Biodiversity, green infrastructure and ecosystem services: an introduction

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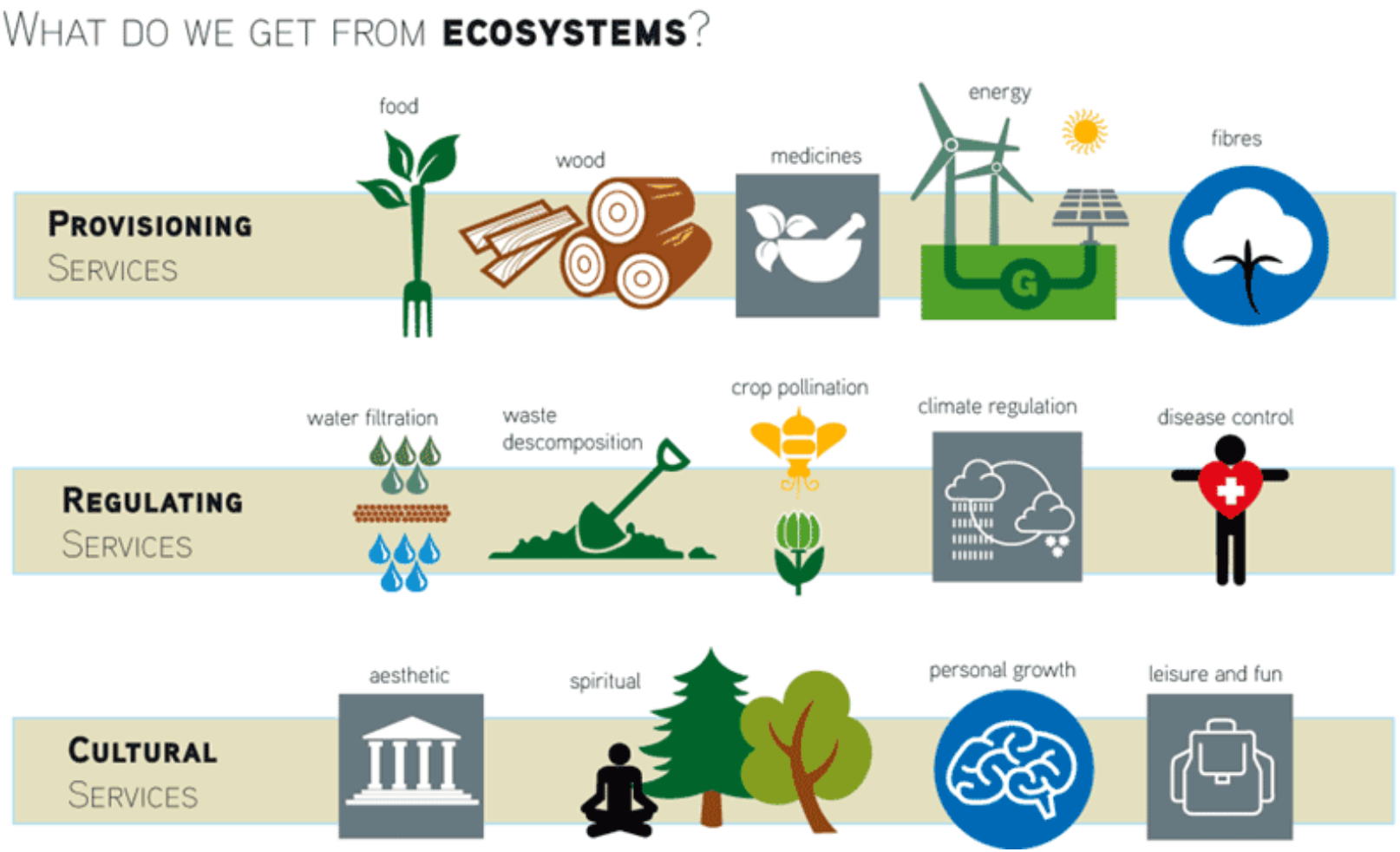
Ecosystem Services



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Source: https://www.greenandgrowing.org/ecosystem-services-importance/

EU Biodiversity Strategy to 2020

- **Target 2:**

  *"to improve knowledge of ecosystems and their services in the EU (Action 5) – the member states shall **map and assess the state of ecosystems and their services** in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020"*

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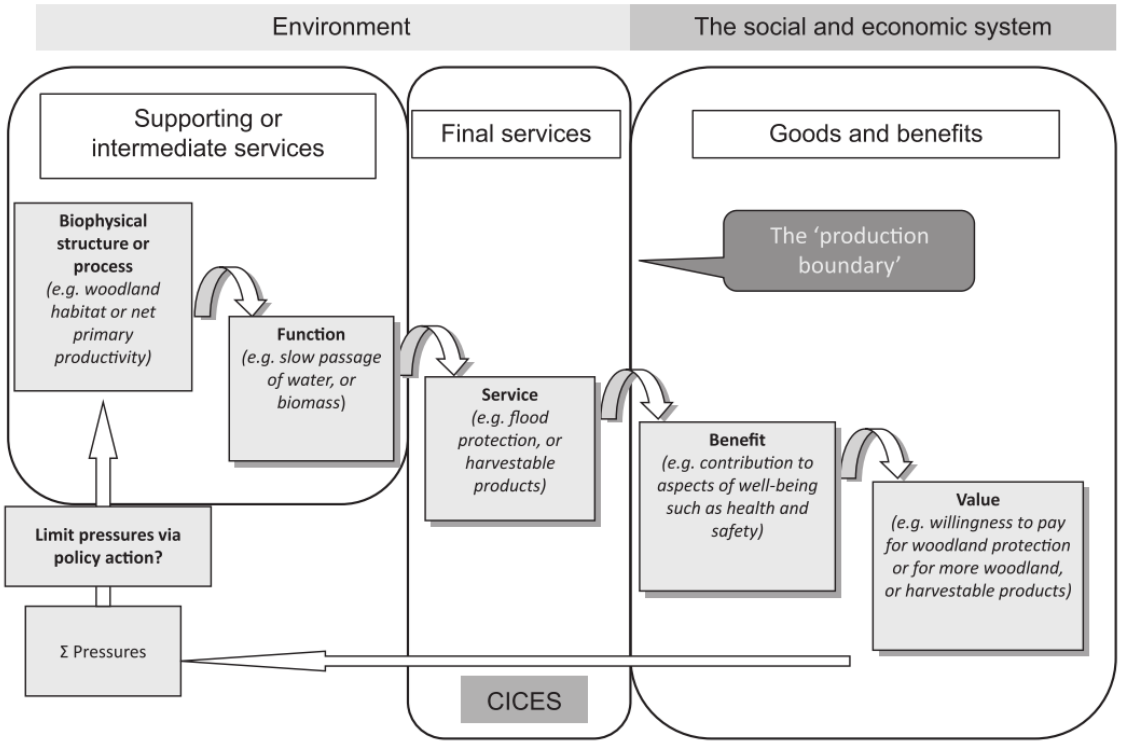
Source: http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm

Ecosystem Services

- A ‘pathway’ for delivering ecosystem services which goes from ecological structures and processes at one end through to the well-being of people at the other
- Ecosystem services are the direct and indirect contributions of ecosystems to human well-being (TEEB)
- Nature’s contributions to people (NCP): All the positive contributions or benefits, and occasionally negative contributions, losses or detriments, that people obtain from nature.



The ecosystem services cascade model

Source: Potschin & Haines-Young, 2016

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Policy Context for ES assessment in Malta

- Targets within Malta's National Biodiversity Strategy and Action Plan (NBSAP), which:

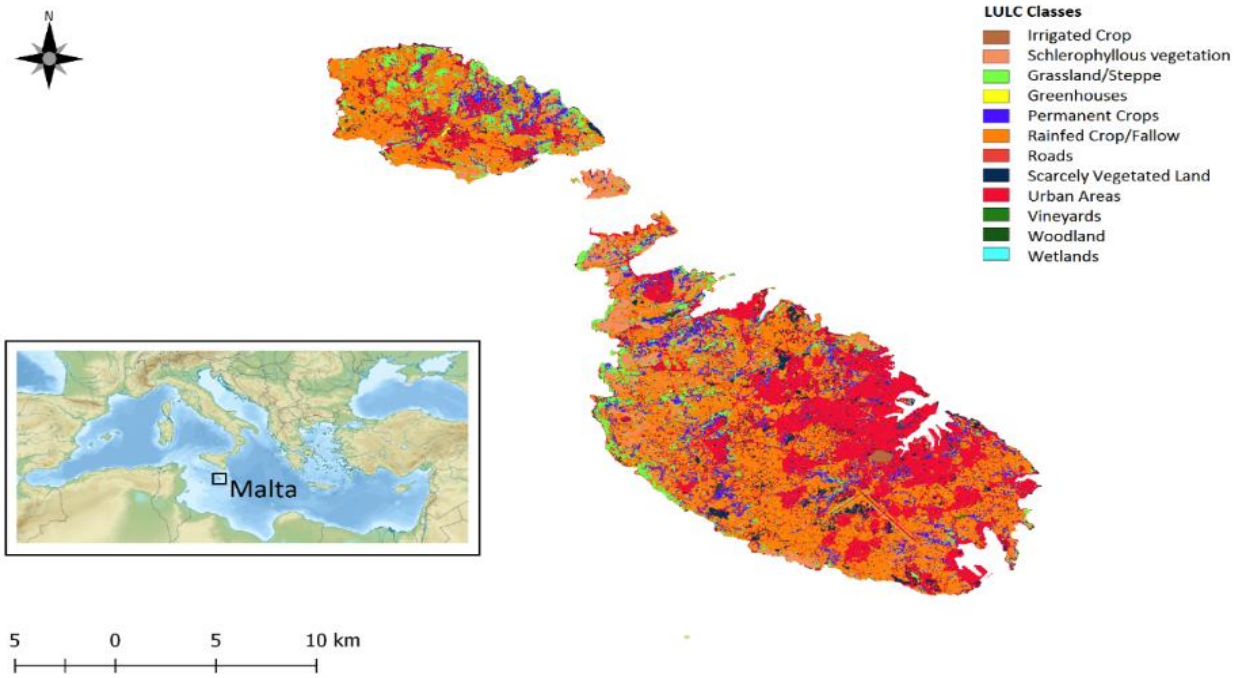
1) recognises the need to develop the knowledge base about biodiversity, its values, functioning, status and trends, and consequences of its loss (Target 18);
2) recognises the value of biodiversity and ecosystem services, and opportunities derived from their sustainable use, and to integrate these in national policies, as well as decision-making and planning processes (Target 2);
3) aims to restore at least 15% of degraded ecosystems and for the essential services provided vulnerable ecosystems to be safeguarded (Target 13)

Policy Context for ES assessment in Malta

- The Strategic Plan for Environment and Development (SPED, 2015) protects existing recreational areas to improve social cohesion, human health, air quality and biodiversity; supports the strengthening of the existing ecological network; calls for more green open spaces and promotes the adoption of sustainable urban drainage systems.
- The development of green infrastructure is considered critical for sustainable growth economic by the National Green Economy Strategy (2015).

Assessing spatial variability of ecosystem services: the Malta case-study

- An archipelago with an interesting biogeography, high biodiversity;
- But, long cultural history; agricultural land cover is approximately 50%; around 30% of the land is built-up
- Strong urbanisation and tourism trends; highest population density in Europe



Source: Balzan et al., 2018, Land Use Policy

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Mapping and Assessing Ecosystem Services

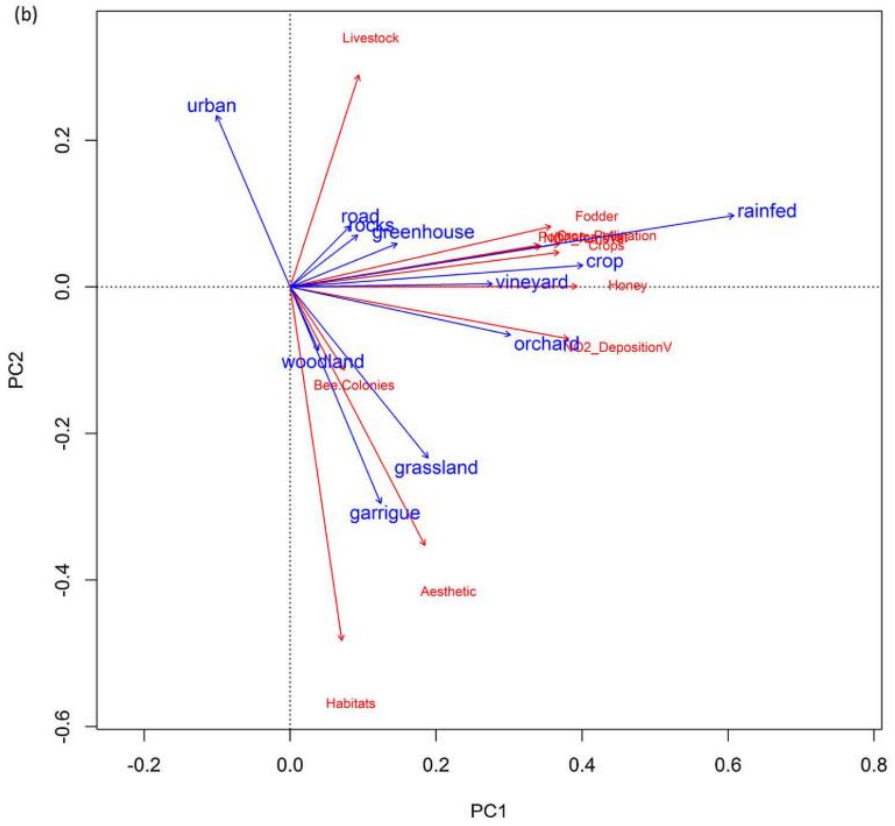
ES according to LULC category

Principal component analysis used to assess the ability of ecosystems to deliver multiple ecosystem services

Followed by environmental fitting of land use data onto ordination plot.

Length of arrow is proportional to correlation between environmental variable and ordination;

Only $p<0.05$ environmental data shown.



Source: Balzan et al., 2018, Land Use Policy

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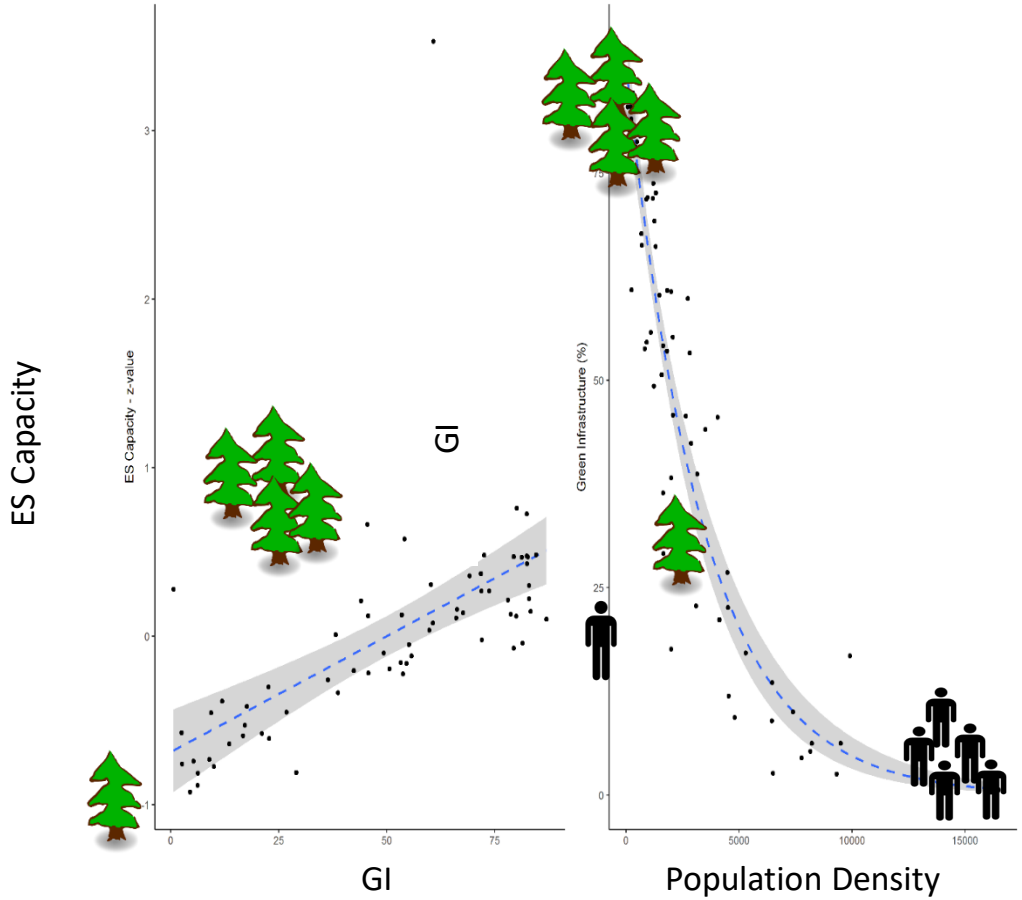
Linking ES capacity to GI availability

a) *ES capacity is directly associated with GI land cover*

b) *GI availability declines with an increase in population density*



Green Infrastructure (GI): *a strategically planned network of natural and semi-natural areas with other environmental features designed & managed to deliver a wide range of ecosystem services. It incorporates green or blue spaces and other physical features in terrestrial, coastal and marine areas. On land, green infrastructure is present in rural and urban settings.*

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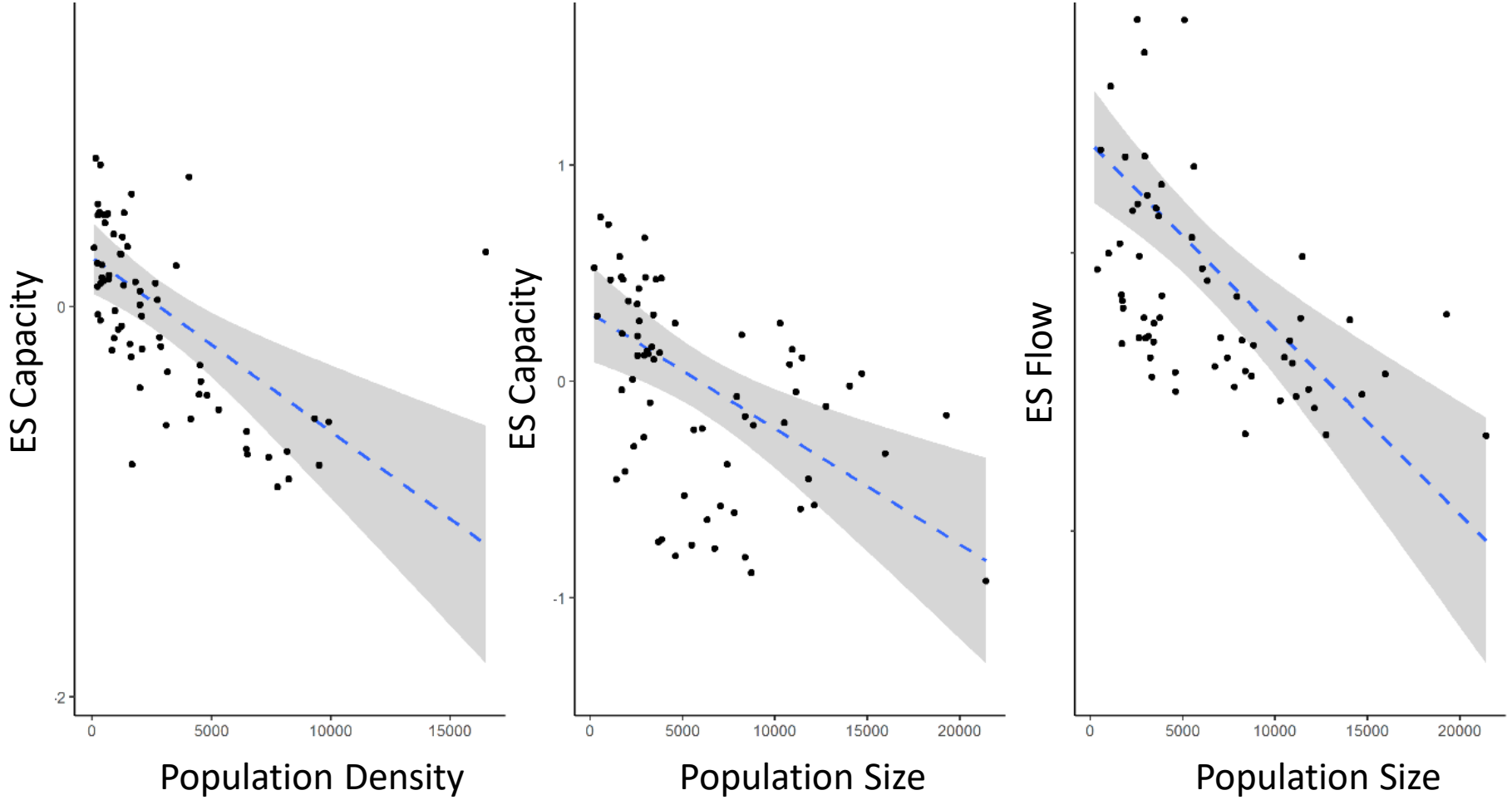
Source: Balzan 2017

Linking ES Capacity and Flow to Population Parameters



Scatterplots presenting the association between (a) ES capacity and population density, (b) ES capacity and population size and (c) ES flow and population size for local councils in Malta. Lines represent the linear regression function and 95% confidence intervals plotted on the scatterplot.

Source: Balzan 2017

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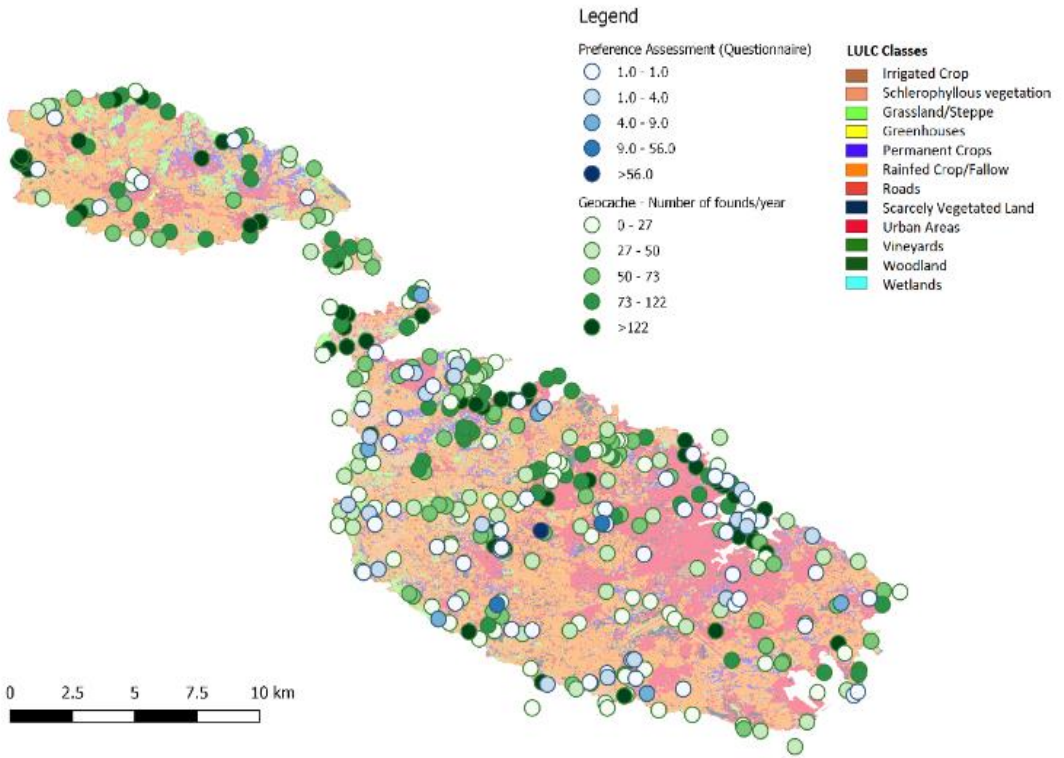
Assessing farm system dynamics

- DIVERCROP Malta case-study: Essentially, agricultural land uses, located outside of dense urban areas are associated with the capacity to provide multiple ES (synergies). But farmland is impacted by key drivers and pressures:
  - Urbanisation;
  - Intensification of agricultural production;
  - Abandonment and reduced farmer population;
  - Water resource availability;
  - Competition within a EU open market

Mapping recreational ecosystem services

Different approaches have been used given that often the data available does not provide a complete overview of the use of ecosystems for recreation. The map shown here includes two datasets on the use of ecosystems for recreation (1) from a questionnaire with 283 residents and (2) using geocache data (base map: Balzan et al., 2018; geocaching data: Balzan and Debono, 2018).



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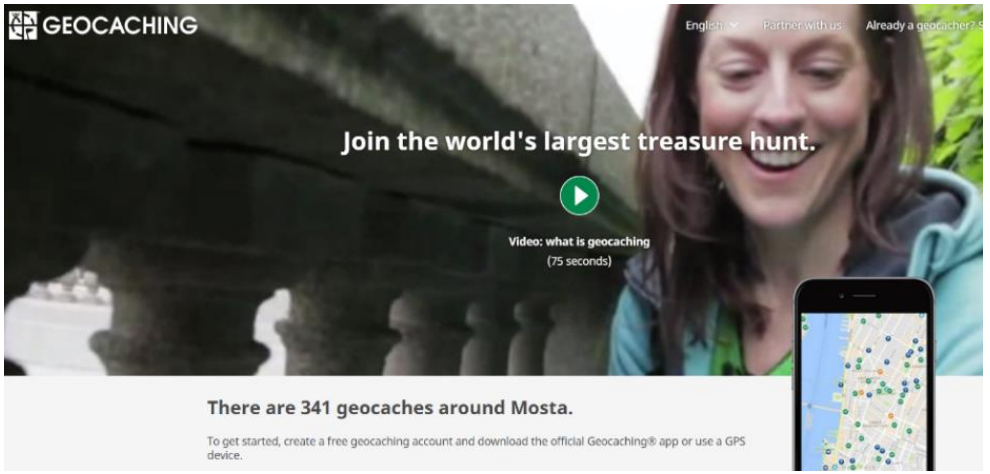
Source: Balzan 2018

Assessing Recreation Ecosystem Services

- Mean number of favourite points (± standard error of the mean) for the reclassified Urban Atlas land use categories



Source: Balzan & Debono, 2018, One Ecosystem

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Mapping Urban Green Infrastructure and Ecosystem Services

European Commission

- The case-study area is located within Malta's Northern Harbour and Southern Harbour regions.
- These regions have a total population of around 200,000, or 48% of Malta's total population (NSO, 2011), and have a total land area of 50.44 km^2.

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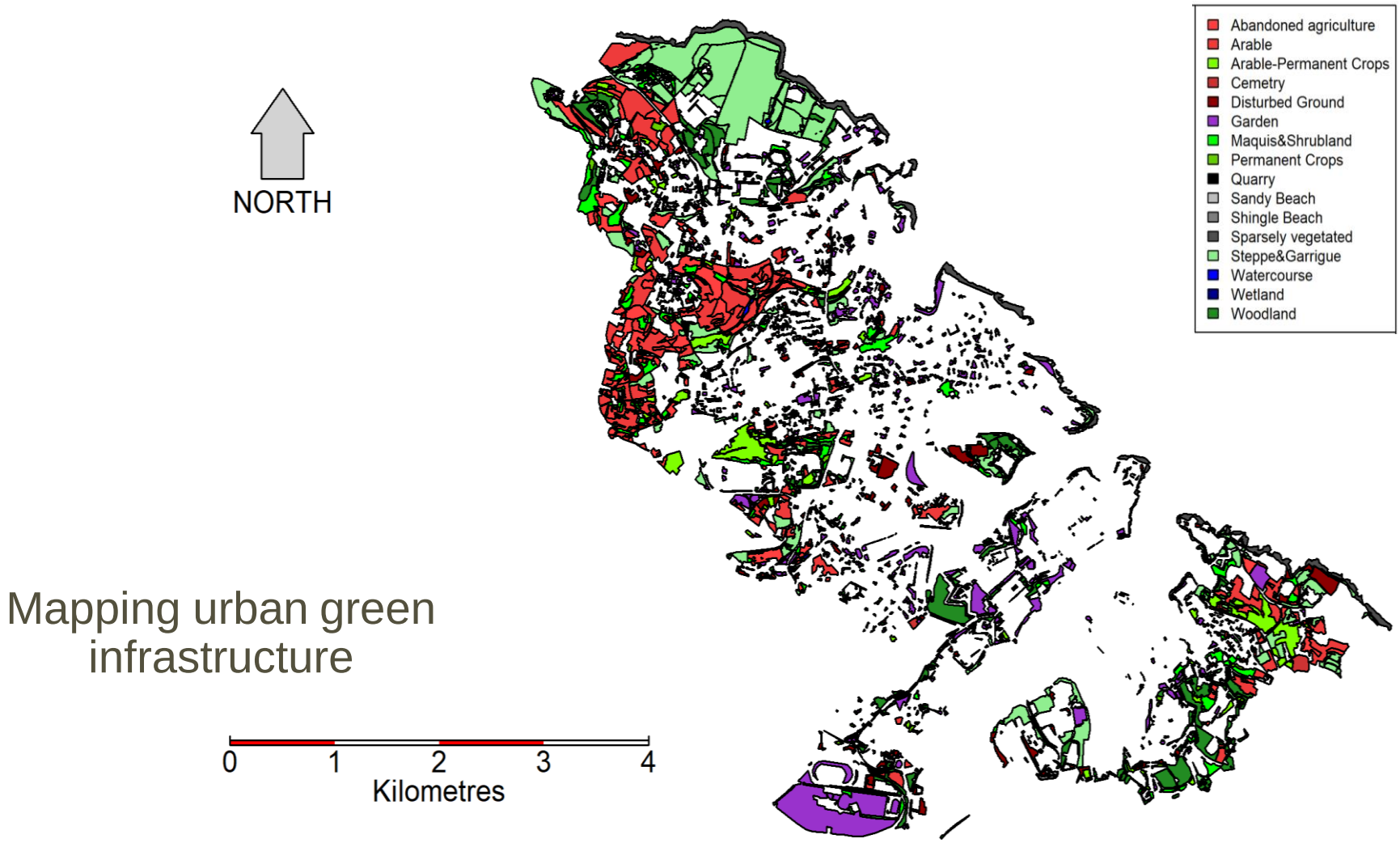
Photo credit: yachtworldcharters.com

Mapping Urban Green Infrastructure



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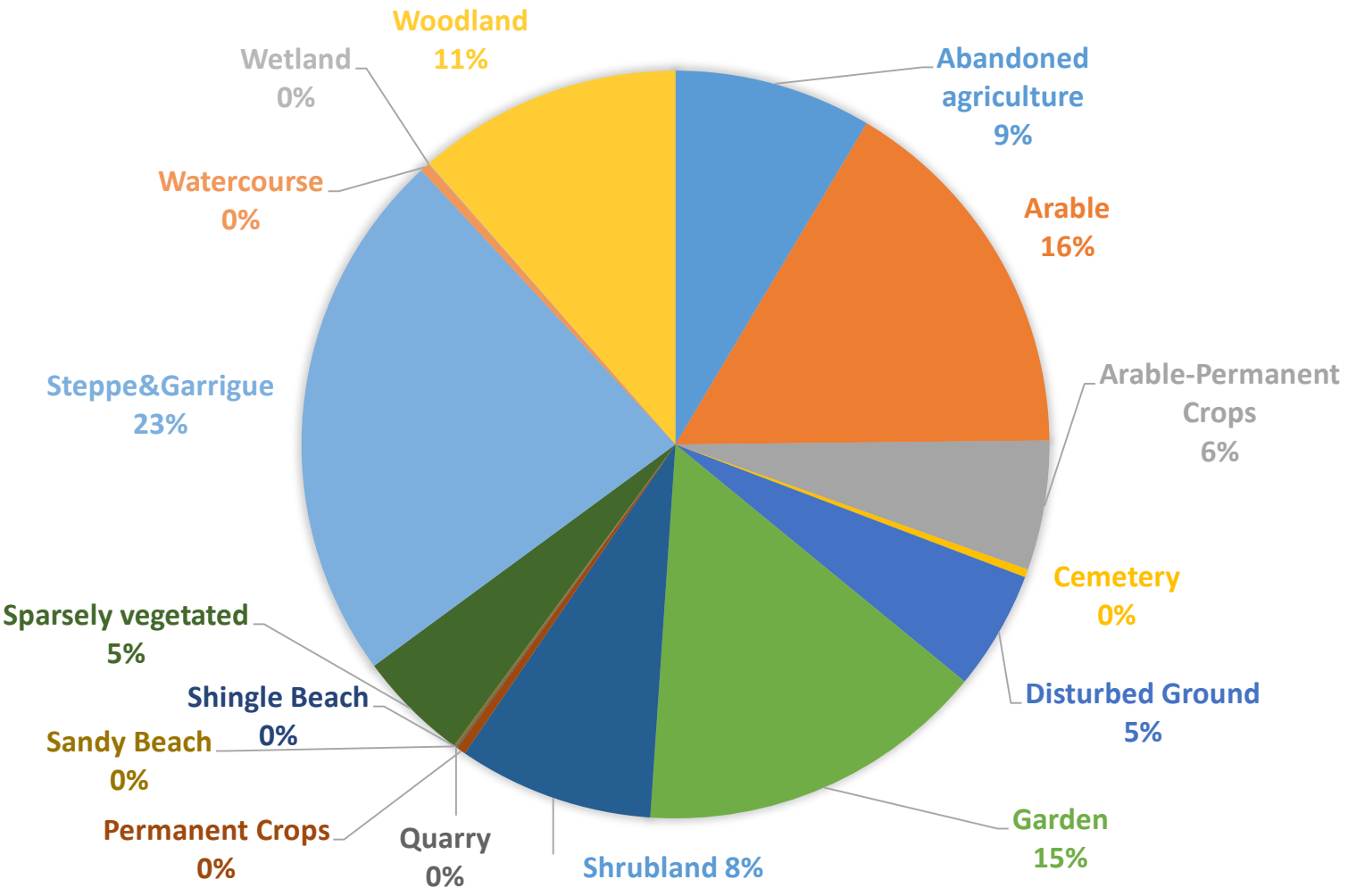
Source: Balzan et al., in prep.

Mapping Urban Green Infrastructure



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Source: Balzan et al., in prep.

	Relative contribution of UGI types to ES within the study area (Source: Balzan et al., in prep.)			
UGI Category	**Noise Abatement**	**Carbon Storage**	**NO_2 Removal capacity**	**Cooling Effect**
Abandoned agriculture	2.17%	5.48%	5.03%	9.50%
Arable	4.56%	7.13%	6.28%	11.91%
Arable-Permanent Crops	4.70%	3.20%	2.87%	3.63%
Cemetery	0.10%	0.10%	0.12%	0.12%
Disturbed Ground	3.90%	4.11%	3.48%	5.48%
Garden	**29.26%**	**22.91%**	**23.08%**	**15.47%**
Maquis & Shrubland	**26.44%**	**18.84%**	**14.77%**	**16.66%**
Permanent Crops	0.75%	0.53%	0.54%	0.55%
Quarry	0.00%	0.05%	0.02%	0.03%
Sandy Beach	0.00%	0.00%	0.01%	0.09%
Shingle Beach	0.00%	0.01%	0.01%	0.06%
Sparsely vegetated	0.00%	0.21%	0.22%	0.78%
Steppe & Garrigue	6.82%	6.04%	23.52%	13.70%
Watercourse	0.00%	2.10%	2.08%	4.24%
Wetland	0.00%	0.10%	0.14%	0.08%
Woodland	**21.29%**	**29.19%**	**17.82%**	**17.68%**

Spatial variation of ecosystem services

- Strong dependence on **rural landscapes** for their capacity to provide key services and benefits (e.g. food, recreation, air quality regulation; biodiversity);
- Low ecosystem service capacity of **urban landscapes** *but high intensity of use (flow)* of green infrastructure/ecosystem services in urban areas (e.g. higher visitation rate to recreational sites; better placed to remove pollutants);

Spatial variation of ecosystem services

- *Some ecosystems appear to be more efficient at providing ecosystem services* (a consequence of their biophysical structure, condition, accessibility, etc.);
- Ecosystem assessments can provide the basis for the implementation of nature-based solutions that enhance ecosystem capacity to provide co-benefits for biodiversity and human well-being.

Nature-based solutions

- Definitions:
  - Living solutions inspired by, continuously supported by and using nature, which are designed to address various societal challenges in a resource-efficient and adaptable manner and to provide simultaneously economic, social, and environmental benefits (EU DG R&I).

  - Nature-based Solutions (NbS) are defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".

IUCN Conceptual Framework

Nature-Based Solutions

NbS cover a wide range of approaches which can be grouped in 5 categories:

Category of NbS Approaches	**Examples**
Ecosystem restoration approaches	Ecological restoration Ecological Engineering Forest landscape restoration
Issue-specific ecosystem-related approaches	Ecosystem-based adaptation Ecosystem-based mitigation Climate adaptation services Ecosystem-based disaster risk reduction
Infrastructure-related approaches	Natural infrastructure Green infrastructure
Ecosystem-based management approaches	Integrated coastal zone management Integrated water resources management
Ecosystem protection approaches	Area-based conservation approaches, including protected area management

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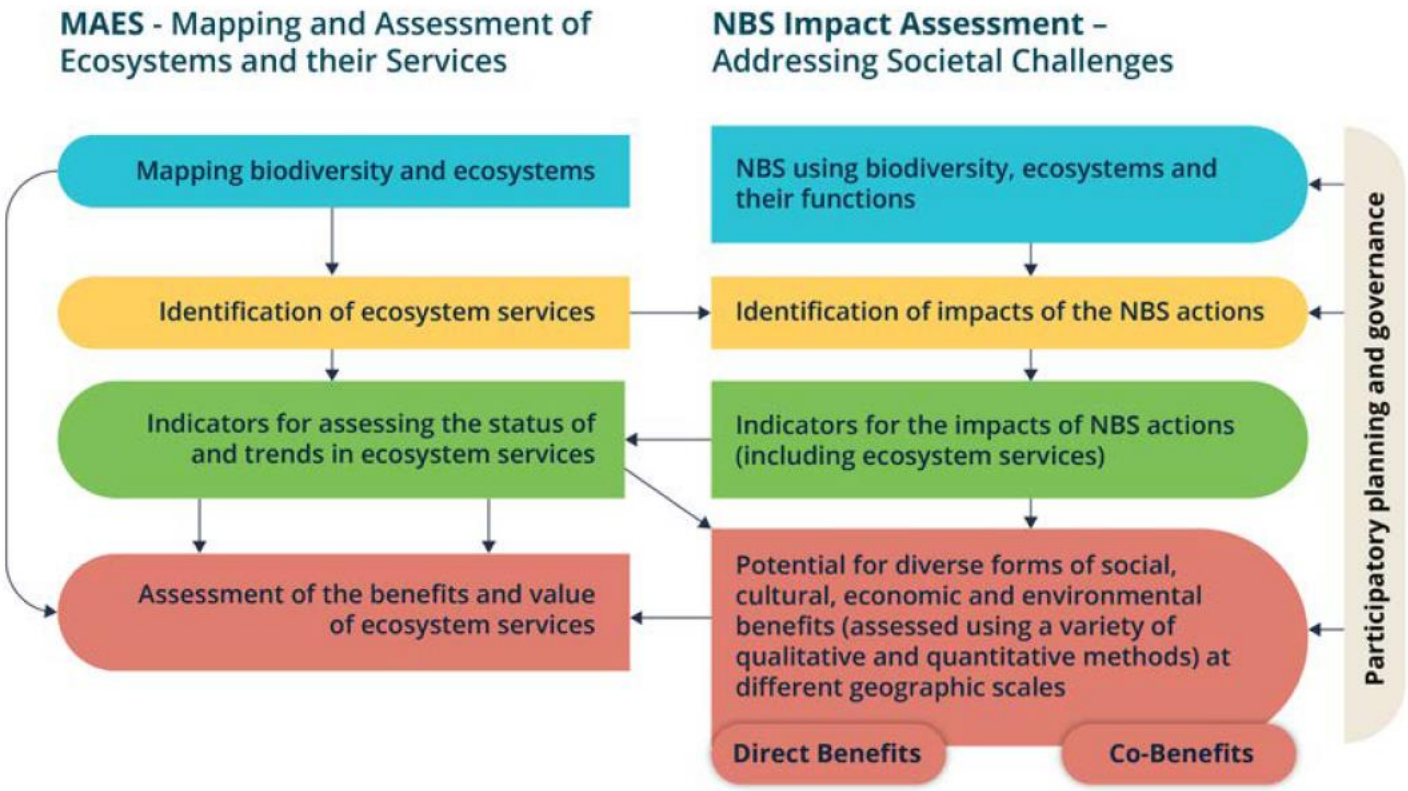
Source: https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions

Relationship between NBS and ES assessments



Flow diagram showing the relationships between the NBS impact assessment framework and MAES

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Source: Raymond et al., 2017

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