High Resolution Layer HRL

Imperviousness – Imperviousness Density Report 2015

Copernicus Land Monitoring 2014 -2020
in the framework of Regulation (EU) No 377/2014 of the European
Parliament and of the Council of 3 April 2014

Specific Contract No 3436/R0-COPERNICUS/EEA.57273 Implementing Framework service contract No
EEA/IDM/RO/16/009/Malta
Malta

Tasks:

1. Production of CLC for the 2018 reference year	Y
2. Post-production **verification** of the High Resolution Layers (HRL's) for the 2015 reference year	
3. Dissemination	Y

1. Abstract

A nation-wide exercise was carried out to analyse the effective built-up areas using in-situ imagery data and the Degree of Imperviousness layers (IMD 2015) provided for verification. The IMD 2015 data layer was superimposed onto the in-situ data; ortho-photos and the CLC layer. Subsequently a thematic map was prepared whereby the main areas to be interpreted as Built-up were highlighted, namely the areas with pixel values of 30% to 100% Imperviousness.

In Malta's case it was deemed best to apply a complete coverage methodology rather than verifying specific area samples. Hence each area marked as "Built-up" was verified visually utilising in-situ Orthoimagery and the CLC databases (for the

reference years 2012 and 2018) and all the major errors identified and categorised as “Commission” or “Omission” error types as per guidelines provided for the verification process. When considering the physical area of the Maltese Islands and the land cover characteristics of the built-up areas, applying this method of photo interpretation, resulted in a more adequate verification of the HRL layer giving us a more detailed result.

Overall, the Impervious HRL layer provides a generalised view compared to the level of detail that is normally utilized locally (1:1000). Even so, the detail provided in the IMD2015 layer can still be deemed very good for the parameters/requirements of this verification exercise. During this verification stage, the majority of the errors were “Omissions” particularly in areas where the development was isolated or their shape was elongated and hence forming narrow strips of built-up areas. The latter issue was particularly evident in the island of Gozo and in some parts of the north west of the island of Malta. A significant number of Omission cases related to greenhouses, cemeteries and sports and recreation areas which were erroneously interpreted as non-impervious.

2. Background

The Planning Authority (PA) is the “National Reference Centre on Landcover” for the European Environment Agency (EEA). In this function the Agency supports European institutions dealing with land cover, land monitoring and land use.

PA has been working on issues like European wide homogeneous data sets emphasising on land cover topics for several years. Land cover plays an important role for environmental spatial and territorial analysis. As PA is composed of both the land-use and spatial planning agencies, it has a wider responsibility in having up-to-date data about landuse and landcover at very high detail, nominally at 1:1000. In view of such detailed-scale usage, maps at scales required by CLC are rarely used due to the generalized product that is not used for local consumption.

PA has also been responsible for the production of the CLC1990, CLC2000, CLC2006, CLC2012 as well as the CLC2018 update. Since it also hosts the NFP, PA's role is twofold, ensuring delivery of all datasets as well as the production of all environmental spatial data and information systems. In effect CLC products will be incorporated within its generalized dissemination process as an example of international datasets Malta is party to.

In addition this specific contract covered the processes of post-production verification of the 2015 High Resolution Layers (HRLs) as per the terms of reference for the Implementing Framework service contract No EEA/IDM/R0/16/009/Malta. The aim of this task was to identify systematic classification errors that are eligible for improvement/enhancement.

The themes covered by the HRL Verification process included:-

- Imperviousness - Imperviousness density

- Forest - Tree Cover Density
- Forest - Dominant Leaf Type
- Grassland
- Wetness and Water
- Small woody features

For each theme the necessary verification guidelines were provided in order to produce the required outputs. At each stage of the process the drafted outputs were reviewed internally and a final 'verification' report for each HRL submitted to and approved by EEA as per outputs delivery guidelines provided.

All CLC and HRL deliverables were affected through the EEA CDR Dataflow system. All datasets are being used for EU reporting as per Directive requirements. Note also that as per Framework Agreement and as per relevant specific contract agreement requirements the revised CLC2012 layer, the 2012-2018 CLC change, CLC2018 layers were concluded in Aug2018 and are currently disseminated locally through the Planning Authority's Geoportal http://geoserver.pa.org.mt/publiceeoserver as well as through the COPERNICUS Land monitoring online services.

3. References

- *CLC2018 Technical Guidelines: I. General* project *description*
- *CLC2018 Technical Guidelines: II. Interpreting land cover changes and producing CLC2012-2018*
- *CLC2018 support package - Including Interchange and Intercheck software packages and their respective user manuals.*
- *Local ancillary data as highlighted in* Section 3.

CLC and HRL Team:

Mr Stephen Conchin — Senior Information Officer - CLC/HRL MT Project Co-ordinator

Ms Maria Refalo — GIS Development Officer - Photo/Image Interpreter

Prof Saviour Formosa — PA Consultant - Final Reviewer

Drafted at the Planning Authority

Date: 05th November 2018

HRL verification report template for IMPERVIOUSNESS 2015

I. Administrative part

HRL	*Degree of Imperviousness 2015, Full delivery 20x20m, national projection*
Country (and region, if regions are verified separately)	Malta
Institution carrying out the work	Planning Authority (PA)
General overview of data quality done by (name,position and e-mail)	Maria Refalo, Photo-Interpreter, maria.refalo@mepa.org.mt Stephen Conchin, Senior Information Officer, stephen.conchin@mepa.org.mt
Look-and-feel analysis done by (name, position and e-mail)	Maria Refalo, Photo-Interpreter, maria.refalo@mepa.org.mt Stephen Conchin, Senior Information Officer, stephen.conchin@mepa.org.mt
Statistical verification done by (name, position and e-mail)	Maria Refalo, Photo-Interpreter, maria.refalo@mepa.org.mt Stephen Conchin, Senior Information Officer, stephen.conchin@mepa.org.mt
In situ data used. *Replace Data-x with the full name of the dataset. Mention quality issues if relevant.*	*National Orthophoto database of the Maltese islands Reference Years:- 2012 and 2016 (Total Coverage) Resolution 0.10m (2016)*
	CLC2012/CLC2018 databases for Malta
	SENTINEL 2 - Visual Products: 27/06/17, 25/10/17
Internal quality control done by (name, position and e-mail)	Prof Saviour Formosa, PA Consultant , saviour.formosa@pa.org.mt
Date and place of writing the report	05/11/18

II. General overview of data quality

Results of the general overview of data quality (obligatory)	

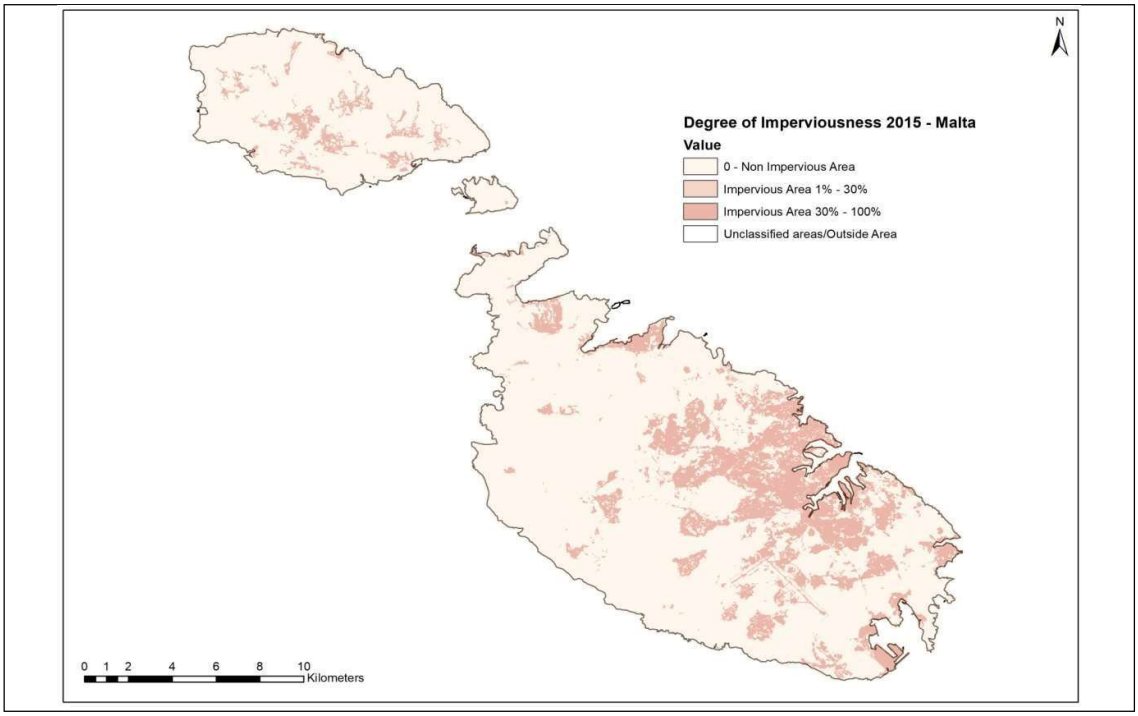
As illustrated in Table 1, a nation-wide exercise was carried out to analyse the effective built up areas using in-situ imagery data and the Degree of Imperviousness layers (IMD 2015) provided for verification. The IMD 2015 data layer was superimposed onto the in-situ data; ortho-photos and the CLC layer. Subsequently a thematic map was prepared whereby the main areas to be interpreted as Built-up were highlighted, namely the areas with pixel values of 30% to 100% Imperviousness.

Table 1: Effective built up areas

IMD 2015 Malta	Pixels Count (20mx20m)	Area (Ha)	%
All Non-Impervious areas 0%	686054.00	27442.16	
Impervious area 1% - 29 %	1795.00	71.80	
Impervious area 30% - 100%	150606.00	6024.24	17.96
Total pixel area		33538.20	

In Malta's case it was deemed best to apply a complete coverage methodology rather than verifying specific area samples. Hence each area marked as "Built-up" was verified visually utilising in-situ Orthoimagery and the CLC databases (for the reference years 2012 and 2018) and all the major errors identified and categorised as "Commission" or "Omission" error types as per guidelines provided for the verification process. When considering the physical area of the Maltese Islands and the land cover characteristics of the built-up areas, applying this method of photo interpretation, resulted in a more adequate verification of the HRL layer giving us a more detailed result.

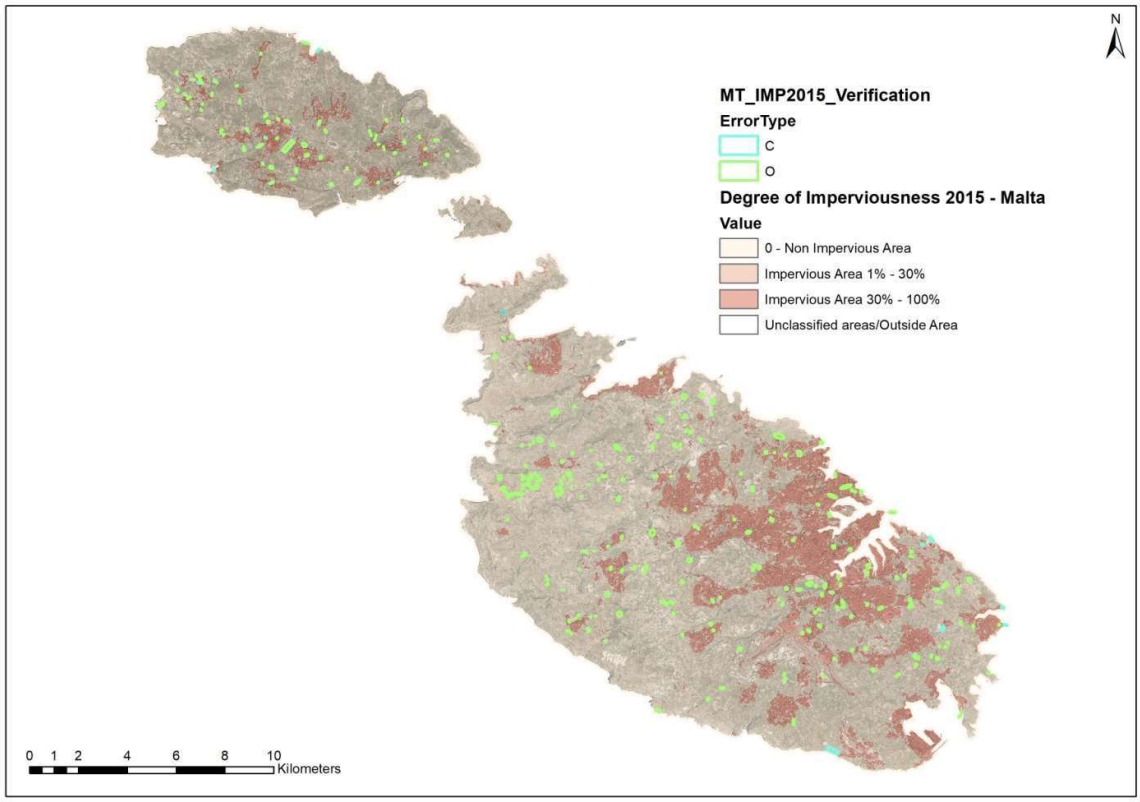
Overall the Impervious HRL layer provides a generalised view compared to the level of detail that is normally utilized locally (1:1000). Even so, the detail provided in the IMD2015 layer can still be deemed very good for the parameters/requirements of this verification exercise. During this verification stage, the majority of the errors were "Omissions" particularly in areas where the development was isolated or their shape was elongated and hence forming narrow strips of built-up areas. The latter issue was particularly evident in the island of Gozo and in some parts of the north west of the island of Malta. A significant number of Omission cases related to greenhouses, cemeteries and sports and recreation areas which were erroneously interpreted as non impervious.



III. Look-and-feel (obligatory)

Stratum	Name of the stratum	Number of errors identified	*Comments*
Commission			
1	Bare rocks	8	Most of the cases where located close to the coast or else in the vicinity of excavated areas. Annex V Figure 1.
2	Sparsely vegetated areas	2	Green areas in the vicinity of built-up areas erroneously interpreted as built-up. Annex V Figure 2.
Omission			
1	Built-up areas	105	The lighter colour signature of the local building material in some areas might have interfered with the HRL layer creation causing the areas to be misinterpreted as “Non Impervious”. Water reflectance from pools, solar panels and other roof structures might have produced the same “omission” errors. Annex V Figures 3 and 4.
2	Cemetery	5	A number of cemetery areas were misinterpreted as non impervious, probably due to the vegetation present. Annex V Figures 5.
3	Greenhouses	98	A significant number of greenhouses were misinterpreted as non impervious probably due to the high reflective surface. Annex V Figures 6.

4	Industrial and Commercial Areas	37	Due to the high number of open spaces with industrial estates some areas were not included as built-up. Annex V Figure 7.
5	Sport and recreation areas	38	Same as above for industrial/commercial areas. Annex V Figure 8.
6	Major ports and airports	3	Land areas within ports and airport left out. Annex V Figure 9.
Overall evaluation			*Good*
Comments			Overall a good evaluation of Impervious areas of 2015.



IV. Statistical verification[1]

Stratification	*A complete coverage photo interpretation method was applied to identify wrongly classified areas (Commission) or for completely omitted areas (Omission). This way all major errors were identified and thus providing a comprehensive overview of the changes required for the enhancement stage of the HRL.*
Comment on stratification	*N/A*
Number of random samples for finding omission errors	*N/A*
Number of valid (applicable) samples for finding omission errors	*N/A*
Omission error (%)[2] with uncertainty	*N/A*
Comment on omissions	*N/A*
Number of random samples for finding commission error	*N/A*
Number of valid (applicable) samples for finding commission error	*N/A*
Commission error (%)[3] with uncertainty	*N/A*
Comment on commissions	*N/A*
Overall evaluation	***Good**, the major error areas were clearly identified, however a reasonable amount of areas where omitted particularly in strip development areas or in isolated built-up areas identified as greenhouses, cemeteries as well as some industrial areas*

[1] not relevant for Grassland product, and also not relevant for permanent/temporary wet, and temporary water classes of WAW product

[2] Producer's accuracy (%) = 1 – omission error (%)

[3] User's accuracy (%) = 1 – commission error (%)

V. Documentation of errors and critical findings.

Commission errors:

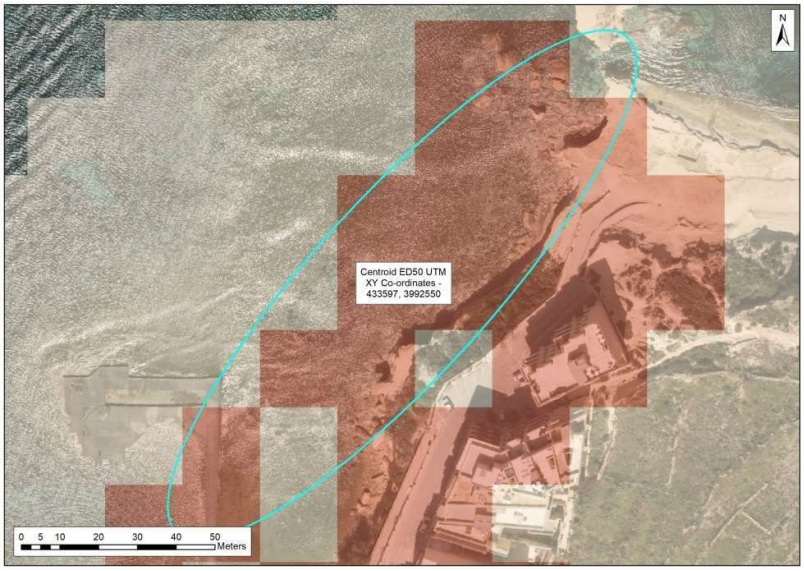


Figure 1: Bare Rocks

Example where most of the 8 cases in the stratum “Bare rocks” located near the coast were mis-interpreted as a non-impervious. This can probably be attributed to the similar colour signature of bare rock to the local building material.

Figure 2: Sparsely vegetated areas

One of the two cases of commission errors for the stratum “Sparsely vegetated areas” where the vegetated area surrounded by built-up has erroneously been classified as Impervious.

Omission errors:

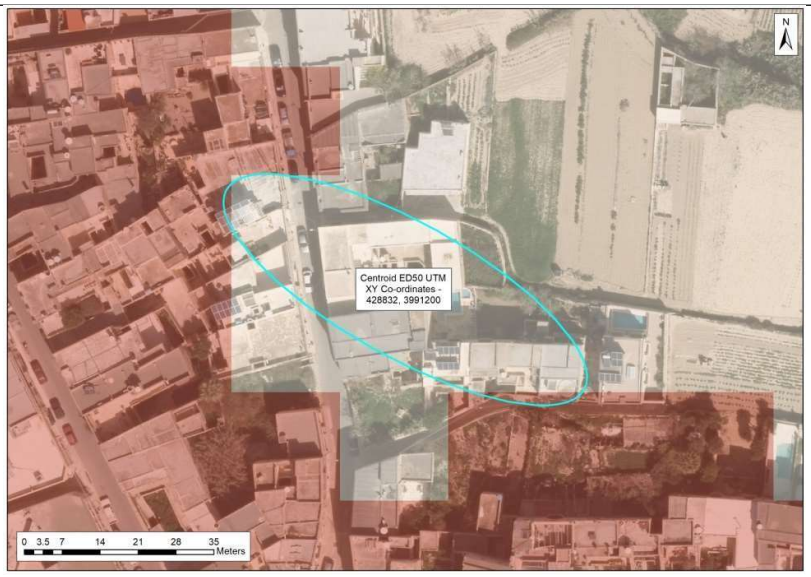


Figure 3: Built-up areas

A typical example of built-up areas around the edge of the development zones, in most cases neighbored by open spaces (agriculture fields or sparsely vegetated areas), that were not classified as impervious.

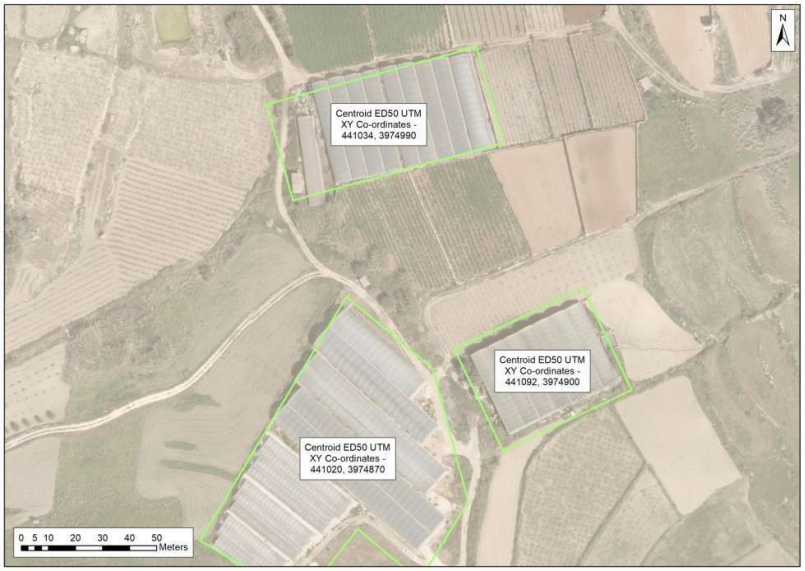


Figure 4: Greenhouses

Figure 4 highlights a typical example where greenhouses have not been classified as impervious. This can be probably attributed to the high reflectivity of the materials used as well as the similarity of the colour signature and feature shape of the surrounding areas.

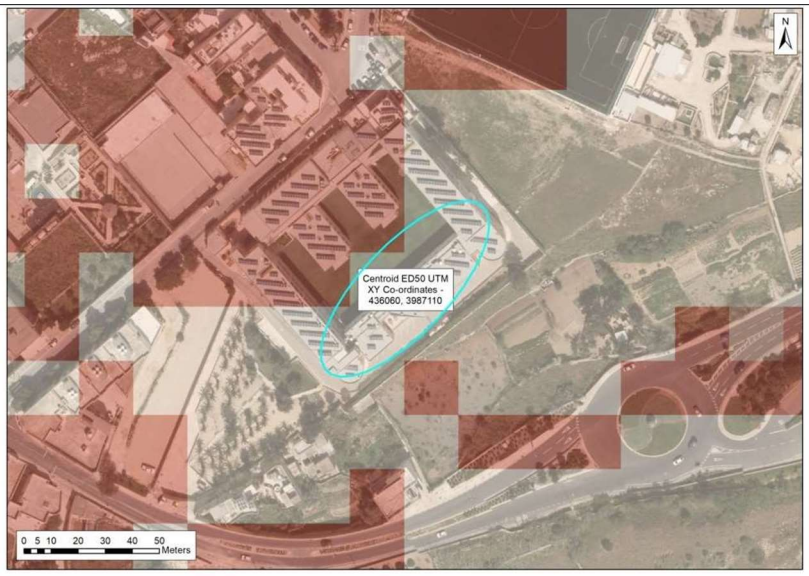


Figure 5: Industrial and Commercial Areas

In figure 5 above one can visualize an example whereby and industrial complex was partially left out from and not classified as impervious. As in most of the 37 cases highlighted this can be probably attributed to the high reflectivity of the roofing material and/or of the solar panels installed as well as due to the surrounding sparsely vegetated areas.

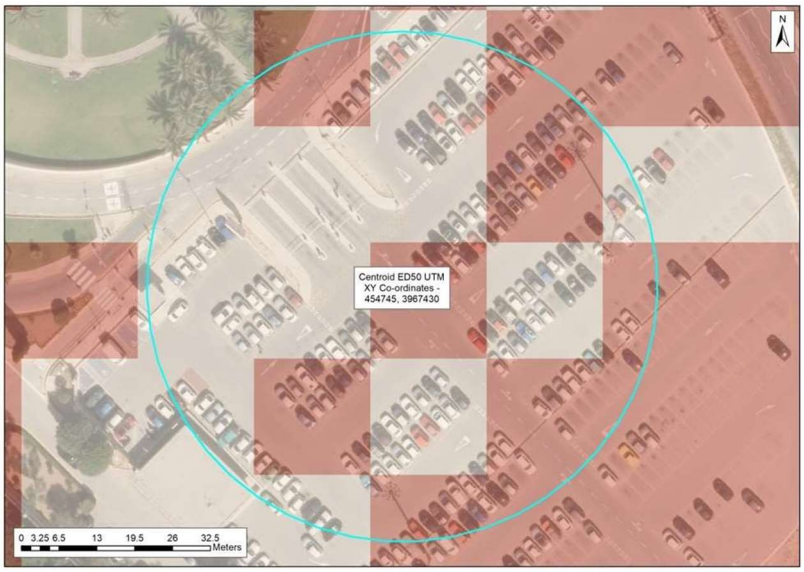


Figure 6: Major ports and airports

The above example shows the parking area of the Malta Airport being erroneously categorized as non-impervious. The other two cases (out of 3 cases in total) highlighted for this stratum type relate to coastal areas where two breakwater structures were not interpreted as impervious.

Figure 7: Sport and recreation areas

Figure 7 above highlights a typical example (in most cases identified) where a sports and recreation area has been left out and miss-classified as non impervious. In most cases these football grounds have been updated from gravel to artificial turf and as such the colour signature resembles sparsely vegetated areas.

VI Documentation of software used for verification

Please provide detailed information on the software type and exact version of software used for the validation.
Software used for the verification process – **Arcmap 10.3.1** as part of the ESRI Enterprise License Agreement deployed at the Planning Authority, Malta.