

Optimising the implementation of the 2nd RBMP in the Malta River Basin District

Assessing ecosystem services for water
catchment management

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GOVERNMENT OF MALTA
MINISTRY FOR GOZO



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Ecosystem service assessment for water management

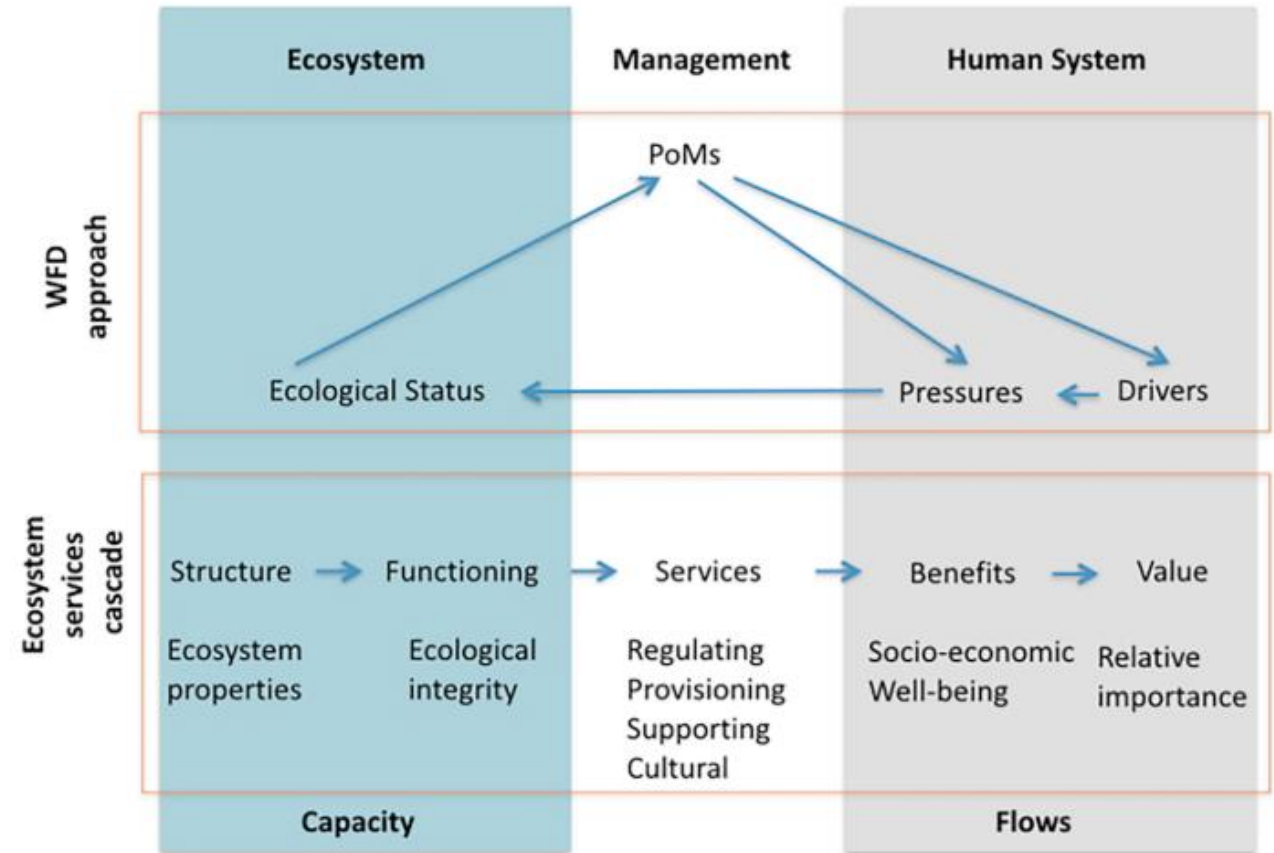
The integration of ES approaches in the Water Framework Directive (WFD) implementation is recognised a significant challenge (Vlachopoulou et al., 2014; Voulvoulis et al., 2017; Carvalho et al., 2019)



Conceptual Framework

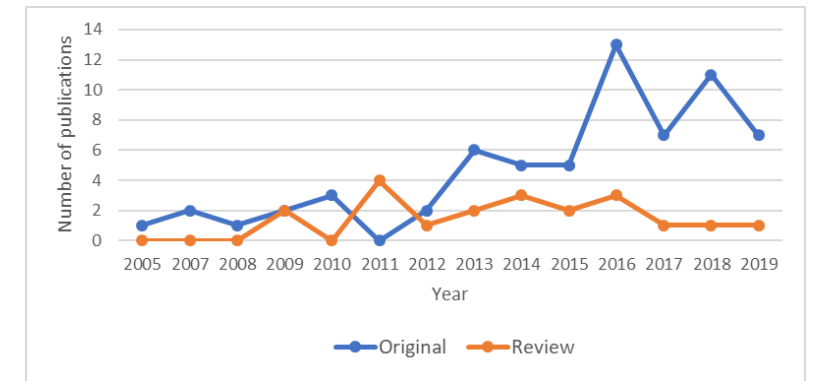
The development of River Basin Management Plans (RBMP) under the WFD is an actual situation where territorial planning for water management is needed, and where the concept of ecosystem services could be adapted to recognise the multifunctionality of water bodies and account for the benefits people receive from nature.

Literature review evaluating how ES approaches in water management, and the implementation of river basin management plans (RBMP)

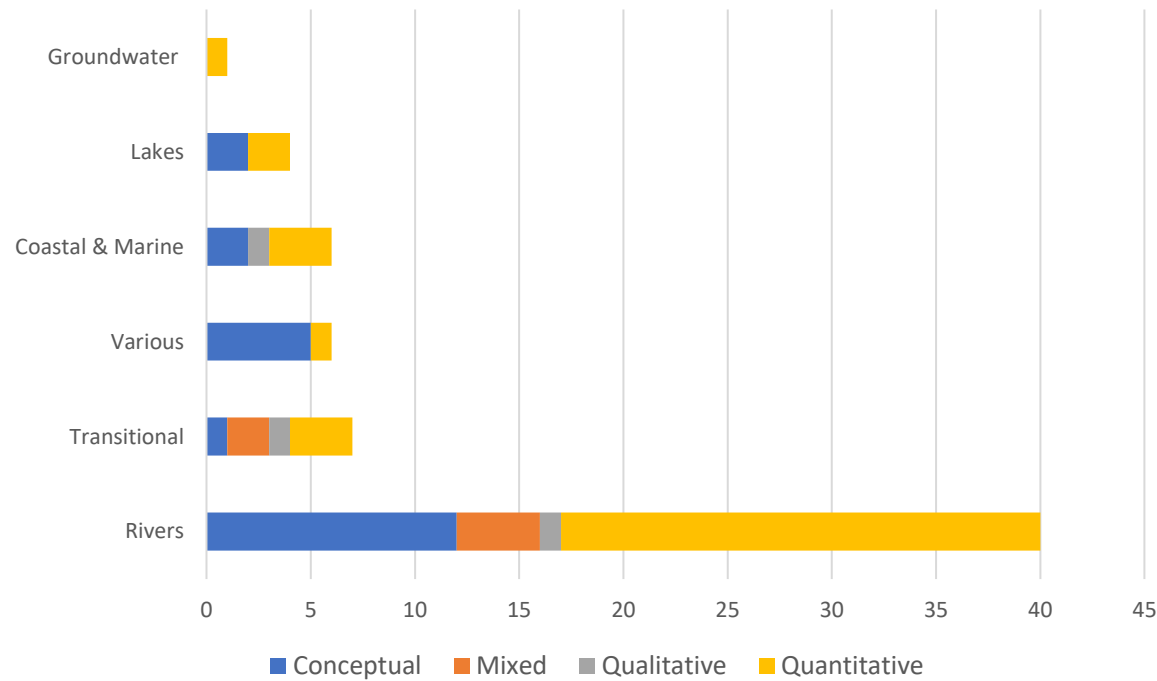
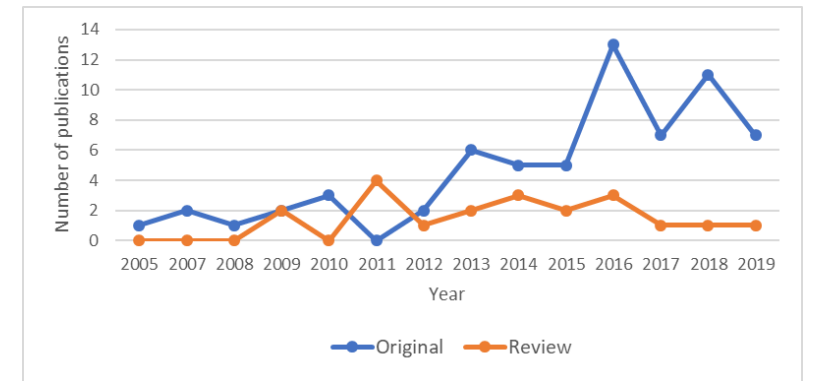


(Source: Giakoumis and Vosulvoulis, 2018)

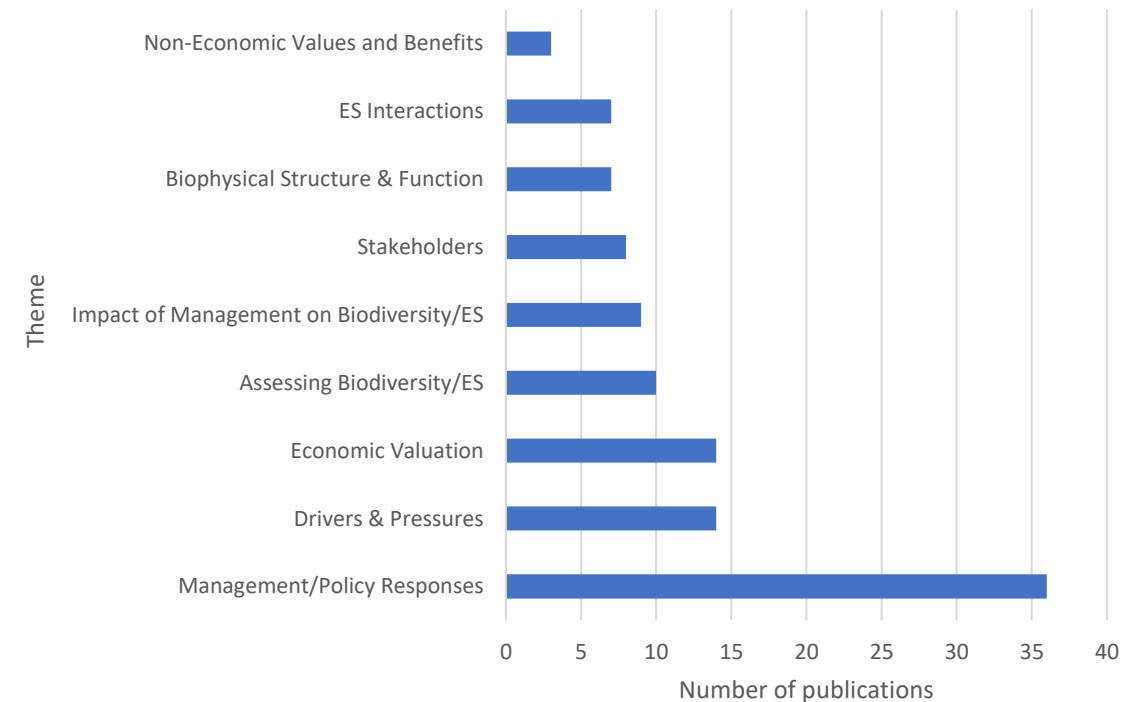
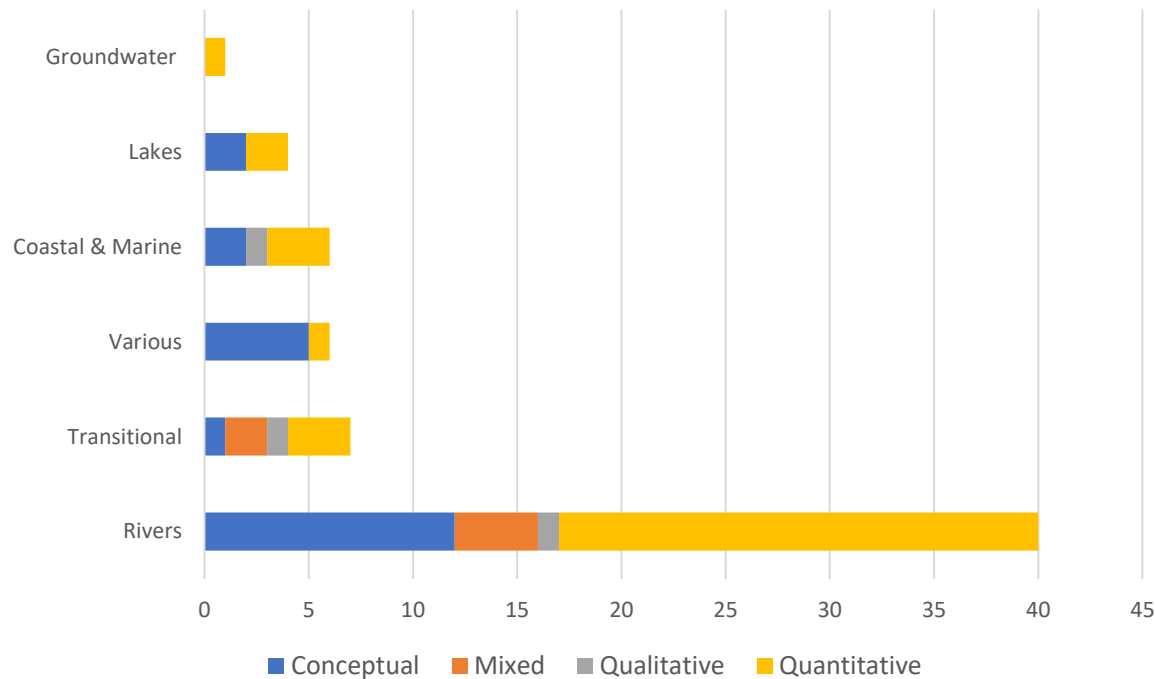
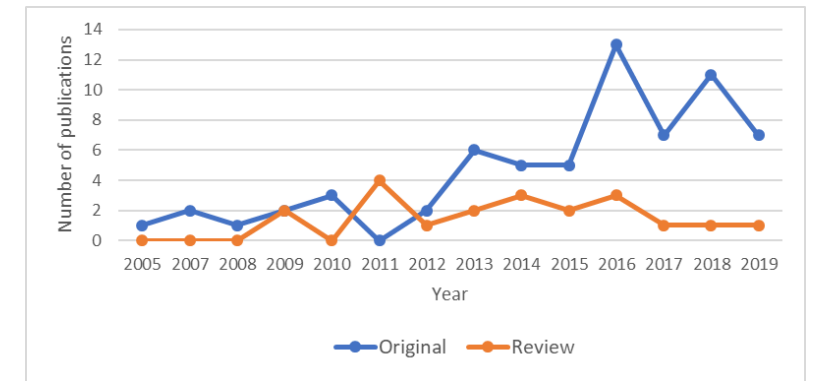
Literature review



Literature review



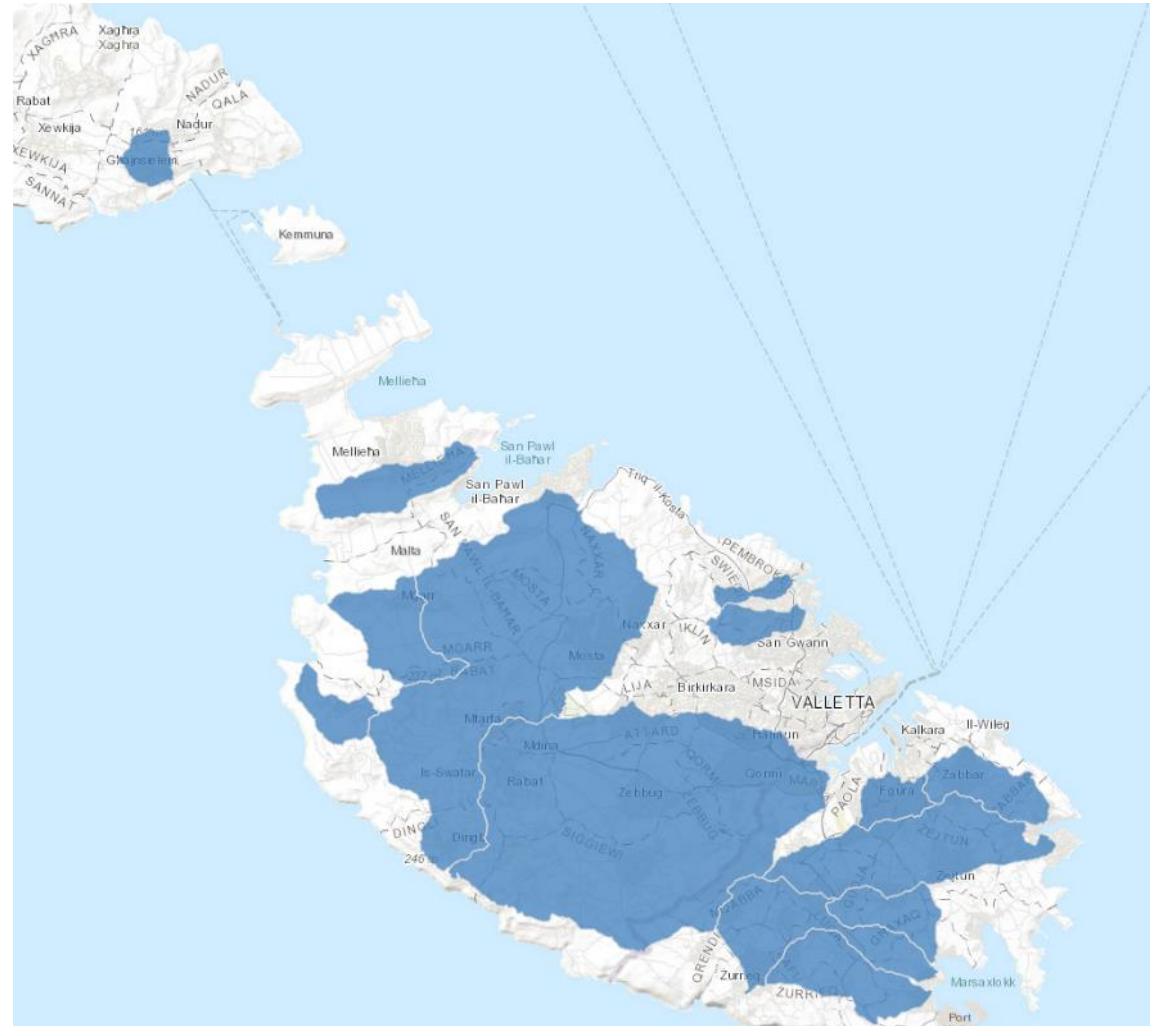
Literature review



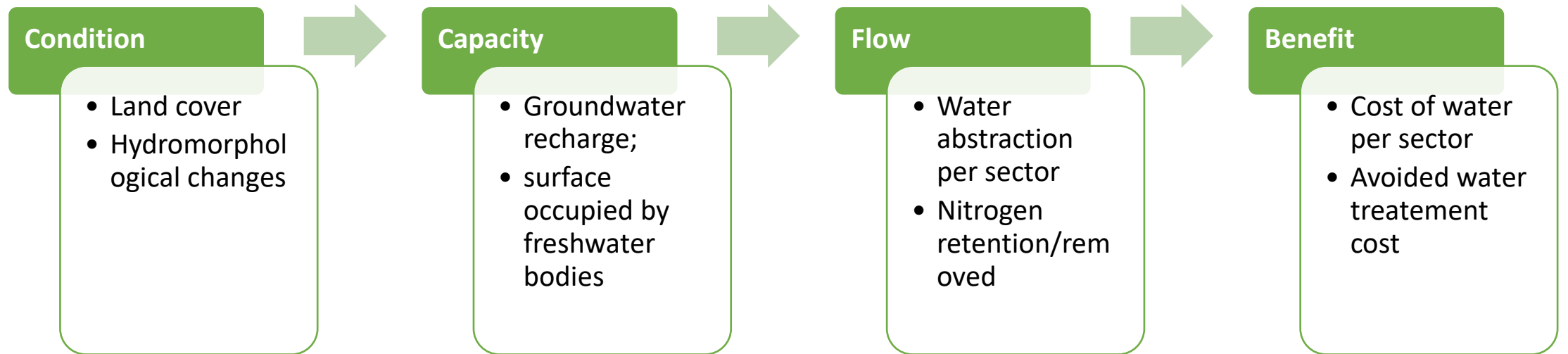


Aims: To develop and implement a methodology for ecosystem service assessment in key water catchments that can be used to support the implementation of the 2nd Water Catchment Management Plan

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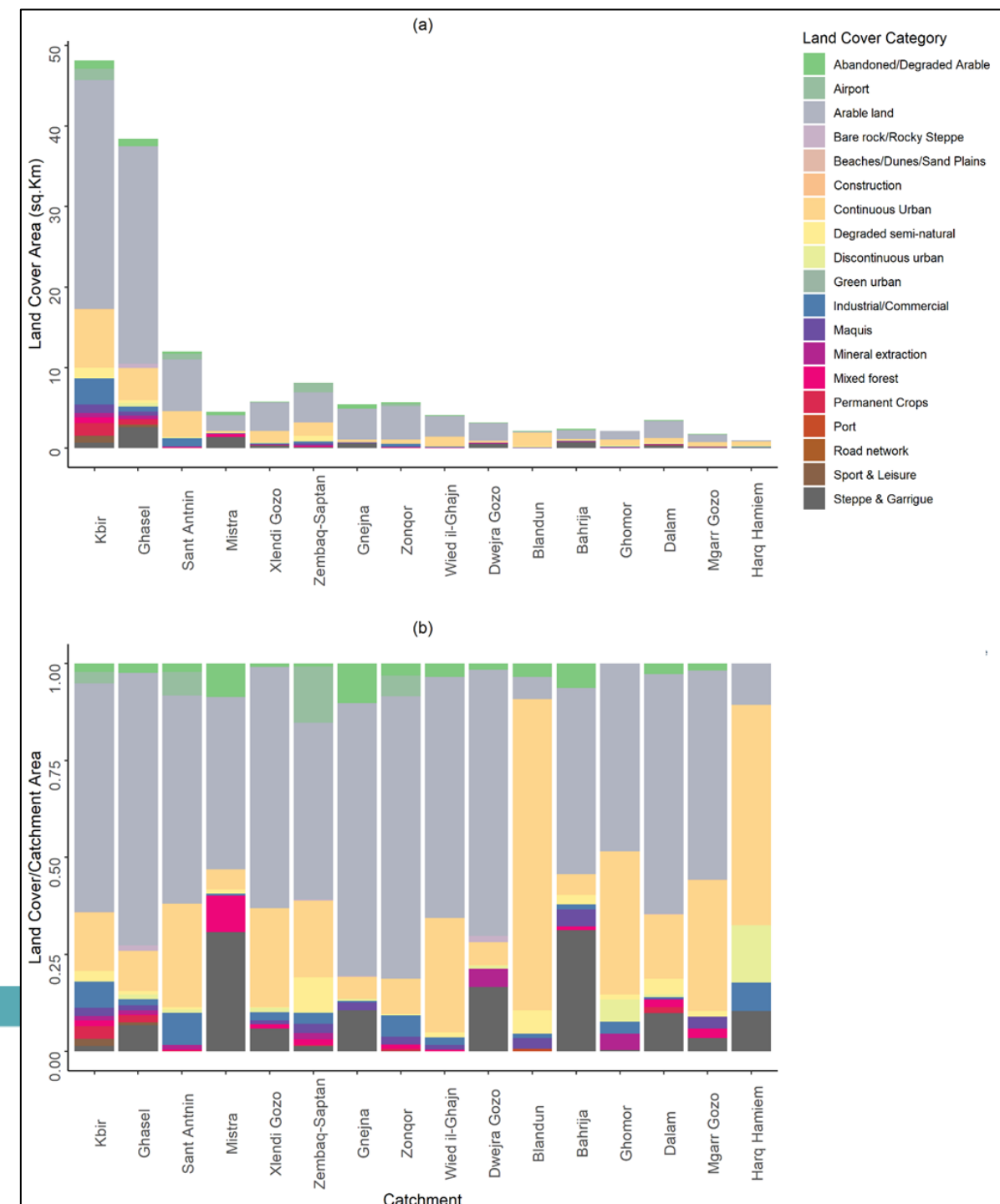


Assessing Ecosystem Condition in Water Catchments

Ecosystem Condition Indicator	Units	Method	Source/Key reference
a) Land take in water catchment	% OR Km ²	Spatial Analysis	PA, ERA
b) Ecosystem Land Cover	% OR Km ²	Spatial Analysis	PA, ERA
c) Alien or Invasive Species along the watercourse	Km ²	Fieldwork and Spatial Analysis	ERA
d) Ecological Status of the riparian habitat (based on habitat structure; habitat function; habitat restoration)	Km ²	Fieldwork and Desk Research	TM
e) Protected area designation	% OR Km ²	Spatial Analysis	ERA
f) Hydromorphological changes	% OR channel length	Fieldwork	TM, ERA
g) Presence of artificial barriers	Number/Km	Fieldwork	TM
h) Presence of reservoirs	Number OR m ² OR m ³	Fieldwork	TM, WSC

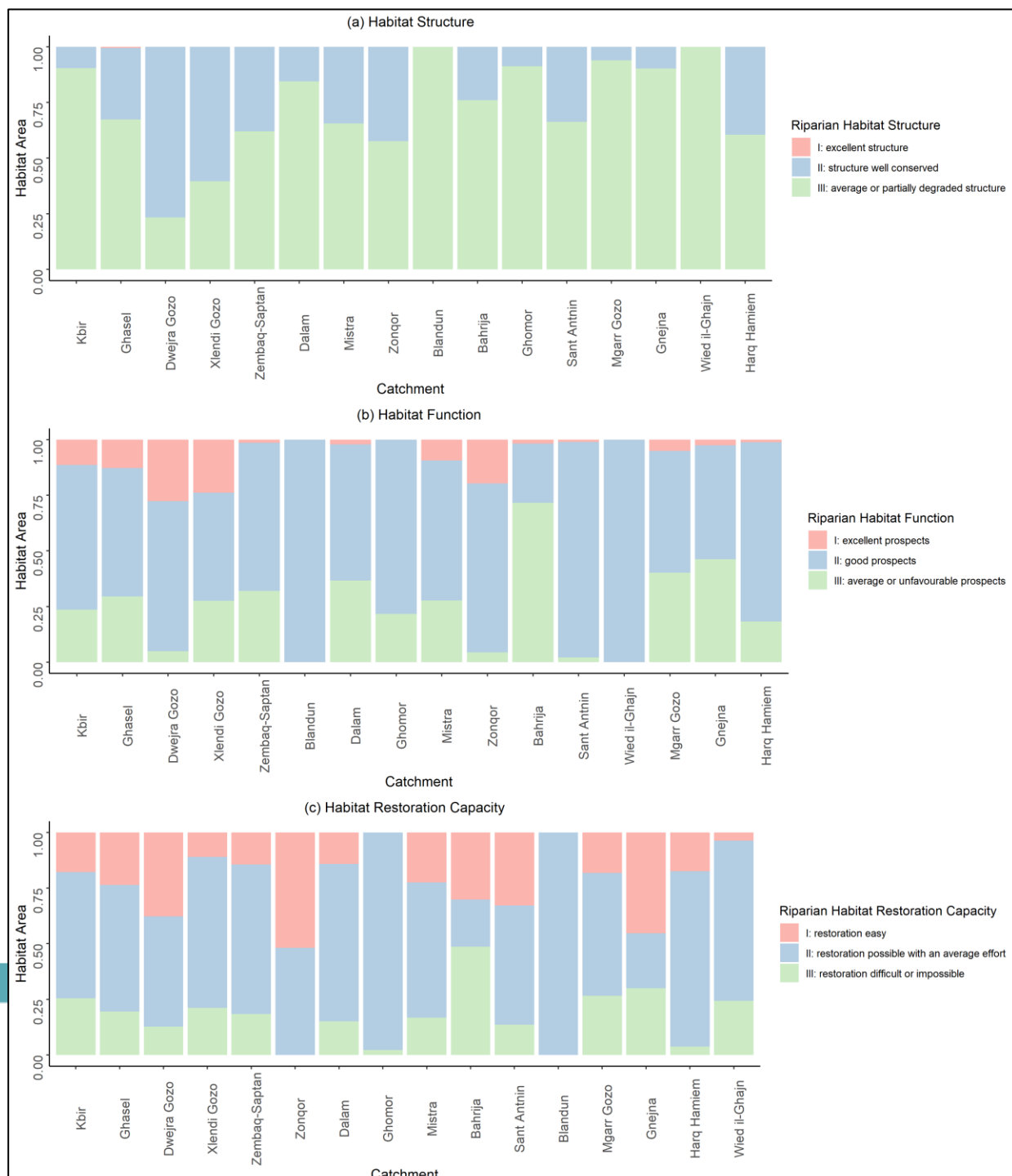
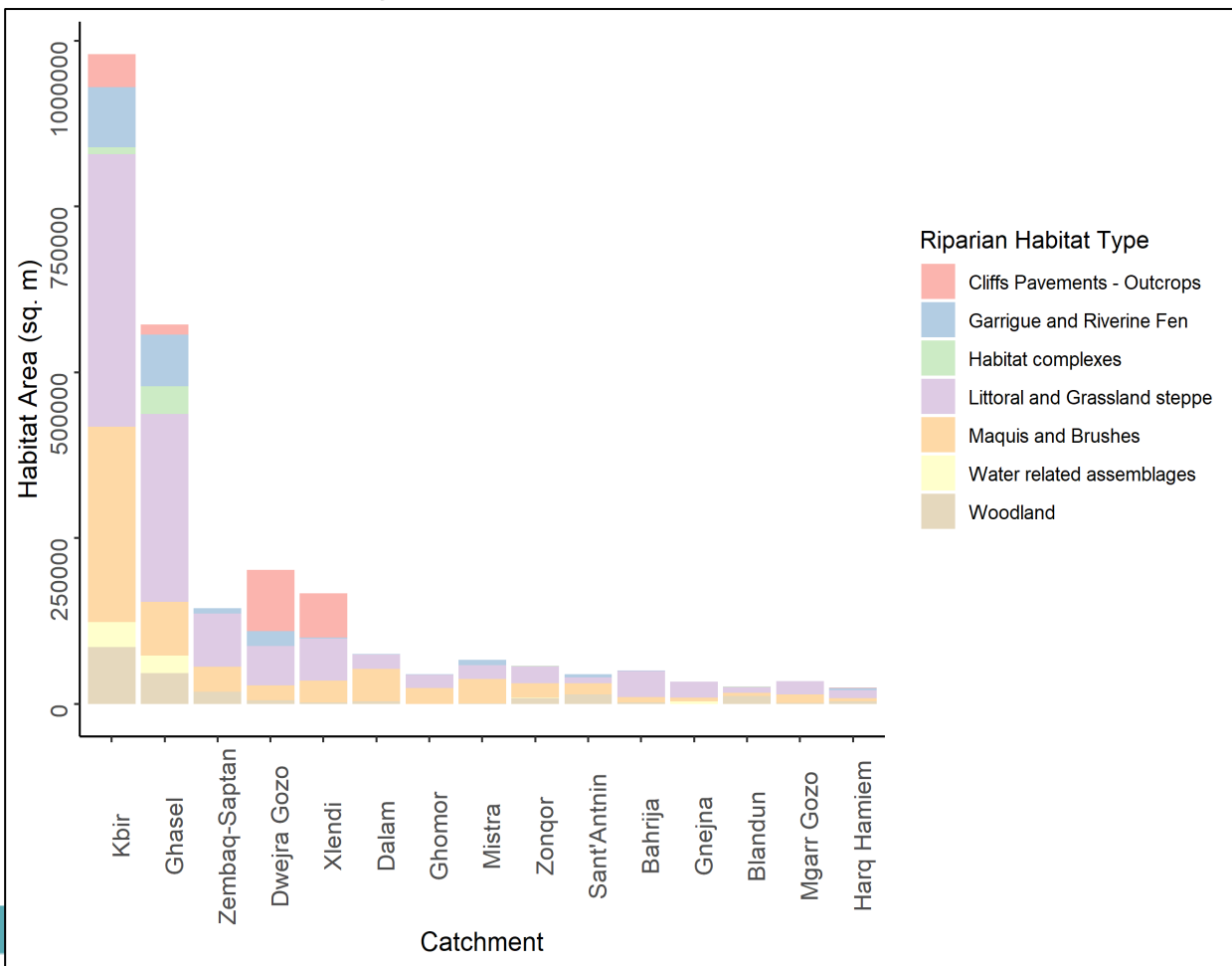


Ecosystem Condition



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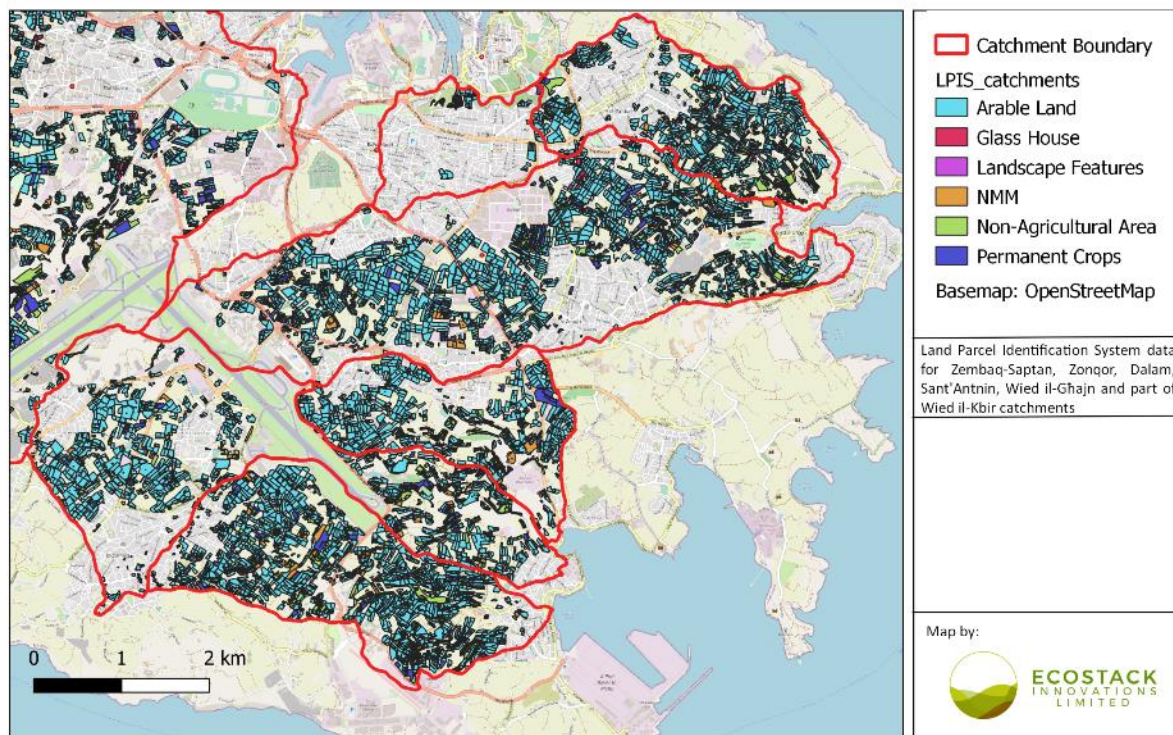
Ecosystem Condition



Assessing Provisioning Ecosystem Services

Ecosystem Service	Indicator	Units	Source/Key reference
Cultivated crops	a) Crop area	Km ²	LPIS
Reared animals and their outputs	b) Livestock Density	Livestock/Km ²	NSO
Surface water for non-drinking purposes	c) Number of reservoirs OR water storage capacity (m ³)	Dimensionless OR m ³	Fieldwork, NSO, EWA, WSC
Groundwater for drinking and non-drinking	d) Infiltration rates	mm/h	EWA
Groundwater for non-drinking	e) Freshwater abstracted within water catchment (non-drinking use)	m ³ /year	NSO, WSC, EWA
Groundwater for drinking	Freshwater abstracted within water catchment (drinking use)	m ³ /year	NSO, WSC, EWA

Provisioning Ecosystem Services



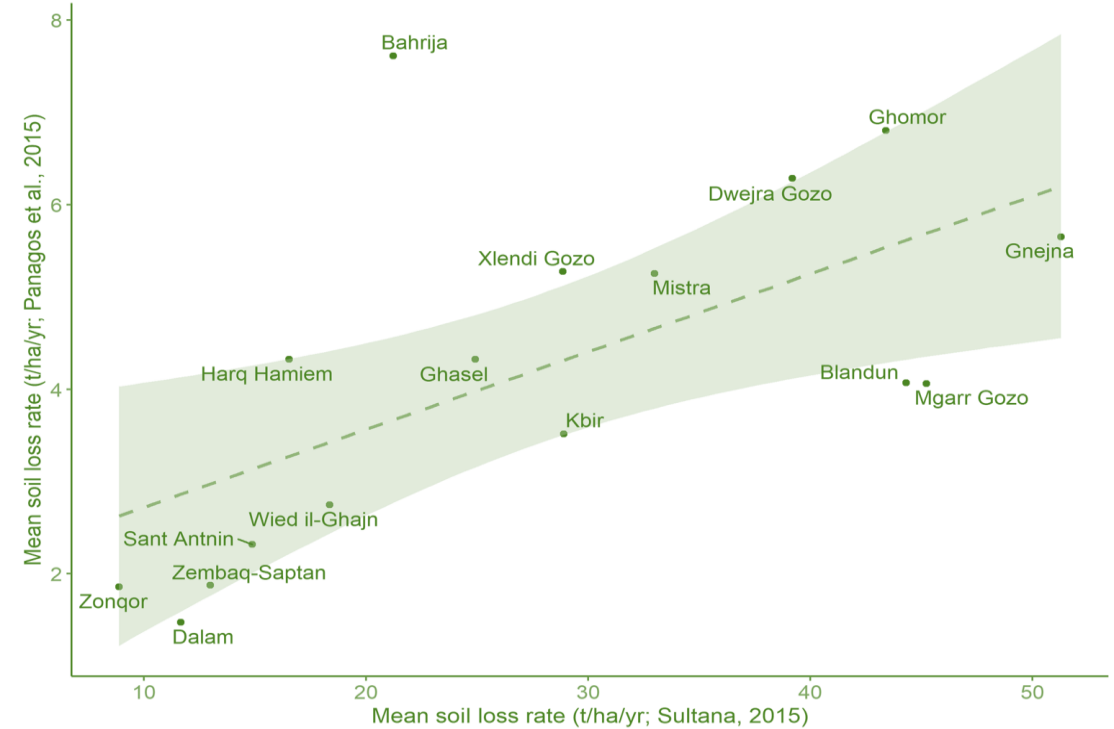
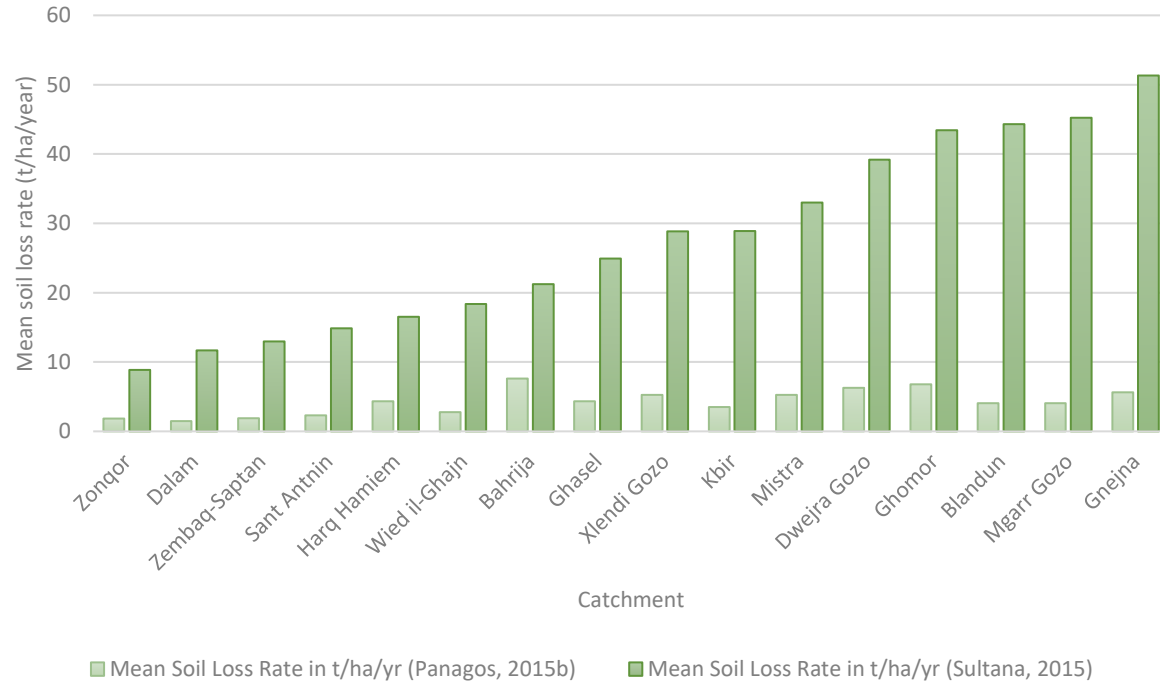
Catchment	Sum of Crop Area (Km ²)	Annual Crop Production (€)
Baħrija	0.837	€157,257.35
Blandun	0.110	€20,747.33
Dalam	1.456	€273,356.26
Dwejra Gozo	1.582	€296,977.99
Għasel	20.166	€3,786,744.92
Għomor	0.369	€69,356.99
Gnejna	2.900	€544,501.70
Ħarq Ħamiem	0.083	€15,494.42
Kbir	21.046	€3,951,840.76
Mistra	1.508	€283,137.98
Sant'Antnin	4.183	€785,452.33
Wied il-Għajn	1.753	€329,152.09
Xlendi Gozo	2.379	€446,704.62
Zembaq-Saptan	2.303	€432,374.92
Zonqor	2.933	€550,726.58
Total	63.608	€11,943,826.25

Assessing Regulating Ecosystem Services

Ecosystem Service	Indicator	Units	Source/Key reference
Mass stabilisation and control of erosion rates	f) Cover management (C-factor)	Dimensionless	Sultana (2015); Panagos et al. (2015a)
	g) Soil loss per unit area	t ha ⁻¹ year ⁻¹	Sultana (2015) Panagos et al. (2015b)
	h) Density of rubble walls in moderate and good state	Number/Km ²	Sultana (2015)
	i) Off-site costs of soil erosion	€/Km ²	MALSIS (2003) Sultana (2016) VMU
	j) Costs associated with soil recovery	€/Km ²	Sultana (2016)
	k) Costs associated with the loss of agricultural production	€/Km ²	MALSIS (2003) NSO
Flood protection	l) Total area of permeable surfaces	Km ²	Copernicus (2015)
	m) Population living in flood risk areas	Number of individuals	NSO, EWA
Pollination	n) Bee Habitat	Km ²	Balzan et al. (2018); ARPA;
	o) Honeybee hive density	Number/Km ²	VRD
Maintenance of nursery populations and habitats	p) Number of Habitats of Community Importance	Dimensionless	ERA
	q) Number of Species of Community Importance	Dimensionless	ERA

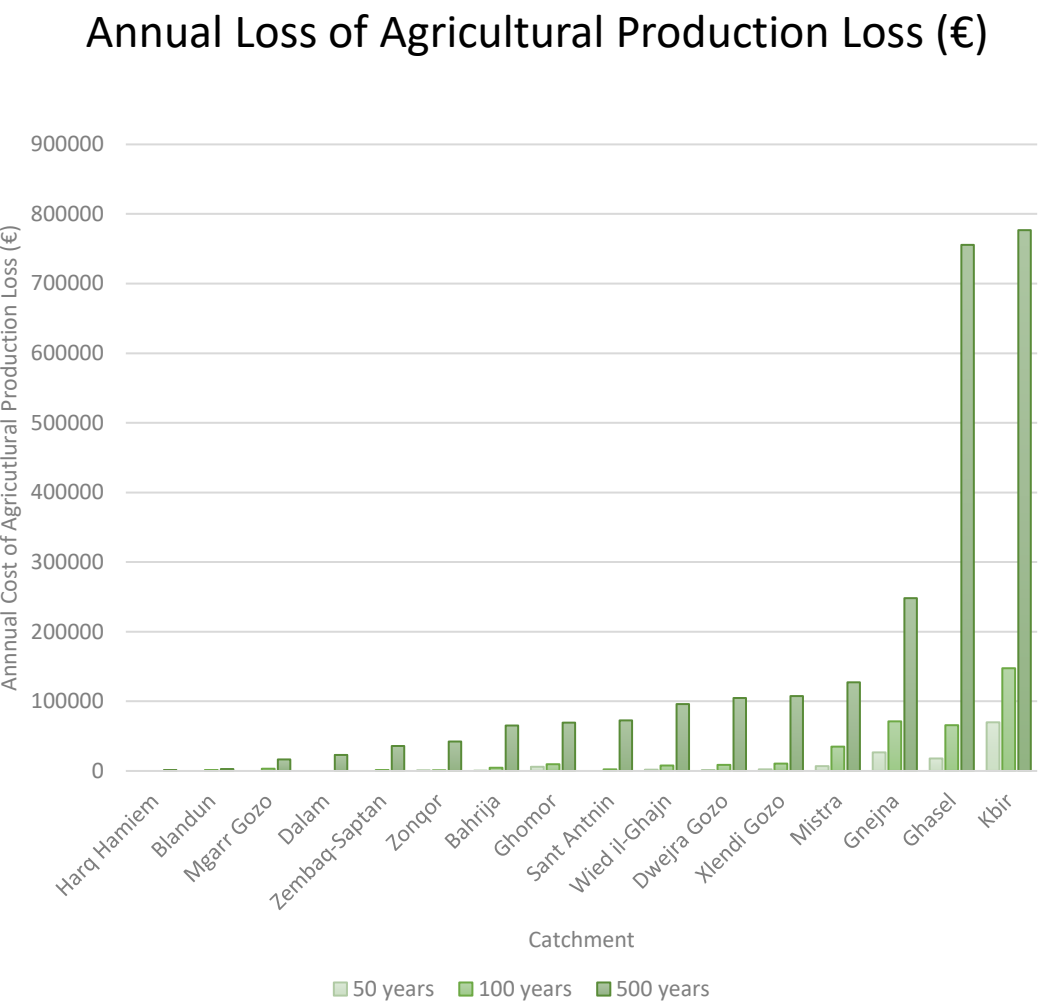
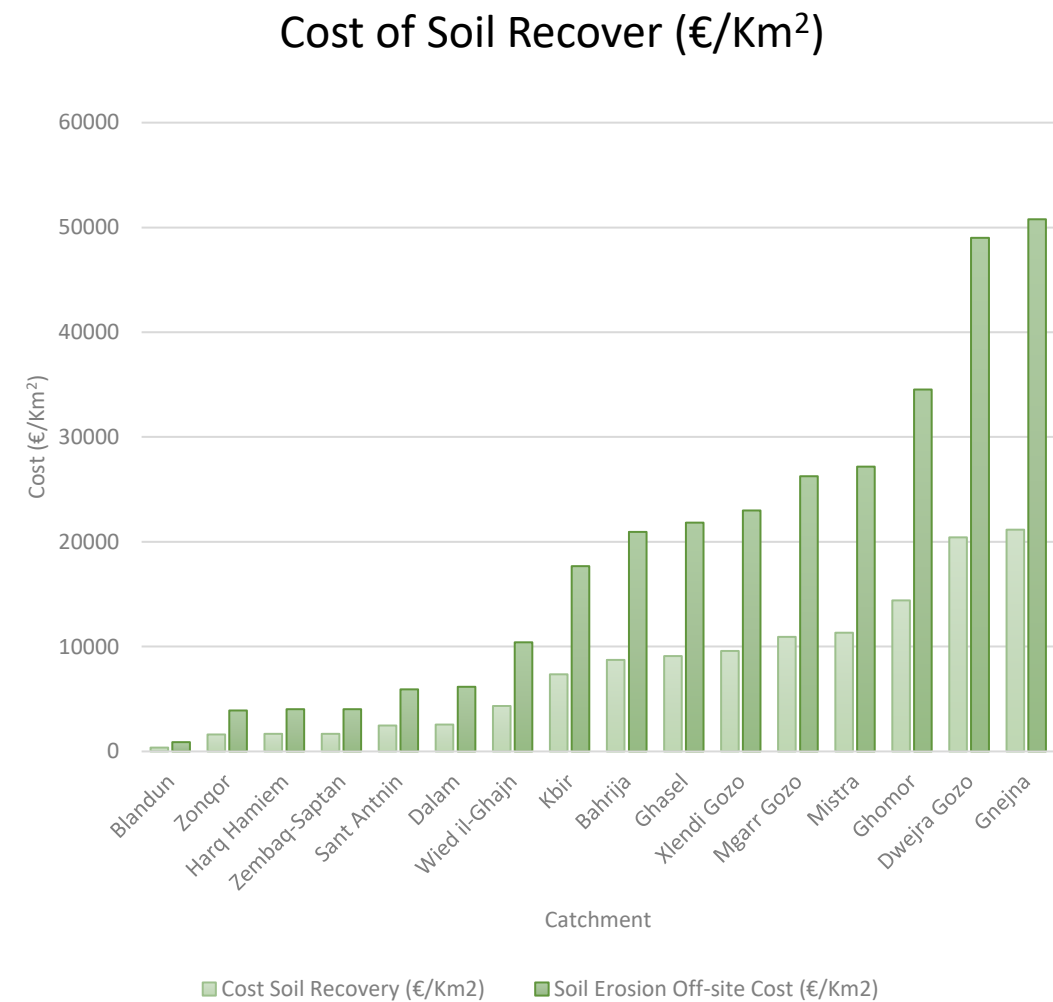
Regulating Ecosystem Services

Soil erosion regulation



Regulating Ecosystem Services

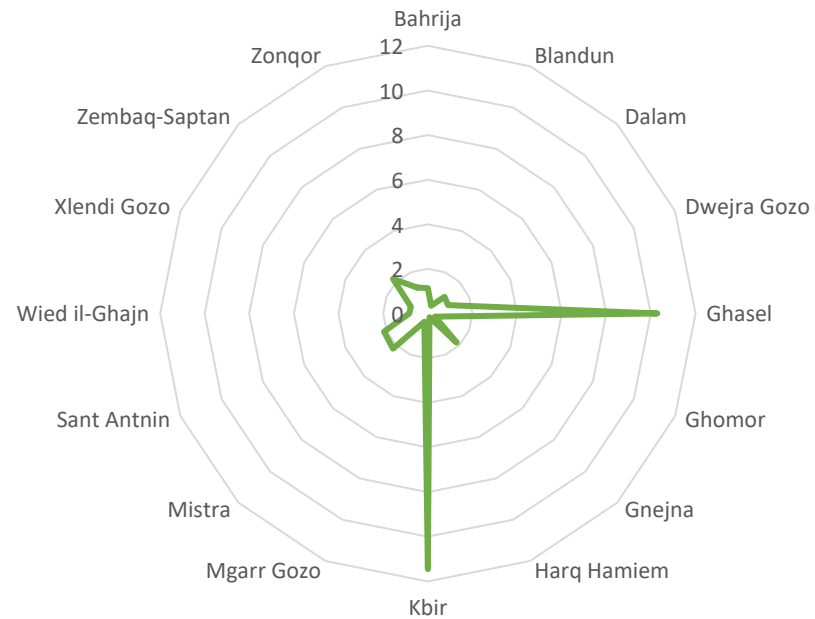
Soil erosion regulation



Regulating Ecosystem Services

Pollination

Relative Pollinator Potential (based on average floral & nesting availability scores)



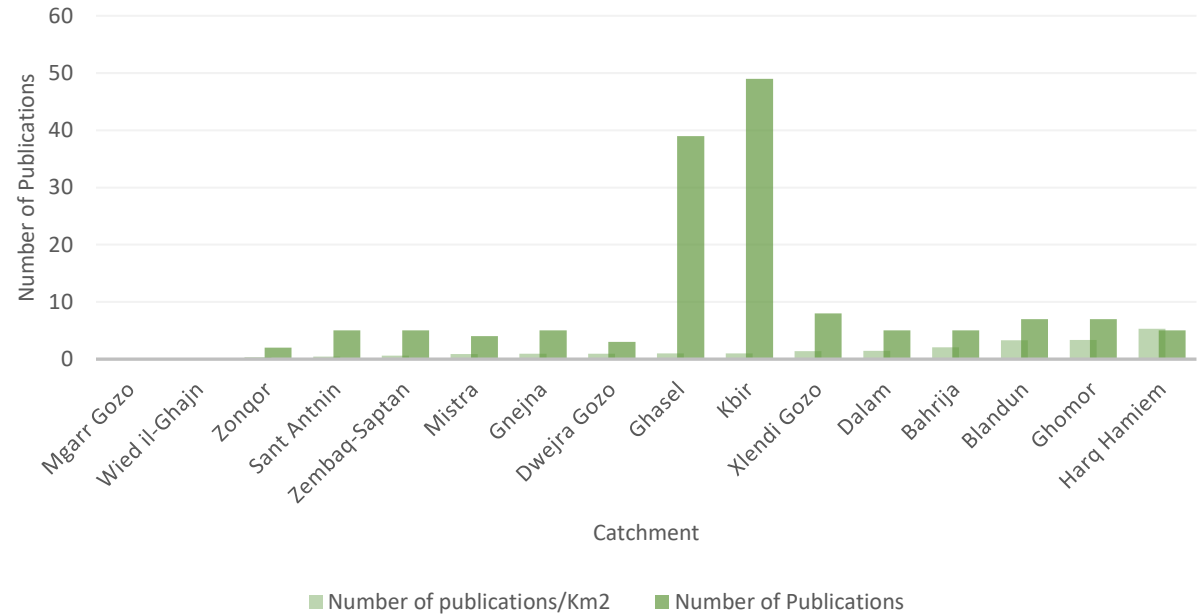
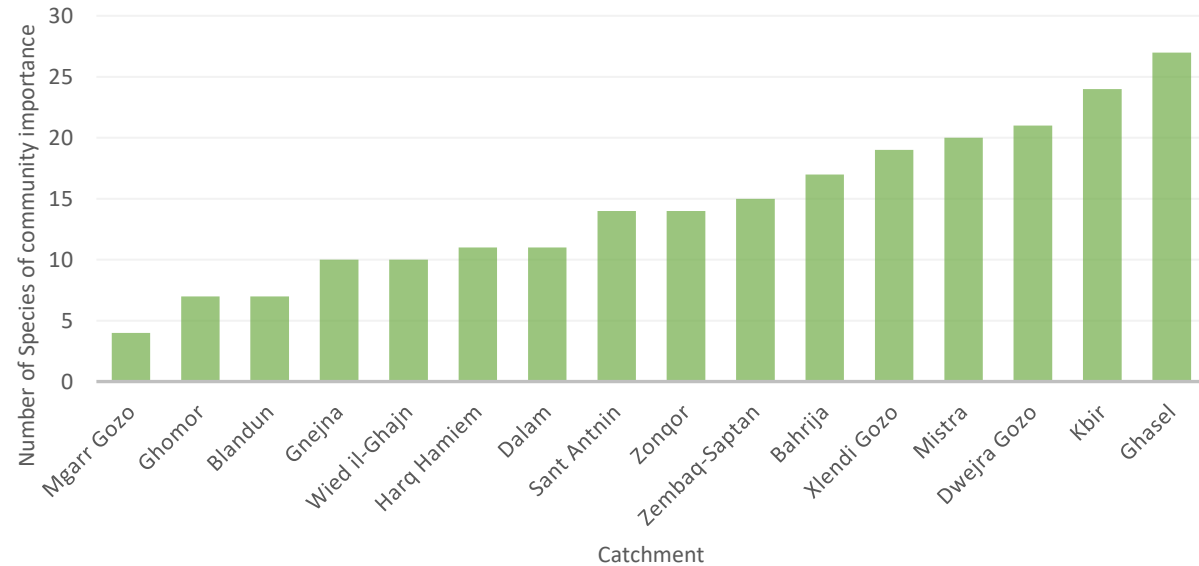
Average Beehive data (Number/Km2)



Assessing Cultural Ecosystem Services

Ecosystem Service	Indicator	Units	Source/Key reference
Scientific and educational	r) Number of scientific and educational publications	dimensionless	Tisbiħ Malta
Heritage	s) Number of heritage sites	dimensionless	Heritage Malta; Tisbiħ Malta; Opensource data (e.g. Openstreetmaps)
Aesthetic	t) Area of high landscape value	Km ²	PA

Cultural Ecosystem Services



Methodology

Economic values were produced per catchment for a selection of services. The selection was based on data availability at the time of the research.

Soil Services

The cost savings provided by catchments for off-site costs of soil erosion, costs of soil recovery and costs of losses in agricultural production within the catchments over the next 50, 100 and 500 years were calculated within our study.

This was done by combining the results of the Revised Universal Soil Loss Equation (RUSLE) per catchment with local costs of soil purchase, transportation and dredging from valley beds and national statistics on crop market value respectively.

Pollination Services

Crops dependent on pollinators were used as an indicator for the service of pollination. The proportion of pollinated crops in tons and the economic value of these crops was derived from pre-existing academic studies of pollinators and crop market values published by the National Statistics Office (NSO).

Crop Services

Crop production was calculated using a dataset of land parcels registered with the Ministry of Agriculture, Fisheries and Animal Rights (MAFA) and national statistics of crop market value from the NSO. You may note that Mgarr Gozo contains agricultural land but has no registered parcels. With this data we calculated the total crop area in kilometres squared, annual total crop production value, and value of crops per kilometre squared.

Catchments



Kbir System	
Offsite costs of soil erosion Eur/Yr	851,142.27
Cost of Soil Recovery Eur/Yr	354,756.10
Yearly cost of agri loss in 50 yrs	0.00
Yearly cost of agri loss in 100 yrs	72,756.33
Yearly cost of agri loss in 500 yrs	2,816.37



Esri, HERE, Garmin, USGS

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Cost of Soil Loss in 50 Years
€ 7,040.93
Bahrija

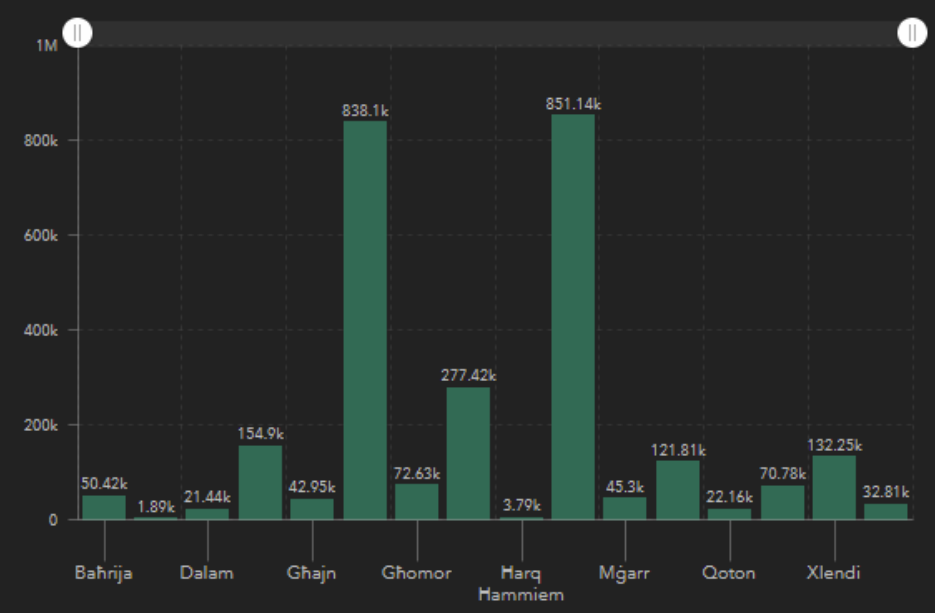
Cost of Soil Loss in 100 Years
€ 127,675.62
Bahrija

Cost of Soil Loss in 500 Years
€ 35,204.67
Bahrija

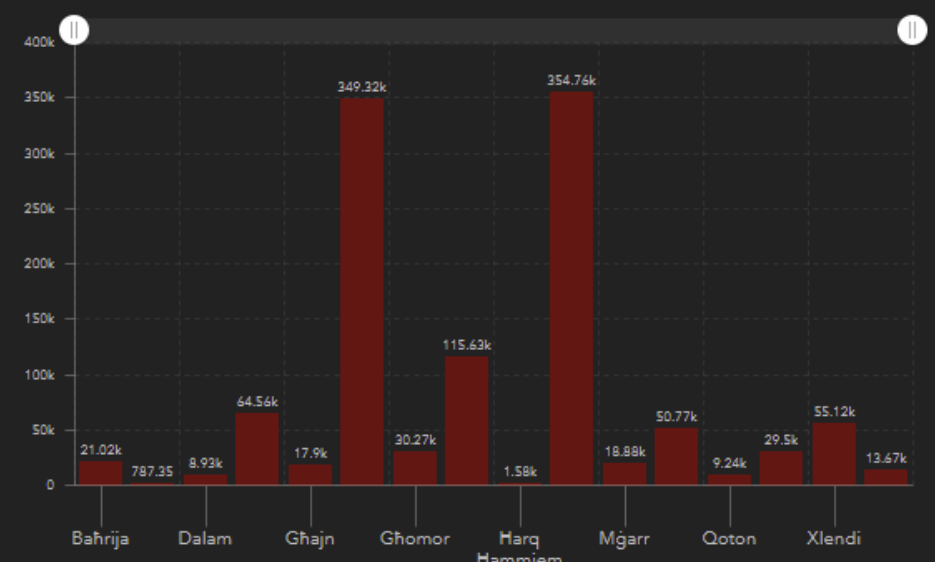
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Use the zoom or select functions of the map (bottom right and top left) to filter data in the indicators and graphs.

Yearly Off-Site Cost of Soil Erosion



Yearly Cost of Soil Recovery

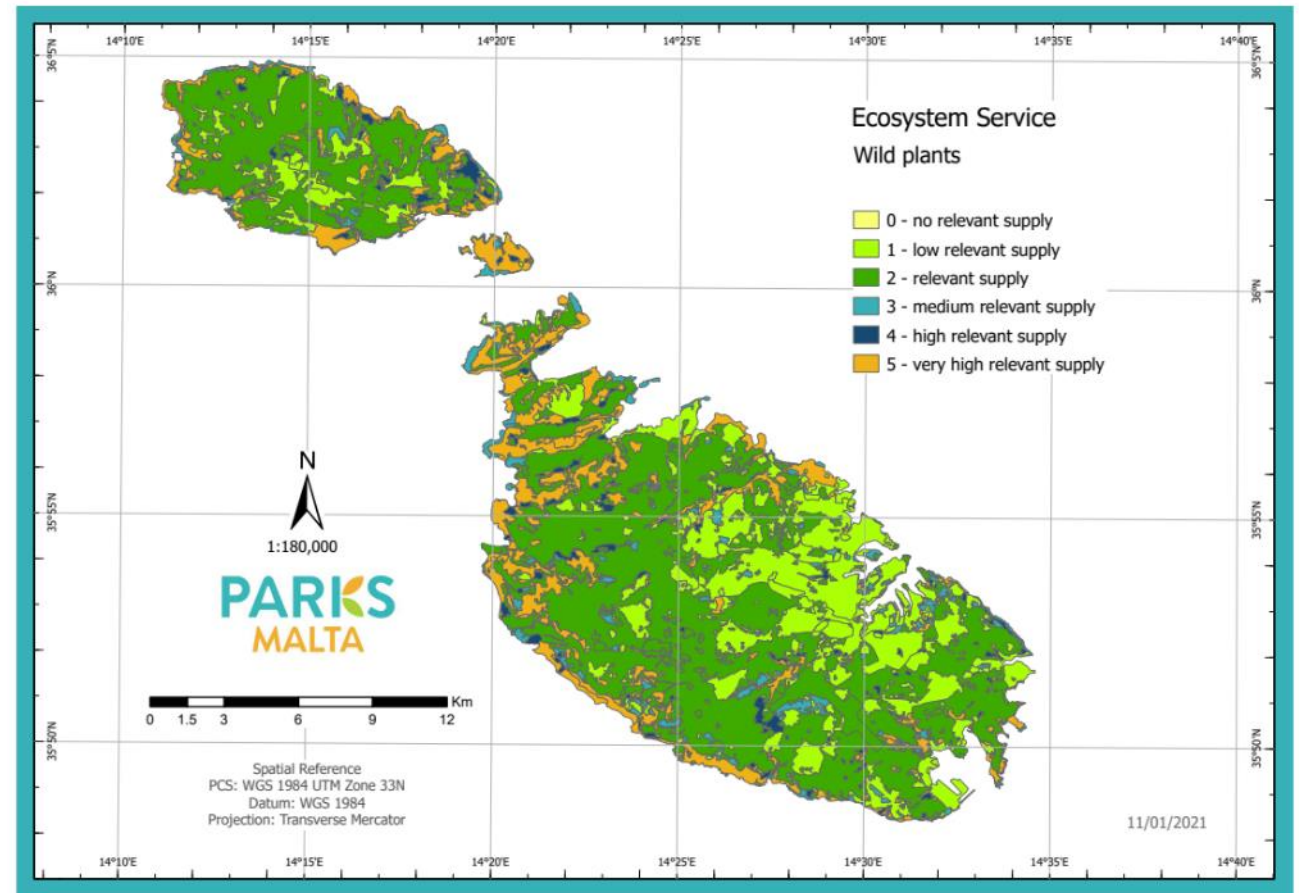


ES Matrix Approach

	Agricultural land in production				Landscape features in agricultural land					Non-agricultural area in agricultural land				Land with no minimum		Semi-natural habitats								Mine/dump/construction sites			Urban areas							
Land Use	Abandoned/Degraded Agricultural Land	Arable Land	Greenhouses	Permanent crops	Habitat areas	Groups/lines of trees	Isolated trees	Rubble walls/vegetated slopes	Field margins	Artificially sealed surfaces	Ornamental and invasive trees	Reeds	Water storage reservoirs	Arable Land	Permanent Crops	Degraded semi-natural	Bare rock/Rocky steppe	Beaches, dunes, sand plains	Watercourses/streams	Maquis	Mixed forest	Salt marsh	Steppe & Garrigue	Mineral extraction	Dump site	Construction site	Continuous urban	Discontinuous urban	Industrial and commercial	Port area	Airport	Road networks and associated land uses	Sports & Leisure	Green urban areas
Ecosystem Service																																		
Cultivated crops																																		
Reared animals and their																																		
Wild plants																																		
Ground water for drinking																																		
Surface water for non-																																		
Ground water for non-																																		
Mass stabilisation and																																		
Flood protection																																		
Pollination																																		
Maintaining nursery																																		
Regulating chemical																																		
Global climate regulation																																		
Micro and regional climate																																		
Physical and experiential																																		
Scientific and educational																																		
Heritage, cultural																																		
Aesthetic																																		

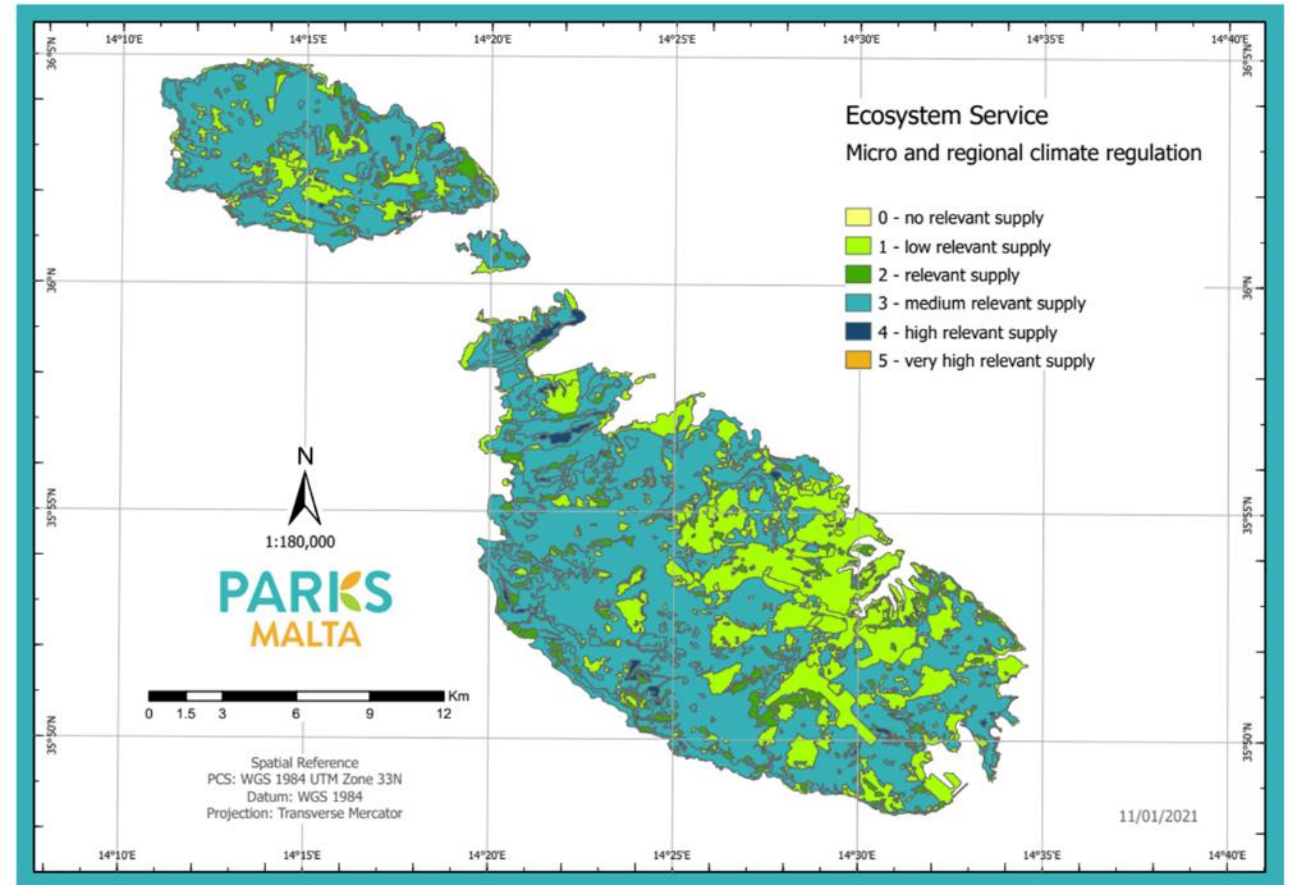
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A look-up table with assigned ecosystem service scores for each ecosystem type, with each of the scores being based on ranks assigned by expert and stakeholders during a consultation workshop.



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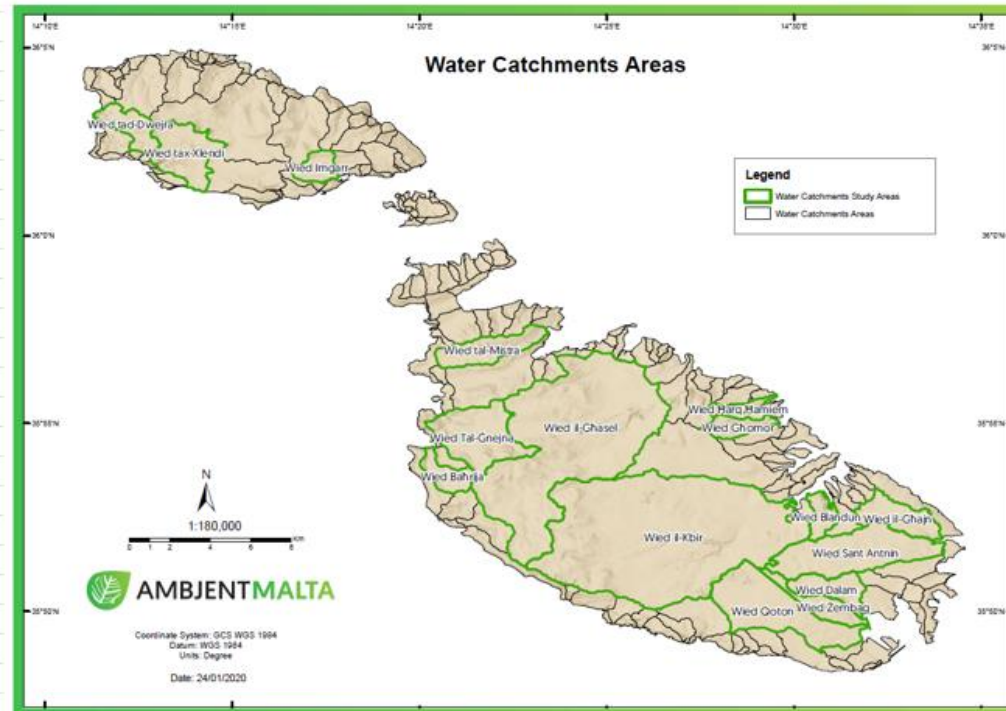


Spreadsheet-based tool

Spreadsheet-based tool for the implementation of the ecosystem services categorisation methodology

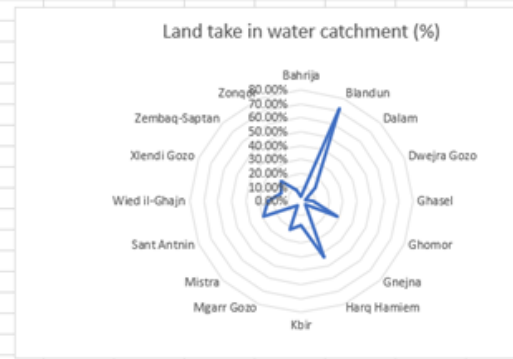
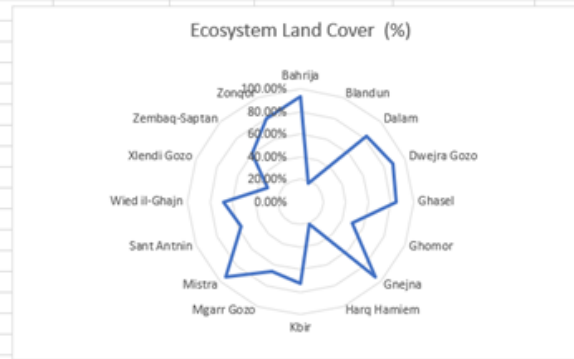
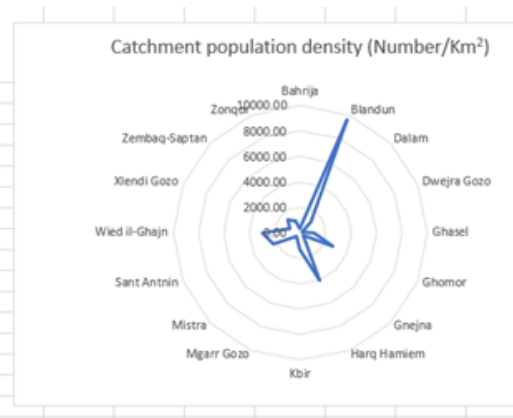
Table of Contents

- 1-Land Cover and Population
- 2-Invasive and Alien Species
- 3-Riparian Habitat Type
- 4-Riparian Habitat Subtype
- 5-Riparian Habitat Structure
- 6-Riparian Habitat Function
- 7-Riparian Habitat Restoration
- 8-Protected Area Desig
- 9-Hydromorphological changes
- 10-Artificial Barriers
- 11-Reservoirs
- 12- Land Cover
- a-Crop Area (LPIS)
- b-Livestock
- c-C-factor (ERA)
- d-Soil Loss & Valuation
- e-Flood Protection
- f-Pollination
- g-Art 17 Habitats
- h-Art 17 Species
- i-Publications
- j-Heritage Sites
- k-Stakeholder ES Scores - Mean
- l-Stakeholder ES Scores - STDEN



Spreadsheet-based tool

Catchment	Catchment Area (Km2)	Land take in water catchment (Km2)	Land take in water catchment (%)	Ecosystem Land Cover (Km2)	Ecosystem Land Cover (%)	Catchment population (Number/Km2)	Catchment population density (Number/Km2)
Bahrija	2406193.22	83068	3.45%	2243492.82	93.24%	812.78	337.79
Blandun	2115733.27	1531156	72.37%	380021.88	17.96%	20426.42	9654.53
Dalam	3481423.31	476220	13.68%	2866331.92	82.33%	4260.42	1223.76
Dwejra Gozo	3161449.16	101528	3.21%	2789360.12	88.23%	626.46	198.16
Ghasel	38414726.70	3303840	8.60%	32632026.56	84.95%	43612.15	1135.30
Ghomor	2102453.27	592864	28.20%	1053637.91	50.11%	5923.94	2817.63
Gnejna	5463925.47	204752	3.75%	5104510.46	93.42%	1537.44	281.38
Harq Hamiem	939847.11	407228	43.33%	197753.78	21.04%	3788.77	4031.27
Kbir	48171568.51	8246840	17.12%	34772973.56	72.19%	61561.12	1277.96
Mgarr Gozo	1725840.14	376776	21.83%	1142040.45	66.17%	1081.22	626.49
Mistra	4483904.41	185836	4.14%	4229539.55	94.33%	1962.58	437.69
Sant Antrnin	11982726.02	3541224	29.55%	6824254.90	56.95%	27239.68	2273.25
Wied il-Ghajj	4126523.54	988680	23.96%	2826734.24	68.50%	12302.48	2981.32
Xlendi Gozo	5753872.63	898268	15.61%	1826758.85	31.75%	5182.45	900.69
Zembaq-Saptan	8131006.80	1676248	20.62%	4966500.41	61.08%	11382.57	1399.90
Zonqor	5687300.61	514156	9.04%	4532603.48	79.70%	5617.74	987.77



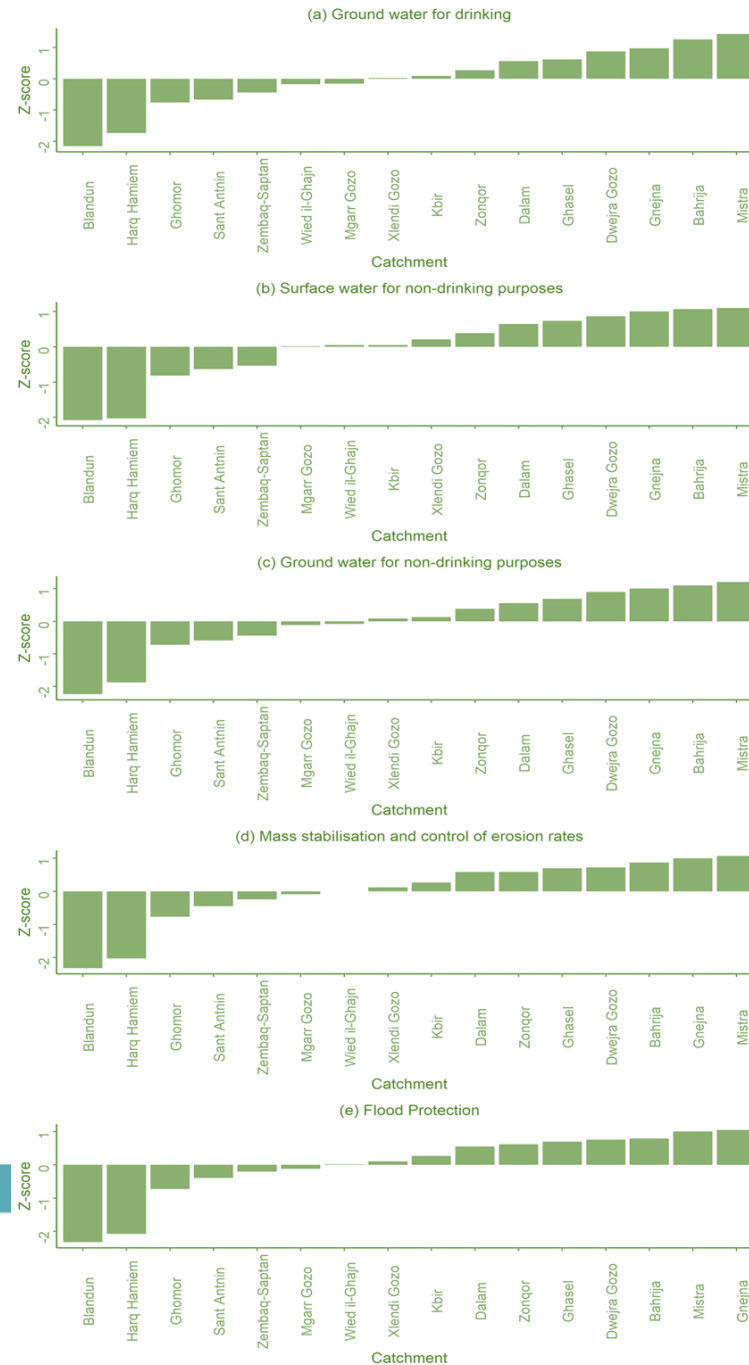
ES Matrix Approach

A look-up table with assigned ecosystem service scores for each ecosystem type, with each of the scores being based on ranks assigned by expert and stakeholders during a consultation workshop.

Ranking ES scale: 0 to 5

Enables comparison between different water catchments.

ES Matrix and indicator data used to inform management plans for each water catchment.



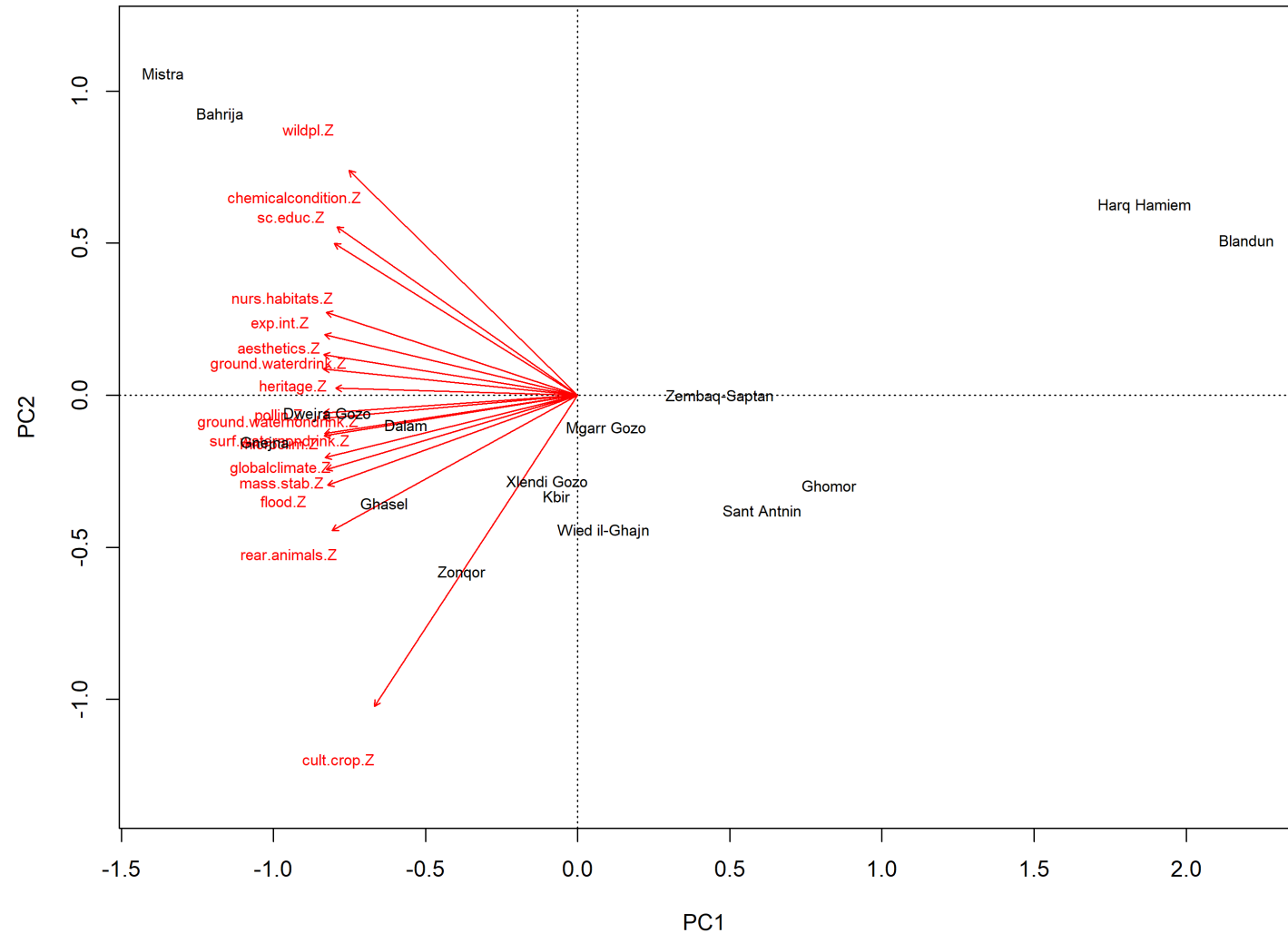
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LIFE IP Programme 2014-2020

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