor	Calculates carbon stored in harvested wood products per pixel	Total carbon stock, including that in HWP (Mg/pixel)
		Future land use/land cover	Calculates difference between carbon stocks	Carbon sequestration rates (Mg/pixel/yr)
Optional	**Value**	Value of sequestered carbon Discount rate Timespan Annual rate of change in price of carbon	Calculates value of carbon	Value of sequestered carbon (currency/pixel/yr)

Sediment Retenion Model: Avoided Dredging and Water Quality Regulation (Tier 1)				
Required	**Supply**	Land use/land cover Rainfall erosivity Soil erodibility Crop factor Management factor DEM Sediment retention efficiency for each LULC Slope threshold (%) Flow accumulation threshold	Calculates generated and retained sediment at pixel scale using USLE and routing	Mean annual erosion (tons/watershed/yr, tons/pixel/yr) Mean annual sediment retention (tons/watershed/yr, tons/pixel/yr)
Required	**Reservoir Service**	Reservoir dead volume (reservoir points of interest) Subwatershed and Watershed shapfiles	Subtracts sediment loads in reservior dead volume	Mean annual generated and retained sediment loads (tons/watershed/yr,
Required	**Treatment Plant Service**	Allowed sediments load in rivers (TMDL, etc.)	Subtracts sediment loads equal to allowed load	Annual average sediment retention of value to water treatment plants
Optional	**Avoided Dredge Value**	Mean annual dredging cost (Currency) Lifespan (years) Discount rate (%)	Calculates present value of dredging costs	Avoided dredge costs (currency/watershed/yr, currency/pixel/yr)
	Avoided Treatment Value	Mean annual sediment removal cost (Currency) Lifespan (years) Discount rate (%)	Calculates present value of treatment costs	Avoided treatment costs (currency/watershed/yr, currency/pixel/yr)
Managed Timber Production (Tier 1)				
Required	**Service**	Location of timber parcels Area per timber parcel Proportion of timber harvested per parcel per period Wood biomass harvested per parcel per period Harvest period per parcel Harvested wood mass:volume conversion factor	Calculates amount of timber harvested	Harvested timber volume (m3/parcel/yr) Harvested timber biomass (Mg/parcel/yr)
Optional	**Value**	Market price of timber Annual average plantation maintenance costs Annual average harvest costs Timeframe into future harvests will be valued Discount rate	Calculates net present value of timber harvested	Net present value of timber (currency/parcel/yr)

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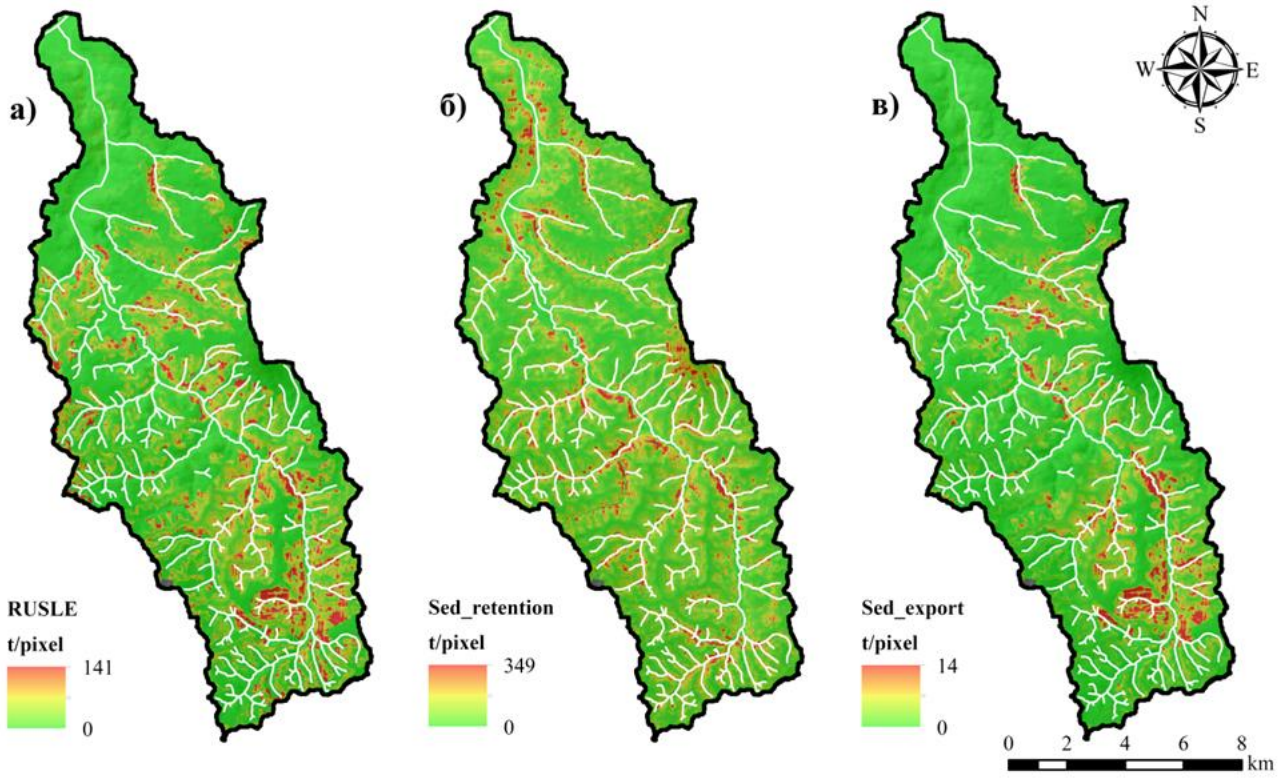
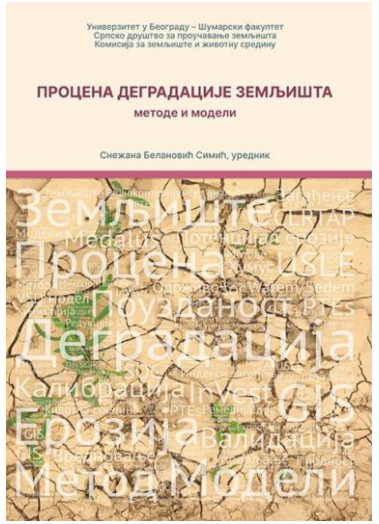
The SDRInVEST model was applied to the Topčiderska river basin





If the processes of degradation (erosion) are more pronounced, the intensity of wear of the productive, surface layer is greater, and the benefits of such soil are less.
From the economic aspect, the special impact of this situation (loss of land) in the basin is reflected in the agricultural areas, of which about 46.75% are in the basin.

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- The metodology proposal in the Republic of Serbia, would start with activities that would lead to the consideration of opportunities and benefits from complex ecosystem relations.
- The focus of the research would be on the soil resource, through the assessment of the state of erosion, that is

the degradation and the soil management.

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The proposal of the activities for the metodology would be:

- Identificating the **study area** (becouse of his local caracter);
- Defining **ecosystem services;**
- **Mapping** ecosystem services by priority;
- Including of all **stakeholder groups** (stakeholder, local self-government, environmental experts, biologists, economists ..., decision-makers);
- Forming the **database** (recording);
- Developing the **methodology**;
- Proposing the basic **guidelines** for the establishment of the mechanism of economic evaluation of ecosystem services.

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That would get relevant data that would serve to integrate these values into *national policies, plans, budgets and strategies* in certain sectors, which would lead to the sustainability of the whole society.

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During the work, it is necessary to continuously *calibrate and verify the data*, as well as a permanent cooperation with direct service users and local self-education.

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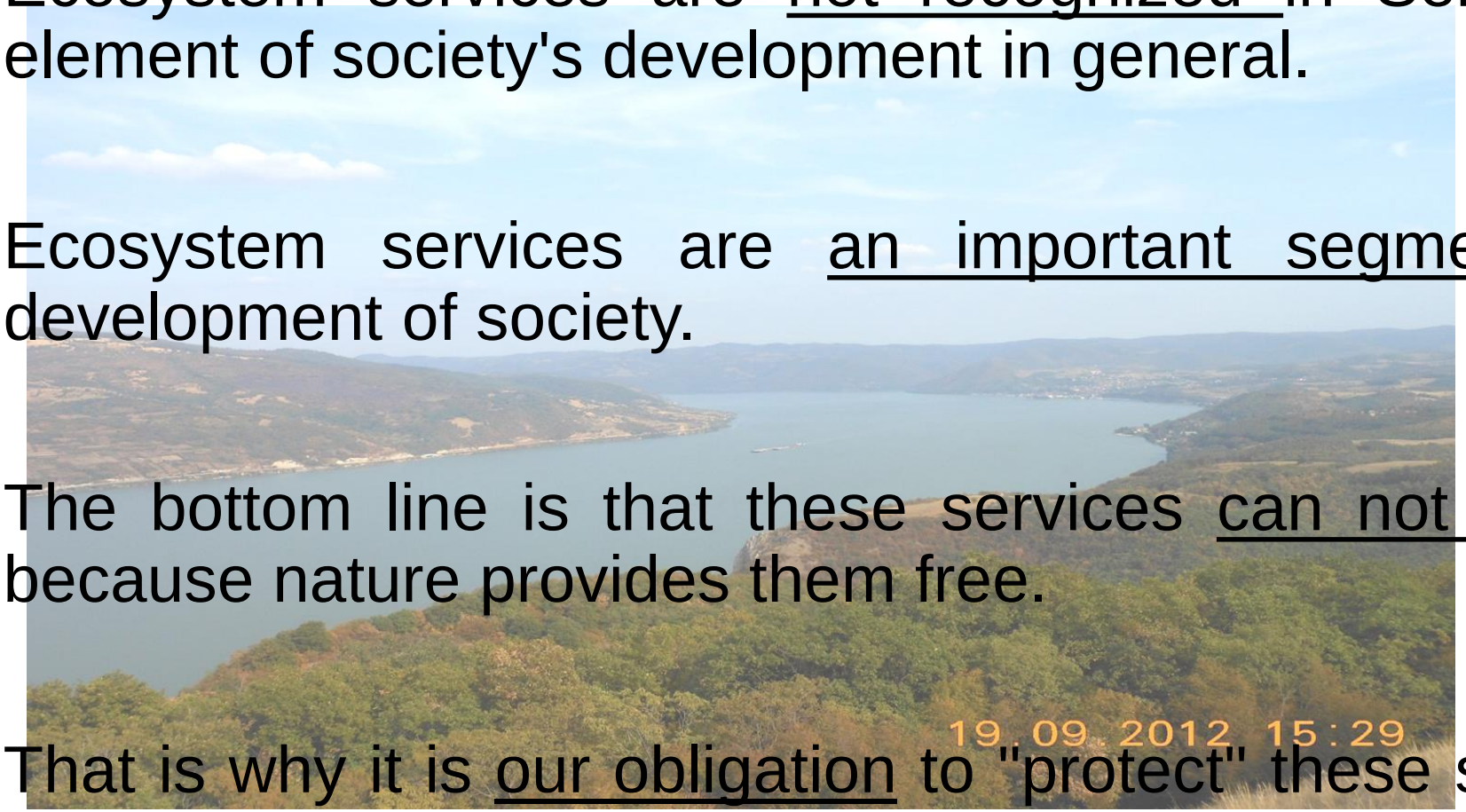
- Ecosystem services are not recognized in Serbia as an element of society's development in general.
- Ecosystem services are an important segment in the development of society.
- The bottom line is that these services can not be bought because nature provides them free.
- That is why it is our obligation to "protect" these services by using them properly.



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