Guidance Factsheet for Common Indicator 25

Adopted at MAP FPs meeting (16-19 September 2025, Athens)

Guidance Factsheet for Common Indicator 25 *Land cover change*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	
Indicator Title	*Land cover change*	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
- Linear coastal development and low-lying terrain coastal development minimised, with perpendiculardevelopment being in balancewith integrity and diversity of coastal ecosystems and landscapes. *- Mixed land-use structure achieved in predominantly human-made coastal landscapes*	*Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved.*	*Proposed targets should be considered as general recommendations to be adapted to regional/local specificities and knowledge.* *- No further construction within the setback zone and avoid further construction in low-lying coastal terrain* *- Change of coastal land use structure, dominance of urbanland use reversed* *- Keep, and increase landscape diversity*
GES, targets and measures cannot be expressed quantitatively (as a threshold value) but due to country specific circumstances (socio-economic, cultural, historical) should be defined by the countries themselves. In doing so the CPs should take their spatial development and planning policies into account, as well as the legal obligations of the Barcelona Convention, in particular theICZM Protocol. The above GES definition and Proposed target(s) are just examples.		
Rationale		
Justification for indicator selection *The UNEP/MAP's Correspondence Group on Monitoring (CORMON) on Coast and Hydrography agreed, in May 2013, on a specific candidate common indicator for the Mediterranean region addressing land cover change.* *Identifying and understanding the processes of land cover change (i.e. how land cover has been changed by humans and the processes that result in landscape transformation) is especially relevantfor critical and vulnerable areas such as coastal zones, where several competitive uses are pressing. In this context urbanization, or land take, is the most dramatic change given the (almost) irreversibilityof the process. The associated impacts could be listed as follows* (Figure 1): • *Habitat loss with the associated impact on related ecosystem functions like C sequestration, regulation of water cycle, or biomass production.* • *Fragmentation. The division of natural habitats in smaller parcels contributes to the isolationof number of species and also compromises its viability.* *Therefore, the accumulated impacts of urbanization including infrastructures (harbours, roads, rail trucks, airports, etc.) highly compromise ecosystem integrity. Since impacts are dependent on the scale and pace of changes it is important to consider these aspects when monitoring land cover changes.*		

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Beyond the process of urbanization there are other changes that are less irreversible and also have important consequences:

- *Conversion from forest to agricultural use. This results in habitat loss, habitat fragmentation and, consequently, loss of biodiversity. There is also a decrease on the degree of soil coverage by vegetation which in turn determines the risk of erosion. Also, this type of change results ina net loss of soil carbon.*
- *Conversion from agriculture to semi-natural. The impact strongly depends on the conditions at the time of abandonment. If conditions are favorable, land abandonment can lead to a recovery of natural vegetation. However, in case of unfavorable conditions like low vegetation coverage and/or steep slope, agricultural abandonment could lead to further land degradation.*
- *Conversion from agricultural land to forest (forestation). This change involves tree plantation and it has a positive impact on land stability by increasing the vegetation cover of the soil and the increase of C sequestration. In terms of biodiversity it strongly depends on the species used for plantation. Native species definitely increase diversity and connectivity.*

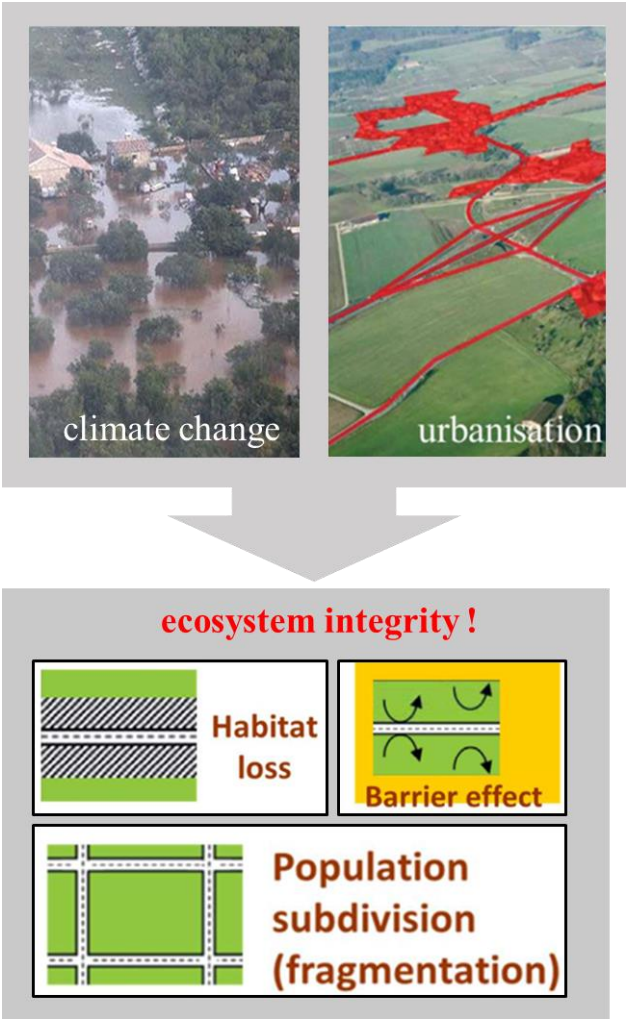

Figure 1. ***Overview of major impacts on coastal habitats***

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In the context of climate change, low-lying coastal terrain is prone to coastal flooding, erosion and salinization. The associated impacts could be listed as follows:

- *Loss of coastal habitats, including wetlands, deltas, mangroves and beaches;*
- *Physical disturbance and hydrographic alterations;*
- *Loss of currently dry land habitats due to advancing seas;*
- *Disruption and destruction of shorebird and sea turtle nests;*
- *Population declines in fishes, shellfish and other species that rely on coastal wetlands for at least part of their lives;*
- *Population declines in migratory birds that rely on coastal habitats during seasonal migrations.*

When preparing coastal adaptation plans to climate change priority should be given to low-lying c*oast*al zone.

Scientific References

References are grouped by the topic addressed. Within each section references are sorted byrelevance (the first ones are more relevant to the current indicator)

Land use/land cover change and related impacts:

Bajocco, S., De Angelis, A., Perini, L., Ferrara, A. i Salvati, L., 2012, 'The Impact of Land Use/Land Cover Changes on Land Degradation Dynamics: A Mediterranean Case Study', *Environmental Management*, 49(5), p.980-989.

Dale,V. H. , Brown, S. , Haeuber, R. A. , Hobbs, N. T. , Huntly, N. , Naiman, R. J. , Riebsame, W. E. , Turner, M. G. and Valone, T. J., 2000. Ecological principles and guidelines for managing the use of land. Ecological Applications 10:639–670.

Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., Snyder, P. K., Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T. i Daily, G. C., 2005. Global Consequences of Land Use. Science, 309(5734), p.570-574.

Haines-Young, R., 2009, 'Land use and biodiversity relationships', Land Use Policy, 26, p.S178-S186.

Climate change and related impacts:

Ali, E., W. Cramer, J. Carnicer, E. Georgopoulou, N.J.M. Hilmi, G. Le Cozannet, and P. Lionello, 2022. Cross-Chapter Paper 4: Mediterranean Region. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2233–2272.

Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari, 2019: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)

MedECC 2020 Summary for Policymakers. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean

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Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/ MAP, Marseille, France, pp 11-40.

Androulidakis, Y. S., Kombiadou, K. D., Makris, C. V., Baltikas, V. N., and Krestenitis, Y. N., 2015. Storm surges in the Mediterranean Sea: Variability and trends under future climatic conditions, Dynamics of Atmospheres and Oceans, vol. 71, pp. 56–82.

Cid, A., Menéndez, M., Castanedo, S. et al, 2016. Long-term changes in the frequency, intensity and duration of extreme storm surge events in southern Europe. Clim Dyn 46, pp 1503–1516.

European Environmental Agency, 2021. Extreme sea levels and coastal flooding, https://www.eea.europa.eu/ims/extreme-sea-levels-and-coastal-flooding

Conservation in a Changing Climate, the Land Trust Alliance, United States, 2022. https://climatechange.lta.org/climate-impacts/changing-ocean-systems/rising-sea-levels/

R.J. Nicholls, F.M.J. Hoozemans, 1996. The Mediterranean: vulnerability to coastal implications of climate change, Ocean & Coastal Management, Volume 31, Issues 2–3, pp 105-132.

Methodology to compute land use change indicator:

Breton, F., Ivanov, E., Morisseau, F., Nowell, M. 2014. D4.2 Report, accompanying database and supporting materials on LEAC Methodology and how to apply it in CASES. PEGASO 06/Deliverable. URL: http://www.pegasoproject.eu/images/stories/WP4/D4.2%20LEAC_UAB_140401.pdf

EEA, 2006. The changing faces of Europe's coastal areas, EEA report. European Environment Agency ; Office for Official Publications of the European Communities, Copenhagen, Denmark : Luxembourg.

Feranec, J., Jaffrain, G., Soukup, T. and Hazeu, G., 2010, 'Determining changes and flows in European landscapes 1990–2000 using CORINE land cover data', Applied Geography, 30(1), p.19-35.

V. Perdigao i S. Christensen, 2000, The LACOAST atlas: Land cover changes in European coastal zones, Joint Research Centre, Milan.

Serra, P, Pons, X., Saurí D. 2008. Land-cover and land-use change in a Mediterranean landscape: A spatial analysis of driving forces integrating biophysical and human factors. Applied Geography, 28(3): 189-209.

Weber, J.-L., 2007, 'Implementation of land and ecosystem accounts at the European Environment Agency', Ecological Economics, 61(4), p.695-707.

EC - DG.ENV, 2013. Mapping and assessment of ecosystems and their services an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper - final, April 2013. Publications Office, Luxembourg.

Baučić M., Morić Špranić A., Gilić F. 2022. Report and GIS database with calculation of the LCC indicator for the pilot areas. Report; PAP/RAC, Split, Croatia.

Baučić M., Morić Špranić A., Gilić F. 2022. Validation of testing results for upgraded LCC Indicator 25 in pilot areas. Report; PAP/RAC, Split, Croatia.

Gilić F. 2022. Manual for calculating IMAP Common Indicator 25, Report; PAP/RAC, Split, Croatia.

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Policy Context	

Policy context description

After agreeing on including the candidate common indicator on Land use change in CORMON on Coast and Hydrography in 2013, it was decided that this candidate common indicator would need further testing, pilot implementation (including during the initial phase of IMAP), before the Contracting Parties could agree to its regional usage as a common indicator.

In order to follow-up on this CORMON Coast and Hydrography recommendation, an EcAp pilot project took place in the Adriatic to test the feasibility of this candidate common indicator on the sub-regional level, in the framework of an EU funded project on the "Implementation of the Ecosystem Approach in the Mediterranean by the Contracting Parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols (EcAp-MED project 2012-2015)". The main conclusions of the Pilot project suggest that by using the common remote data and a common method for processing and presenting the results are feasible and a very positive step forward as far as monitoring the processes, the state and evolution of the coastal zones.

The results of this pilot are presented in document UNEP(DEPI)/MED WG.420/Inf.18.

The EcAp Coordination Group meeting held in September 2019 approved elaboration on the proposal for the upgrading of the common indicator on Land use change within the GEF Medprogramme project.

The results of elaboration and testing are presented in PAP/RAC documents (2022): Upgraded LCC Indicator 25 proposal; Report and GIS database with calculation of the LCC indicator for the pilot areas; Validation of testing results for upgraded LCC Indicator 25 in pilot areas.

As for the protocols of the Barcelona convention, the ICZM protocol identifies the need of balanced use of coastal zones in several articles.
*For example, the **Article 5** sets the objectives of integrated coastal management:*

(a) to facilitate, through the rational planning of activities, the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into account in harmony with economic, social and cultural development;
(b) preserve coastal zones for the benefit of current and future generations;
(c) ensure the sustainable use of natural resources, particularly with regard to water use;
(d) ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology;

*In **Article 6**, where general principles of ICZM are discussed, it is highlighted that the formulation of land use strategies, plans and programs covering urban development and socioeconomic activities, as well as other relevant sectoral policies, shall be required (f). In addition, the Article 6 calls for the allocation of uses throughout the entire coastal zone to be balanced, and unnecessary concentration and urban sprawl to be avoided(h).*

*The **Article 8** calls to Contracting Parties to ensure that their national legal instruments include criteria for sustainable use of the coastal zone. Some of such criteria ask for "identifying and delimiting, outside protected areas, open areas in which urban development and other activities are restricted or, where necessary, prohibited" (a). In addition, it asks for limiting the linear extension of urban development and the creation of new transport infrastructure along the coast(b).*

*In addition, the **EU's Habitats Directive** (92/43/EEC), **Birds Directive** (2009/147/EC), as well as **Convention of Biological Diversity** can also be relevant for policy context regarding land cover*

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change.

*Necessity to actively mainstream climate resilience considerations in all relevant policy fields is stressed in the **EU Strategy on Adaptation to Climate Change**. The European Commission stresses the implementation of adaptation strategies and plans at all levels of governance, particularly including three cross cutting priorities: integrating adaptation into macro-fiscal policy, nature-based solutions for adaptation, and local adaptation action.*

The EU's 8th Environment Action Programme (EAP) to 2030 *(Decision (EU) 2022/591) set out thematic priority objectives in areas of climate change mitigation, adaptation to climate change, protecting and restoring terrestrial and marine biodiversity, a non-toxic circular economy, a zero-pollution environment and minimising environmental pressures from production and consumption across all sectors of the economy. The EU's 8th EAP to 2030 is relevant for coastal zones management in the context of climate change.*

*The **paragraph 32** highlights degradation of marine and coastal ecosystems through harmful practices, pollution and processes such as eutrophication and acidification, and asks for urgent action to protect and restore marine and coastal ecosystems, including the ocean floor. In addition, it states that environmental degradation and the adverse effects of climate change are expected to increase further in the years to come, impacting the hardest on developing countries and vulnerable populations.*

*In order to help build resilience and support third countries in their efforts to mitigate, and adapt to climate change, as well as to protect biodiversity, **Article 33** proposes that financial assistance from the Union and Member States to third countries should promote the **UN 2030 Agenda**, **the Paris Agreement** and the post-2020 global framework of the **UN Convention on Biological Diversity** and be in line with the priority objectives of the 8th EAP.*

In addition, integrated costal management is expressly mentioned in Art 7 of marine spatial planning Directive (2014/89/EU), where there is an obligation to take land-sea interaction into account, and then if there are other planning processes the Member States shall aim to "promote coherence" between them.

Targets

- *No construction within the setback zone and avoid further construction in low-lying coastal terrain*
- *Change of coastal land use structure, dominance of urban land use reversed*
- *Keep, and increase landscape diversity*

Interpretation of targets and setting the measures to achieve them should be left to the countries. The reason is the strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions in each country. In other words: although the indicatoris a simple tool to show trends in land-cover changes for interpretation purposes, additional criteria should be taken into account i.e. due to strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions the interpretation should be left tothe countries.

These targets should be taken as general guidelines that need to be considered in light with the local knowledge. Given the relevance of the socio-economic, historic and cultural dimension, in addition to specific geographical conditions, local experts will provide the needed input in support to this indicator.

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Policy documents

ICZM Protocol (available in different languages at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22009A0204(01)) Convention on Biological Diversity (www.cbd.int)
Habitats Directive (92/43/EEC)
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

Birds Directive (2009/147/EC)
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0082&from=EN

The EU's 8th Environment Action Programme to 2030
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022D0591

Biodiversity Strategy for 2030 Bringing nature back into our lives (COM/2020/380)
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0380&qid=1633372990508

Marine Spatial Planning Directive (2014/89/EU)
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN

Indicator analysis methods

Indicator Definition

Land use/land cover change is the change of purpose to which land is profited by humans (e.g., protected areas, forestry for timber products, plantations, row-crop agriculture, pastures, or human settlements). Different parameters can be considered for evaluation of indicator on land use/land cover change. The parameters are summed in Table 1. The combined analysis of these parameters entails an inventory of the urbanization pressures on coastal ecosystems. In practice the parameters can identify: (i) where pressures are higher (by amount of change and by pace of the process); (ii) spatial trends (along the coast and landwards and in low-lying coastal terrain); and (iii) areas for priority action. However, responsible (local) institutions are necessary to correctly interpret these processes and to understand the drivers behind them.

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Table 1. ***Description of the parameters calculated for the indicator Land Cover Change***

Parameter	*Units*	*Data required*	*Reporting units*	*Meaning*
Area of built-up land in coastal zone as a proportion of the total area in the same unit	*% of artificial areas*	*Artificial surfaces ata single time shot*	*Coastal zone asdefined by the country Also coastal strips (<300m*, 300m-1km, 1-10 km). Also low-elevation coastal zone (LECZ)**.*	*State of urban areas at a particular time. This is used as a baseline, i.e. initial conditionfor the analysis of changes.*
Area of built-up land in coastal units as a proportion of the area of built-up land in the wider coastal unit	*% of artificial areas*	*Artificial surfaces ata single time shot*	*Coastal strips within coastal zone.*	*This parameter shows in which coastal strip the process of urbanisation is the most intensive. It also reflects the relevance of economic activities on the coast as a driver of urban development.*
Land take as % initial urban area on the coastal zone	*% of increase of urban areas*	*Artificial surfaces at t0 and t1*	*Coastal zone asdefined by the country. Also coastal strips (<300m*, 300m-1km, 1-10 km) Also low-elevation coastal zone (LECZ). Also protected areas.*	*Intensity of the process of urbanization in a given period of time.*
Change of forest and semi-natural areas	*% of change of forest and semi-natural areas*	*Forest and semi-natural land at t0 and t1*	*Coastal zone as defined by the country. Also coastal strips (<300m*, 300m-1km, 1-10 km) Also low-elevation coastal zone (LECZ).*	*This parameter would reflect to what extent management is leading to an increase, maintenance or decrease of forest and semi-natural areas. This represents the land cover closer to "natural land" excluding wetlands (specific indicator).*
Change of wetlands	*% of change of wetlands*	*Wetlands at t0 and t1*	*Coastal zone as defined by the country. Also coastal strips (<300m*, 300m-1km, 1-10 km) Also low-elevation coastal zone (LECZ).*	*This parameter will indicate how effective is the protection of wetlands, (including deltas) in terms of coverage. The indicator could reflect and increase, maintenance or a decrease of wetlands.*
Change of protected areas	*% of change of protected areas*	*Protected areas at t0 and t1*	*Coastal zone as defined by the country. Also coastal strips (<300m*, 300m-1km, 1-10 km) Also low-elevation coastal zone (LECZ).*	*This parameter shows how the extent of protected areas changes in time.*

**the 300m wide coastal strip is proposed as relevant representation of the coastal setback (alsoconsidering the resolution issues)*

*** Low Elevation Coastal Zone (LECZ) is an area within the coastal zone potentially prone to future risks caused by climate change: sea level rise, coastal flooding, erosion and salinization. LECZ should be constructed as area contiguous to the coast and below elevation threshold. For the Mediterranean region, 5 m above sea level is recommended elevation threshold. Within this zone, each country can implement country-specific measures to cope with the risks based on the most relevant climate change scenario for the country.*

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Methodology for indicator calculation

1. Data compilation *- Land cover classes are typically mapped from digital remotely sensed data through the process of a supervised digital image classification or, alternatively, determined by in situ monitoring. Land cover classes needed for the indicator are based on the Land Cover Classification System (LCCS) developed by the United Nations (UN) Food and Agriculture Organization (hereinafter UN-LCCS system). Level 1 of the UN-LCCS system is sufficient for the indicator's land cover classes and they are listed in the Table 2. If more detailed classification is available, then it could be provided making the clear link with Table 2.*

Table 2. Land cover classes for the Land Cover Change indicator

LU/LC class	*UN-LCCS classes (code and description)*
Artificial surfaces (also referred as built-up areas)	***50 Urban/Built-up*** *Land covered by buildings and other human-made structures. Urban green (parks, sport facilities) is not included in this class. Waste dump deposits and extraction sites are considered as bare.*
Agricultural	***40 Cultivated and managed vegetation/agriculture (cropland)*** *Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Greenhouses are considered as built-up.*
Forest and semi-natural land	***10 Forest/Tree cover*** *Closed (tree canopy >70 %) / open forests (tree canopy 15-70%), evergreen/deciduous, needle/broad leaf, mixed. Plantation (e.g. olive trees and orchards) are included in this class.* ***20 Shrubs*** *These are woody perennial plants with persistent and woody stems and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous. Vineyards are included in this class.* ***30 Herbaceous vegetation/grasslands*** *Plants without persistent stem or shoots above ground and lacking definite firm structure. Tree and shrub cover is less than 10 %. Irrespective of different human and/or animal activities, such as: grazing, selective fire management etc. It may also contain uncultivated cropland areas (without harvest/ bare soil period) in the reference year.* ***60 Bare / sparse vegetation*** *Lands with exposed soil, sand, or rocks and never has more than 10 % vegetated cover during any time of the year.* ***70 Snow and Ice*** *Lands under snow or ice cover throughout the year.* ***100 Moss and lichen*** *Moss and lichen*
Wetlands	***90 Herbaceous wetlands*** *Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present in either salt, brackish, or fresh water.* ***95 Mangroves***
Water bodies	***80 Permanent water bodies*** *Lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.* ***200 Open sea*** *Oceans, seas. Can be either fresh or salt-water bodies.*

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2. Protected areas

Surfaces with any of the protection status (such as Natura 2000, IUCN or national-specific categories with the objectives to protect biodiversity, habitats, species, landscapes and alike in the coastal zone).

3. Data processing

Data processing includes the following steps (Figure 2):

(i) Pre-processing

Land cover data could be available in two formats: vector data (polygons) or raster data (grid). For practical reasons, and to simplify the computing process, the first step is to ensure that all the data is in a grid of 1 ha or smaller. Conversion of vector data to a grid, or raster, is a common procedure in GIS techniques. Most of the GIS software provides different options to convert vector data into a grid. Here the 'Maximum area' criterion is suggested as one of the most standard methods.

(ii) Combining data

Once the data is available in 1 ha or smaller grid, the different layers are combined. This process is automatically done by any GIS software and creates an associated table with all the information available for each cell in the grid. The layers to be combined are listed as follows:

1. *Baseline land cover data (y0).*
2. *Land cover change data (y0-y1).*
3. *Delimitation of coastal zone and strips.*
4. *Delimitation of protected areas.*
5. *Delimitation of Low Elevation Coastal Zone.*

Therefore, the minimum information that the resulting table should contain is as follows:

1. *Grid ID. Unique identifier for each cell in the grid of 1 ha.*
2. *Coastal zone. Yes/No. Boolean parameter that indicates if the cell is within the coastal zone, as defined by the country.*
3. *Coastal strip 0-300 m. Yes/No. Boolean parameter that indicates if the cell is within the coastal strip.*
4. *Coastal strip 300 m – 1 km. Yes/No. Boolean parameter that indicates if the cell is within the coastal strip.*
5. *Coastal strip 1 km – 10 km. Yes/No. Boolean parameter that indicates if the cell is within the coastal strip.*
6. *Protected area at t_0. Yes/No. Boolean parameter that indicates if the cell is within the protected area.*
7. *Protected area at t_1. Yes/No. Boolean parameter that indicates if the cell is within the protected area.*
8. *Low Elevation Coastal Zone. Yes/No. Boolean parameter that indicates if the cell is within the Low Elevation Coastal Zone.*
9. *Land cover class at t_0. Code for the land cover class of the cell.*
10. *Land cover class at t_1. Code for the land cover class of the cell.*

(iii) extracting statistics

As a result of the previous step a table should be available with the unique code of each cell of the 1ha grid and all related parameters. Therefore, the extraction of the statistics for the calculation of the indicator could be done in a spreadsheet and does not require any GIS processing (see Data analysis and assessment outputs section for the details).

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Detailed description of the calculation for the Land Cover Change indicator using open-source software is given in the Manual for calculating IMAP Common Indicator 25, Report; PAP/RAC, Split, Croatia (Gilić F. 2022).

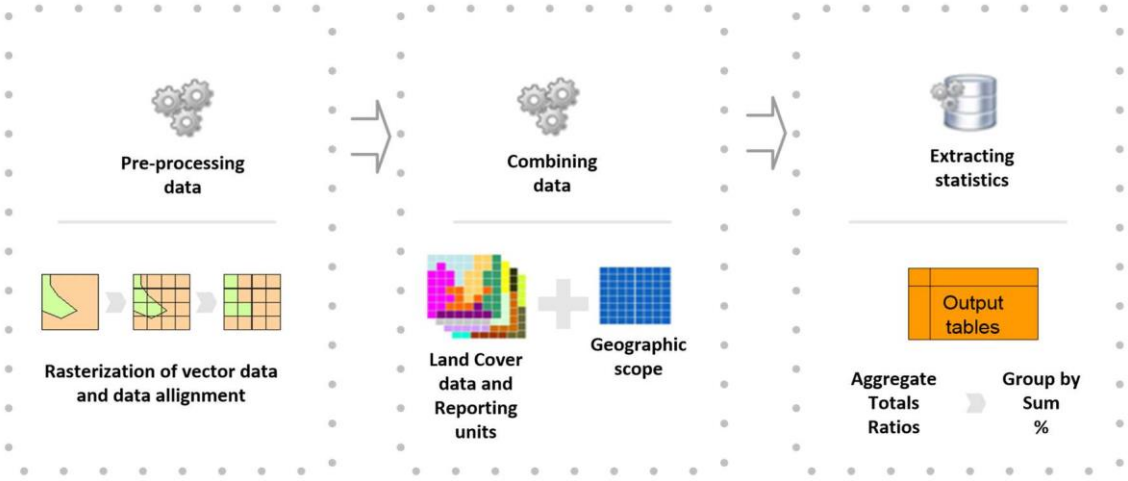

Figure 2. ***Data processing for the Land Cover Change indicator***

Indicator units

The first monitoring will focus on the baseline. The indicator units are indicated below:

1. *km^2 of built-up area in coastal strips/coastal zone;*
2. *% of built-up area in coastal strips/coastal zone;*
3. *% of other land cover classes in coastal strips/ coastal zone;*
4. *% of built-up area within coastal strips of different width (see Table 1) compared to coastal zone;*
5. *% of other land cover classes within coastal strips of different width (see Table 1) compared to coastal zone;*
6. *km^2 of protected areas within coastal strips/coastal zone;*
7. *km^2 of built-up area within protected areas;*
8. *% of built-up area within protected areas;*
9. *km^2 of LECZ within coastal strips/coastal zone;*
10. *km^2 of built-up area within LECZ;*
11. *% of built-up area within LECZ;*
12. *% of other land cover classes within LECZ;*
13. *km^2 of protected areas within LECZ.*

For second monitoring the following units will also be relevant:

14. *% of increase of built-up area, or land take in coastal strips/coastal zone;*
15. *% of change of other land cover classes in coastal strips/coastal zone;*
16. *% of change of protected areas in coastal strips/coastal zone;*
17. *% of increase of built-up area, or land take within protected areas;*
18. *% of increase of built-up area, or land take within LECZ;*
19. *% of change of other land cover classes within LECZ;*
20. *% of change of protected areas within LECZ.*

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List of Guidance documents and protocols available

Pilot project in the Adriatic on testing the candidate common indicator 'Land use change' in the Mediterranean, by: Anna Marín. Raquel Ubach. and JaumeFons-Esteve. Coordinated by: Marko Prem, PAP/RAC. URL: http://www.pap- thecoastcentre.org/pdfs/Pilot%20Adriatic_Final_Sep2015.pdf

Upgraded LCC Indicator 25 proposal. Report; PAP/RAC, Split, Croatia (Baučić M., Morić Špánić A., Gilić F. 2022)

Report and GIS database with calculation of the LCC indicator for the pilot areas. Report; PAP/RAC, Split, Croatia (Baučić M., Morić Špánić A., Gilić F. 2022)

Validation of testing results for upgraded LCC Indicator 25 in pilot areas. Report; PAP/RAC, Split, Croatia (Baučić M., Morić Špánić A., Gilić F. 2022)

Manual for calculating IMAP Common Indicator 25, Report; PAP/RAC, Split, Croatia (Gilić F. 2022)

Data confidence and uncertainties

Production of land use/land cover data from remote sensing is always a compromise between precision and efforts required to derive the information from satellite images. The data sources listed below (see Available data sources) have been validated by the responsible institutions or providers of the data. Additionally, if analogue maps from official institutions are available they could be digitalised and used accordingly.

Quality assurance/control always involve a selection of percentage of points where the derivedinformation is checked against "ground truth" –usually ancillary information like official maps,cadastre,... but also field inspections.

Validation of testing results for upgraded LCC Indicator 25 in pilot areas. Report; PAP/RAC, Split, Croatia (Baučić M., Morić Špánić A., Gilić F. 2022)

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

The most elaborated guidelines are available from the Corine Land Cover programme (currentlyintegrated in the Copernicus Programme).

http://www.eea.europa.eu/publications/technical_report_2007_17

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
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Available data sources

The data sources listed below are open global data bases (free for use). The report "Validation of testing results for upgraded LCC Indicator 25 in pilot areas. Report; PAP/RAC, Split, Croatia (Baučić M., Morić Špánić A., Gilić F. 2022)" has proved their use. In the case where national datasets (official) are available as more updated and with better resolution, these should be used instead of open-source datasets proposed.

ESA WorldCover Project Land cover:
WorldCover provides a global land cover product at 10 m resolution for 2020 and 2021 based on Sentinel-1 and 2 data. The ESA WorldCover product is provided free of charge, without restriction of use. https://esa-worldcover.org/en

OpenStreetMap (OSM) data:
OpenStreetMap (OSM) is based on crowdsourced volunteered geographic information, it is often being used as a valuable data source for extracting useful information. OSM coastline can be downloaded from https://osmdata.openstreetmap.de/. Administrative boundaries from https://osm-boundaries.com/.
Copernicus DEM 30:
Copernicus DEM is a digital surface model (DSM) in resolution of 30 m, it has world cover and is freely available, https://land.copernicus.eu/global/content/annual-100m-global-land-cover-maps-available

***World Database on Protected Areas**:*
World Database on Protected Areas is the most exhaustive global database on terrestrial and marine protected areas, managed by UNEP World Conservation Monitoring Centre (UNEP-WCMC) and is being updated on a monthly basis *https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA.*

Spatial scope guidance and selection of monitoring stations

The exact territorial extent (coastal area for the analysis) of the monitoring should be defined. The Mediterranean ICZM Protocol defines the landward limit of coastal zone as the "limit of the competent coastal units as defined by the Parties (Article 3)." In other words, the landward limit will be country-specific, e.g. dependant on definition given by certain Contracting party when ratifying the Protocol.

As for the resolution of the source data it is a „compromise between precision and efforts needed in processing the satellite images. The following indications could be considered
minimum requirements:

- *Minimum mapping unit of 1 ha and 100 m of linear elements*
- *Minimum change detection 1 ha*

Temporal Scope guidance

The temporal scale should be 6 years, in order to be effective on the counteracting negative effectsand taking early actions on problematic areas. That will ensure complementarity with the cycle of the monitoring of CI 16 and the QSR preparation.

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Data analysis and assessment outputs	

Statistical analysis and basis for aggregation

The statistics can be computed as follows (assuming that 1 cell equals 1 ha):

1. *Percentage of built-up area in coastal zone/coastal strips.*
   a) *Filter the data by the grids belonging to the coastal zone/coastal strips.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within the coastal zone/coastal strip, by land cover "artificial areas" (see Table 2 for the definition of land cover classes).*
   d) *Calculate area of "artificial areas" by counting the number of cells. This is the area in ha.*
   e) *Divide 1d by 1b in order to obtain the percentage of artificial area on the coastal zone/coastal strip.*

2. *Percentage of other land cover classes on the coastal zone/coastal strip. As complementary to "Percentage of built-up area in coastal zone" the same procedure could be applied to eachland cover class as defined in Table 2. In that case the procedure described in 1 will be replicated by changing "artificial areas" with the other land cover classes.*

3. *Area of built-up land in coastal strip as a proportion of the area of built-up land in the coastal zone.*
   a) *Divide 1d calculated for coastal strip by 1d calculated for coastal zone. This value is the percentage of built-up land in the coastal zone that is located inside the coastal strip.*
   b) *Replicate the procedure described in a) for each coastal strip.*

4. *Percentage of built-up area in protected areas.*
   a) *Filter the data by the grids belonging to the protected area.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within protected area, by land cover "artificial areas" (see Table 2 for the definition of land cover classes).*
   d) *Calculate area of "artificial areas" by counting the number of cells. This is the area in ha.*
   e) *Divide 4d by 4b in order to obtain the percentage of artificial area in the protected area.*

5. *Percentage of built-up area in LECZ.*
   a) *Filter the data by the grids belonging to the LECZ.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within LECZ, by land cover "artificial areas" (see Table 2 for the definition of land cover classes).*
   d) *Calculate area of "artificial areas" by counting the number of cells. This is the area in km^2.*
   e) *Divide 5d by 5b in order to obtain the percentage of artificial area on the LECZ.*

6. *Percentage of other land cover classes on the LECZ. As complementary to "Percentage of built-up area in LECZ" the same procedure could be applied to each land cover class as defined in Table 2. In that case the procedure described in 5 will be replicated by changing "artificial areas" with the other land cover classes.*

7. *Percentage of protected area in LECZ.*
   a) *Filter the data by the grids belonging to LECZ.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within the LECZ, by protected areas.*
   d) *Calculate area of "protected areas" by counting the number of cells. This is the area in ha.*
   e) *Divide 7d by 7b in order to obtain the percentage of protected area on the LECZ.*

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8. *Land take as % of initial urban area on the coastal zone/coastal strip. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline(state at t0).*
   a) *Filter the data by the grids belonging to the coastal zone/coastal strip.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within the coastal zone/coastal strip, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t0.*
   d) *Filter, within the coastal zone/coastal strip, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t1.*
   e) *Calculate 8d-8c and then divide by 8c. This provides the percentage of land take compared to the initial built-up area.*

9. *Change of forest and semi-natural land. This parameter will start to be computed on thesecond monitoring since the first monitoring focus only on the baseline (state at t0).*
   a) *Filter the data by the grids belonging to the coastal zone/coastal strip.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within the coastal zone/coastal strip, by land cover "Forest and semi-natural land" (see Table 2 for the definition of land cover classes) for t0. Calculate area by counting the total number of cells. This is the area in ha.*
   d) *Filter, within the coastal zone/coastal strip, by land cover "Forest and semi-natural land" (see Table 2 for the definition of land cover classes) for t1. Calculate area by counting the total number of cells. This is the area in ha.*
   e) *Calculate 9d-9c and then divide by 9c. This provides the percentage of change of forestand semi-natural areas for the given period.*

10. *Change of wetlands. This parameter will start to be computed on the second monitoringsince the first monitoring focus only on the baseline (state at t0).*
   a) *Filter the data by the grids belonging to the coastal zone/coastal strip.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter, within the coastal zone/coastal strip, by land cover "Wetlands" (see Table 2 for the definition of land cover classes) for t0. Calculate area by counting the total number of cells. This is the area in ha.*
   d) *Filter, within the coastal zone/coastal strip, by land cover "Wetlands" (see Table 2 for the definition of land cover classes) for t1. Calculate area by counting the total number of cells. This is the area in ha.*
   e) *Calculate 10d-10c and then divide by 10c. This provides the percentage of change of wetlands for the given period.*

11. *Change of protected area. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t0).*
   a) *Filter the data by the grids belonging to the protected area for t_0.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*
   c) *Filter the data by the grids belonging to the protected area for t_1.*
   d) *Calculate total area by counting the total number of cells. This is the area in ha.*
   e) *Calculate 11d-11b and then divide by 111b. This provides the percentage of change of protected area for the given period.*

12. *Land take as % of initial urban area in the protected area. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline(state at t0).*
   a) *Filter the data by the grids belonging to the protected area.*
   b) *Calculate total area by counting the total number of cells. This is the area in ha.*

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c) Filter, within the protected area, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t0. Calculate area by counting the total number of cells. This is the area in ha.

d) Filter, within the protected area, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t1. Calculate area by counting the total number of cells. This is the area in ha.

e) Calculate 12d-12c and then divide by 12c. This provides the percentage of land take compared to the initial built-up area.

13. Land take as % of initial urban area on the LECZ. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline(state at t0).

a) Filter the data by the grids belonging to the LECZ.

b) Calculate total area by counting the total number of cells. This is the area in ha.

c) Filter, within the LECZ, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t0. Calculate area by counting the total number of cells. This is the area in ha.

d) Filter, within the LECZ, by land cover "artificial areas" (see Table 2 for the definition of land cover classes) for t1. Calculate area by counting the total number of cells. This is the area in ha.

e) Calculate 13d-13c and then divide by 13c. This provides the percentage of land take compared to the initial built-up area.

14. Change of other land cover classes on the LECZ. As complementary to "Land take on the LECZ" the same procedure could be applied to eachland cover class as defined in Table 2. In that case the procedure described in 13 will be replicated by changing "artificial areas" with the other land cover classes.

15. Change of protected area within LECZ. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline(state at t0).

a) Filter the data by the grids belonging to the LECZ.

b) Calculate total area by counting the total number of cells. This is the area in ha.

c) Filter, within the LECZ, protected area for t0. Calculate area by counting the total number of cells. This is the area in ha.

d) Filter, within the LECZ, protected area for t1. Calculate area by counting the total number of cells. This is the area in ha.

e) Calculate 15d-15c and then divide by 15c. This provides the percentage of land take compared to the initial built-up area.

The above-mentioned analysis can be complemented with the following ones that provide additional insight on the land cover indicator.

16. Additional analytical units

a) Setback zone (if defined by country). Given the relevance of this part of the coastal area, as referred on the ICZM protocol, the indicators on % of built-up and land take can be analysed for this specific zone.

b) Elevation breakdown within the coastal area. Distance to the coast and elevation are*elements that configure different habitat distribution and patterns. With available local knowledge 3 to 5 elevations classes could be considered to be analysed independently within the coastal area in order to better link the pressure of land take to specific habitats (5 – 10, 10 – 50, 50 – 100. 100 – 300, > 300).*

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17. Additional parameters

What has been lost by urbanization?

a) Filter the data by the grids belonging to the coastal zone.

b) Calculate total area by counting the total number of cells. This is the area in km^2.

c) Develop a pivot table with land cover classes at t0, on rows, and land cover classes att1 on columns. Cells in this matrix will contain the area that has changed from certainland cover class at t0to a new class in t1.

d) Select the column for "Built-up areas".

e) Values on the rows indicate the different land cover classes at t0 that have been converted into built-up area.

f) Values from e) can be divided by the corresponding area of the same class at t0. Thiswill provide the percentage of certain land cover class that has been converted into built-up.

Expected assessments outputs

The outputs are detailed below:

- *Digital map with the land cover classes for the coastal area. Land cover classes should follow the classification provided in Table 2. If more detailed classification is available, thenit could be provided making the clear link with Table 2. The following specifications will ensure the interoperability of the maps provided by different institutions/countries:*
  - *Format: raster GeoTIFF (Geographic Tagged Image File Format) 1 ha*
  - *Metadata:*
    - *Title of the map*
    - *Geographic reference.*
      - *Bounding box.*
      - *Coordinate reference system*
    - *Temporal reference (year)*
    - *Responsible organisation*
- Spreadsheet with the calculated indicators as described in the methodology.
- Starting with the second monitoring, additional maps will be provided indicating areas of land take (new urbanization). The specifications for these maps are the same as indicatedabove.

Known gaps and uncertainties in the Mediterranean

The definition of the analytical units of the coastal zone could be revised in view of more detailed data on habitats distribution, or input from national experts. In any case it is important to take intoaccount the implications of the different delineations on the interpretation of the results.

The use of remote sensing and the selected resolution is the main constrain when analysing the outcomes

- *Not all changes are observed since there is minimum change detection. Therefore, the patterns observed indicate that changes are underestimated. In any case the proposed approach is still relevant since it provides an idea of the magnitude of the processes of urbanization.*
  Given the resolution and processing, linear elements are not well captured; therefore, linear elements perpendicular to the coast, for example, are not detected.
- *The information currently available does not allow identifying built-up on the territorialwaters.*

Since these limitations arise from the definition of the resolution, there is space for improvement if it is needed. However, there is always a trade-off between resolution and efforts required to obtain the information.

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In addition, countries may obtain data from different sources (different resolution, different level of precision) which may make comparability of data difficult.	
Contacts and version Date	
Key contacts within UNEP for further information	

Version No	**Date**	**Author**
V.1	27/6/16	PAP/RAC
V.2	20/07/16	UAB
v.3	01/04/19	PAP/RAC
v.4	15/09/22	PAP/RAC
v.5	06/04/23	PAP/RAC