

**Office of Communications – October 2024**

[Mapping land cover in Tunisia – In the context of the Soil Land and Water Digital Information System initiative]

**Corrigendum**


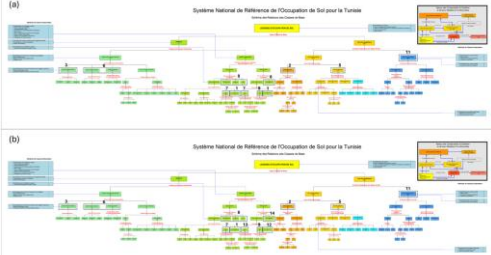
Updated on [15/10/2024]

The following corrections were made to the PDF after it went to print.

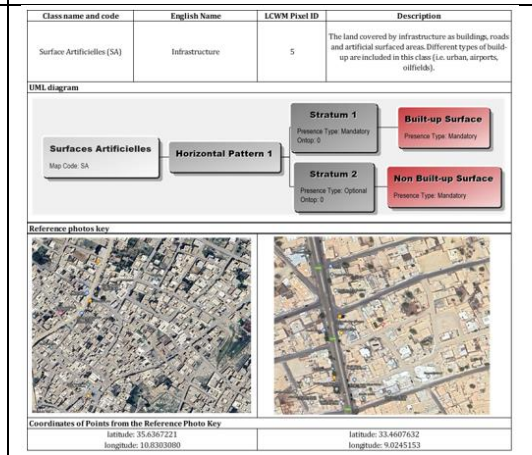
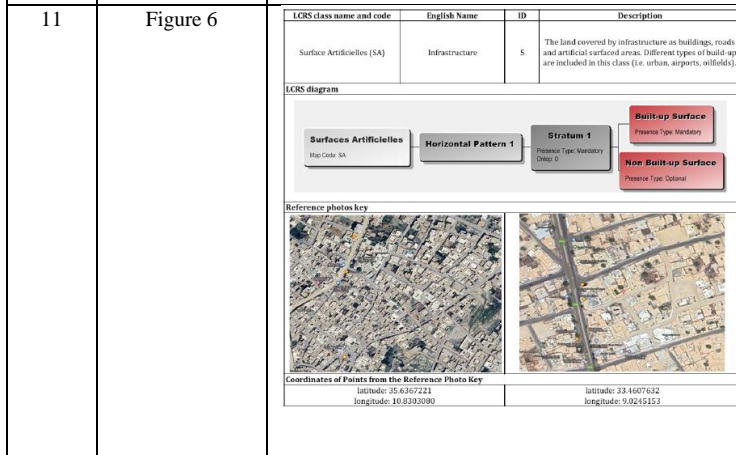
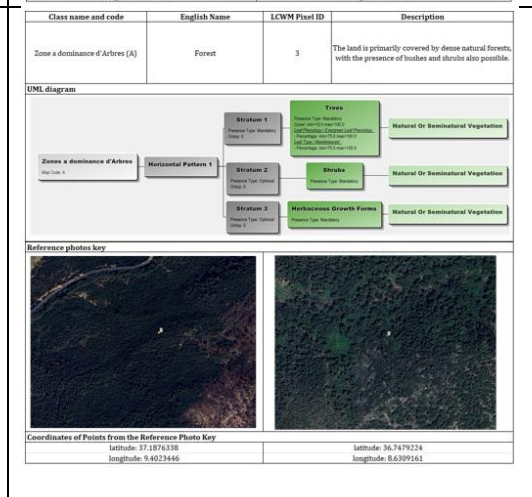
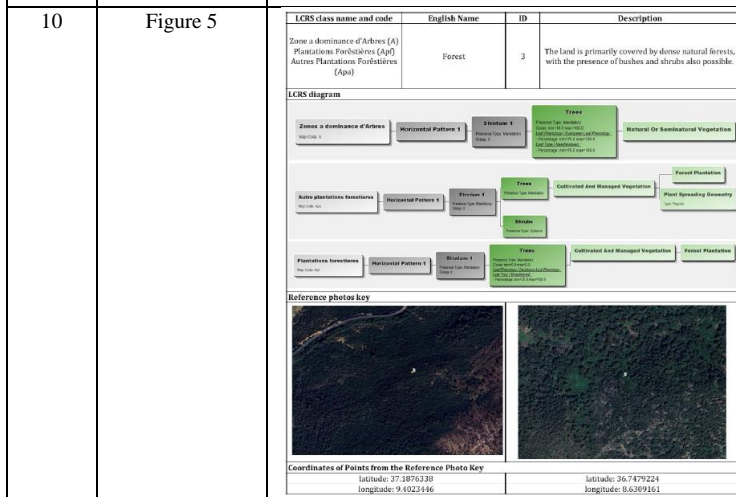
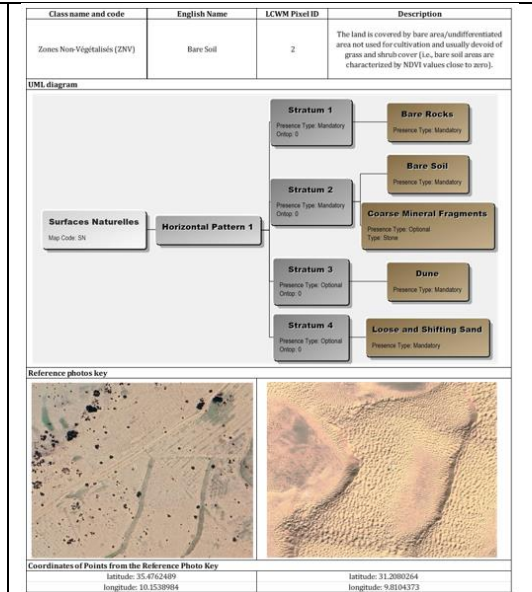
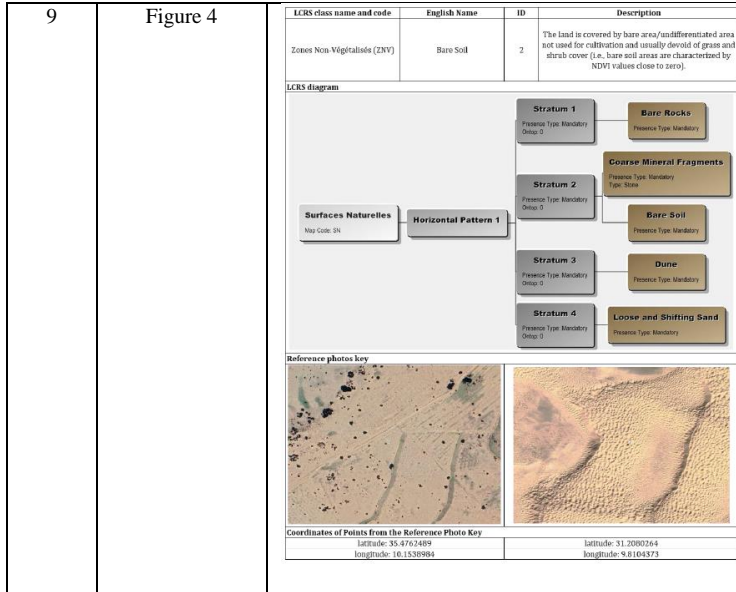
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ix	Acknowledgements	Thanks to Rémi Dannunzio and the Direction Générale des Forêts for sharing useful ground sample points. Special thanks to Carlotta Nardi for preparing the cover page for this publication.	Thanks to Rémi Dannunzio and the Direction Générale des Forêts for sharing useful ground sample points. Thanks to Livia Peiser (Land and Water Division) for providing feedback to the report. Special thanks to Carlotta Nardi for preparing the cover page for this publication.
x	Abbreviations	Was not present	Defined: LCWM (Land Cover with Water Management)
3	2. Land cover mapping in Tunisia	For the mapping of Tunisia's land cover, we used the GEE cloud platform, taking advantage of its capabilities to handle multi-source satellite data and offer high-performance computing services. This has allowed fast and flexible computation between several satellite images, greatly speeding up the mapping process.	For the mapping of Tunisia's land cover, the GEE cloud platform, taking advantage of its capabilities to handle multi-source satellite data and offer high-performance computing services was used. This has allowed fast and flexible computation between several satellite images, greatly speeding up the mapping process. Once the main land covers classes of the country were identified, validation was conducted to assess the map's accuracy. Subsequently, the irrigation management of the classes within the agricultural context was analyzed. Specifically, each land cover class related to agriculture was stratified with external data to determine whether the area was irrigated or rainfed. However, it was not possible to perform a validation for this analysis due to the lack of field data points.
5	Figure 1		
6	b. Land cover classes definition	By offering concrete examples of how each land cover unit appears on the ground, the photographic keys simplify the interpretation process, facilitating more accurate and efficient image analysis.	By offering concrete examples of how each land cover unit appears on the ground, the photographic keys simplify the interpretation process, facilitating more accurate and efficient image analysis. However, it is worth to highlight that, due to the absence of field data as mentioned earlier, the difference between irrigated and rainfed areas was mapped by stratifying the Tunisia land cover map with auxiliary data. This process resulted in a new layer called the Land Cover Map with Water Management (LCWM). Therefore, two different land cover maps were generated with different encodings, Table 1 shows the classes mapped in both the land cover map with and without the irrigation management information.

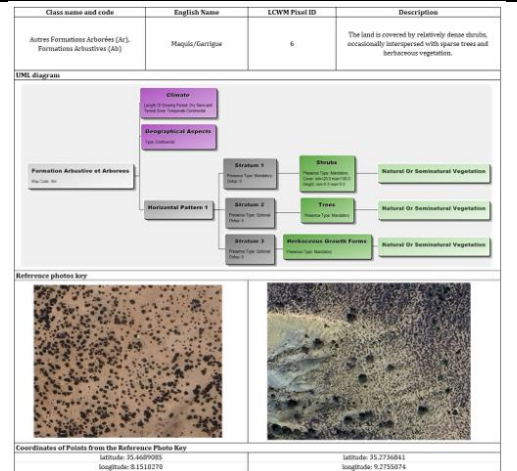
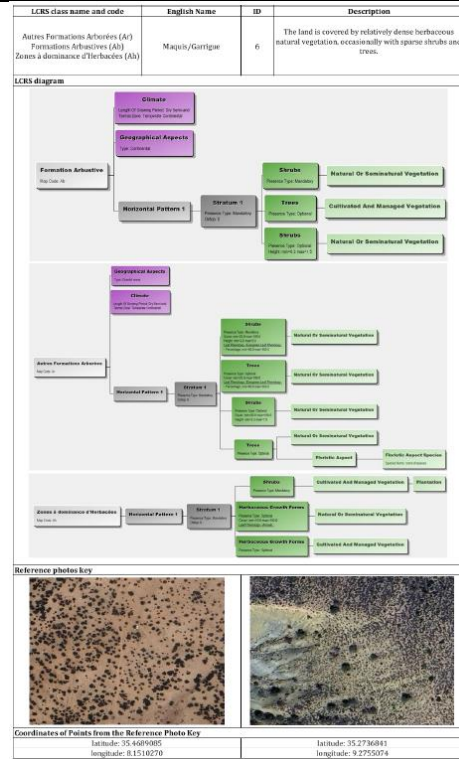
6	Table 1 was added		<p>Table 1 Land cover classes identify for Tunisia land cover maps with and without the water management information</p> <table border="1"> <thead> <tr> <th>LC Tunisia Pixel ID</th> <th>Land cover without irrigation information classes</th> <th>LCWM Tunisia Pixel ID</th> <th>Land cover with irrigation information classes</th> </tr> </thead> <tbody> <tr><td>1</td><td>Orchards</td><td>1</td><td>Rainfed Orchards</td></tr> <tr><td>2</td><td>Bare soil</td><td>2</td><td>Irrigated Orchards</td></tr> <tr><td>3</td><td>Forest</td><td>3</td><td>Bare soil</td></tr> <tr><td>5</td><td>Infrastructure</td><td>5</td><td>Forest</td></tr> <tr><td>6</td><td>Maquis</td><td>6</td><td>Infrastructure</td></tr> <tr><td>7</td><td>Olives</td><td>7</td><td>Maquis</td></tr> <tr><td></td><td></td><td>13</td><td>Rainfed Olives</td></tr> <tr><td>8</td><td>Other crops</td><td>8</td><td>Irrigated Olives</td></tr> <tr><td></td><td></td><td>14</td><td>Other Rainfed Crops</td></tr> <tr><td>9</td><td>Dates</td><td>9</td><td>Other Irrigated Crops</td></tr> <tr><td></td><td></td><td>11</td><td>Irrigated Dates</td></tr> <tr><td>11</td><td>Water and wetland</td><td>11</td><td>Water and wetland</td></tr> </tbody> </table>	LC Tunisia Pixel ID	Land cover without irrigation information classes	LCWM Tunisia Pixel ID	Land cover with irrigation information classes	1	Orchards	1	Rainfed Orchards	2	Bare soil	2	Irrigated Orchards	3	Forest	3	Bare soil	5	Infrastructure	5	Forest	6	Maquis	6	Infrastructure	7	Olives	7	Maquis			13	Rainfed Olives	8	Other crops	8	Irrigated Olives			14	Other Rainfed Crops	9	Dates	9	Other Irrigated Crops			11	Irrigated Dates	11	Water and wetland	11	Water and wetland
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7	Figure 2	Figure 2 was added	<table border="1"> <thead> <tr> <th>Class name and code</th> <th>English Name</th> <th>LCWM Pixel ID</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Autres Arbres Fruitières (Fp)</td> <td>Rainfed Orchards</td> <td>1</td> <td>The land is covered by rainfed orchards cultivated for the production of fruits (i.e. orange, citrus, fig, apple, peach and apricot), and other type of plantations.</td> </tr> </tbody> </table> <p>UML diagram</p> <p>Reference photos key</p> <p>Coordinates of Points from the Reference Photo Key</p> <table border="1"> <tr> <td>latitude: 36.9947446 longitude: 9.82729455</td> <td>latitude: 36.5318675 longitude: 9.8328446</td> </tr> </table>	Class name and code	English Name	LCWM Pixel ID	Description	Autres Arbres Fruitières (Fp)	Rainfed Orchards	1	The land is covered by rainfed orchards cultivated for the production of fruits (i.e. orange, citrus, fig, apple, peach and apricot), and other type of plantations.	latitude: 36.9947446 longitude: 9.82729455	latitude: 36.5318675 longitude: 9.8328446																																										
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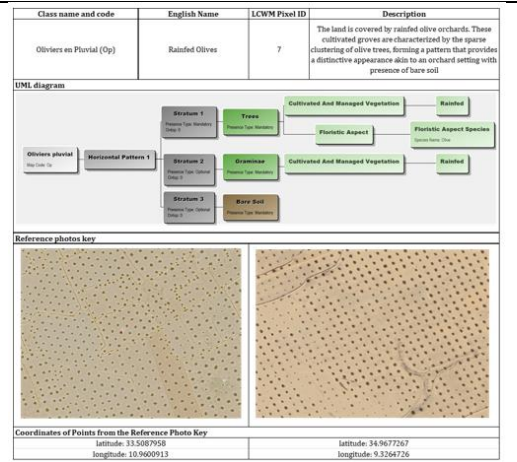
Figure 7



13

Figure 8

Figure 8 was added



14 Figure 9

LCRS class name and code	English Name	ID	Description
Oliviers (Op)	Olive trees	7	The land is covered by olive orchards. These cultivated groves are characterized by the sparse clustering of olive trees, forming a pattern that provides a distinctive appearance akin to an orchard setting with presence of bare soil.

**LCRS diagram**

**Reference photos key**

**Coordinates of Points from the Reference Photo Key**

latitude: 33.5467958 longitude: 10.9640913	latitude: 35.2107421 longitude: 9.2791373
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Class name and code	English Name	LCWM Pixel ID	Description
Oliviers en Irrigée (OI)	Irrigated Olive	13	The land is covered by irrigated olive orchards. These cultivated groves are characterized by the sparse clustering of olive trees, forming a pattern that provides a distinctive appearance akin to an orchard setting with presence of bare soil.

**DMI diagram**

**Reference photos key**

**Coordinates of Points from the Reference Photo Key**

latitude: 36.6937685 longitude: 9.7487145	latitude: 35.2107421 longitude: 9.2791373
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15 Figure 10

Figure 10 was added

Class name and code	English Name	LCWM Pixel ID	Description
Cultive en Pluvial (Cp)	Other Rainfed Crops	8	The land is covered by rainfed agricultural fields, featuring various types of crops: cereal crops such as wheat and barley, horticultural crops like tomatoes and onions, legumes, and forage crops. The crop water management in these areas is rainfed.

**DMI diagram**

**Reference photos key**

**Coordinates of Points from the Reference Photo Key**

latitude: 36.7957397 longitude: 9.9538414	latitude: 35.0811685 longitude: 8.3128397
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16 Figure 11

LCRS class name and code	English Name	ID	Description
Vegetation Cultivee (VC)	Cultivated Land	8	The land is covered by agricultural fields, featuring various types of crops: cereal crops such as wheat and barley, horticultural crops like tomatoes and onions, legumes, and forage crops. The crop water management in these areas can be irrigated or rainfed.

**LCRS diagram**

**Reference photos key**

**Coordinates of Points from the Reference Photo Key**

latitude: 36.6201372 longitude: 8.8735730	latitude: 36.6177669 longitude: 9.8484954
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Class name and code	English Name	LCWM Pixel ID	Description
Cultive en Irrigée (OI)	Other Irrigated Crops	14	The land is covered by irrigated agricultural fields, featuring various types of crops: cereal crops such as wheat and barley, horticultural crops like tomatoes and onions, legumes, and forage crops. The crop water management in these areas is irrigated.

**DMI diagram**

**Reference photos key**

**Coordinates of Points from the Reference Photo Key**

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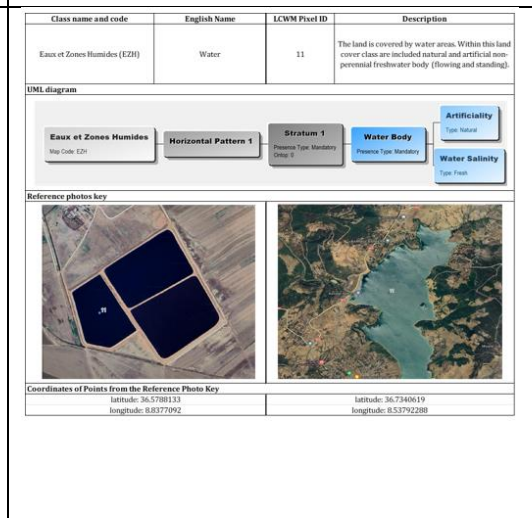
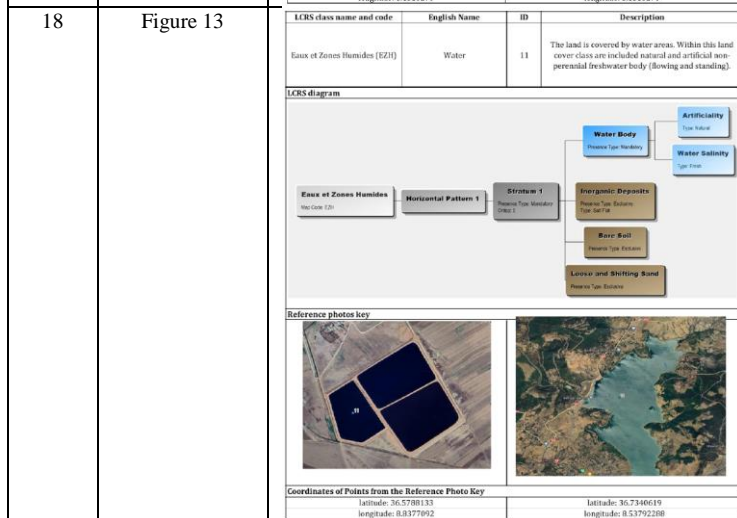
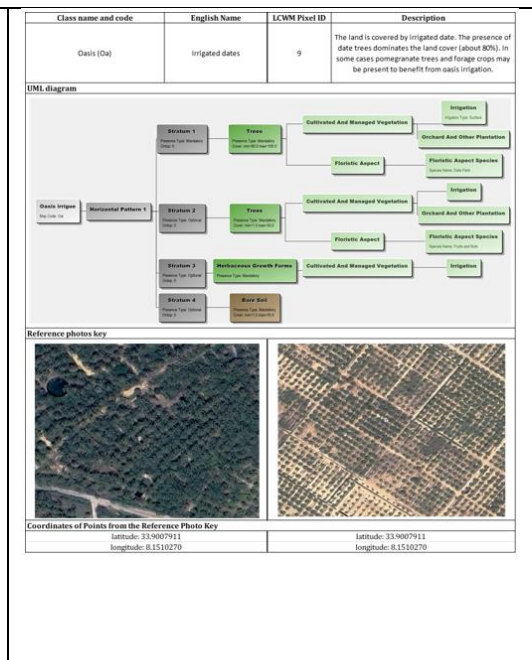
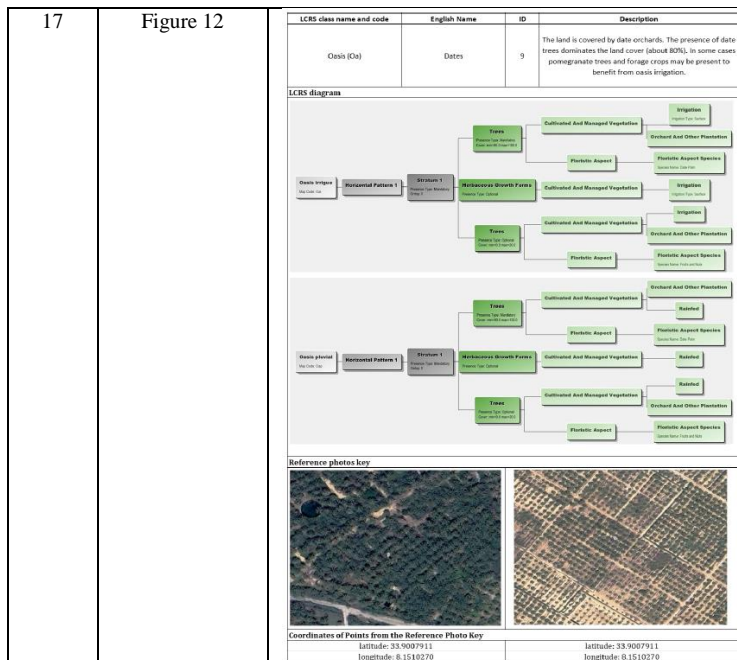


Table 1. Number of points for the different land cover classes and corresponding training and validation sets

Classes ID	Land cover classes name	Number of points	Training points	Validation points
1	Orchards	372	266	106
2	Bare soil	478	323	155
3	Forest	679	474	205
5	Infrastructure	159	108	51
6	Maquis/Garrigue	421	304	117
7	Olives	653	444	209
8	Cultivated land	1756	1261	495
9	Dates	127	91	36
11	Water and wetlands	102	76	26
<b>Total</b>		<b>4747</b>	<b>3347</b>	<b>1400</b>

Table 2. Number of points for the different land cover classes and corresponding training and validation sets

LC Tunisia Pixel ID	Land cover classes name	Number of points	Training points	Validation points
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8	Other crops	1756	1261	495
9	Dates	127	91	36
11	Water and wetlands	102	76	26
<b>Total</b>		<b>4747</b>	<b>3347</b>	<b>1400</b>

23 ii. 2015 Tunisia land cover

Starting from the 2015 Tunisia land cover, the following four classes were selected: irrigated cultivated land, rainfed cultivated land, irrigated orchards and rainfed orchards.

Starting from the 2015 Tunisia land cover, the following four classes were selected: other irrigated crops, other rainfed crops, irrigated orchards and rainfed orchards.

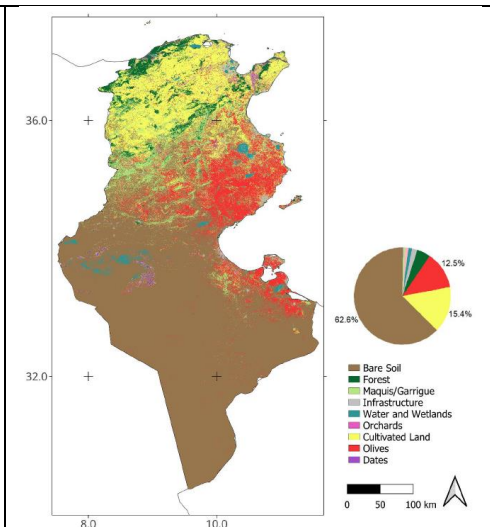
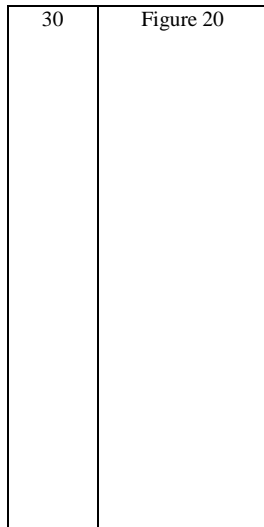
24 iii. Irrigated and rainfed areas

Starting from this dataset (hereafter called crop water management (CWM)), we extracted information on both irrigated and rainfed areas within AOI (Figure 16). Subsequently, the mask was applied to all classes that were not matched by the previously mask obtained by the land cover 2015. In this way, it was

Starting from this dataset (hereafter called crop water management (CWM)), information on both irrigated and rainfed areas within AOI (Figure 19) was extracted. Subsequently, the mask was applied to all classes that were not matched by the previously mask obtained by the land cover 2015. In this way, it was possible to retrieve



		possible to retrieve the water management information of all classes within the farming context.	the water management information of all classes within the agricultural context.																																																																						
27	b. Supervised classification	Automatic classification	Supervised classification																																																																						
28	d. Land cover and water management practices	<p>In order to recover water management information practices within Tunisia's agricultural context, the land cover map, once generated and validated, was stratified with the mask obtained from the 2015 Tunisia land cover map. Specifically, only the classes that could be linked to the agricultural context were selected (i.e., olives, dates, orchards, cultivated land).</p> <p>This operation was carried out using the grid calculator available in QGIS. Accordingly, a new map was generated with information on water management practices. The map values and the corresponding class description are reported in Table 3.</p>	<p>In order to recover the water management information within the Tunisia's agricultural context, the land cover map, once generated and validated, was stratified with the mask obtained from the 2015 Tunisia land cover map. Specifically, only the classes linked to the agricultural context were selected (i.e., olives, dates, orchards, other crops). This operation was carried out using the grid calculator available in QGIS. Accordingly, LCWM a new map was generated with information on water management practices. Although it was not possible to validate the LCWM due to the lack of field observations, this map shows still provides valuable insights into water availability and management within the agricultural context, which naturally affects crop selection and development. The map values and the corresponding class description are reported in Table 4.</p>																																																																						
29	Table 4	<p><i>Table 3. Land cover classes and corresponding pixel value after the CWM stratification</i></p> <table border="1"> <thead> <tr> <th>Class name</th> <th>Pixel Value</th> </tr> </thead> <tbody> <tr><td>Orchard</td><td>1</td></tr> <tr><td>Bare Soil</td><td>2</td></tr> <tr><td>Forest</td><td>3</td></tr> <tr><td>Infrastructure</td><td>5</td></tr> <tr><td>Maquis Garrigue</td><td>6</td></tr> <tr><td>Olives</td><td>7</td></tr> <tr><td>Cultivated Land</td><td>8</td></tr> <tr><td>Dates</td><td>9</td></tr> <tr><td>Water</td><td>11</td></tr> <tr><td>Irrigated Orchard</td><td>100</td></tr> <tr><td>Irrigated Olives</td><td>700</td></tr> <tr><td>Irrigated Cultivated Land</td><td>800</td></tr> <tr><td>Irrigated Dates</td><td>900</td></tr> <tr><td>Rainfed Orchard</td><td>1000</td></tr> <tr><td>Rainfed Olives</td><td>7000</td></tr> <tr><td>Rainfed Cultivated Land</td><td>8000</td></tr> <tr><td>Rainfed Dates</td><td>9000</td></tr> </tbody> </table>	Class name	Pixel Value	Orchard	1	Bare Soil	2	Forest	3	Infrastructure	5	Maquis Garrigue	6	Olives	7	Cultivated Land	8	Dates	9	Water	11	Irrigated Orchard	100	Irrigated Olives	700	Irrigated Cultivated Land	800	Irrigated Dates	900	Rainfed Orchard	1000	Rainfed Olives	7000	Rainfed Cultivated Land	8000	Rainfed Dates	9000	<p><i>Table 4. Land cover classes and corresponding pixel value after the CWM stratification</i></p> <table border="1"> <thead> <tr> <th>Class name</th> <th>Pixel Value</th> </tr> </thead> <tbody> <tr><td>Orchard</td><td>1</td></tr> <tr><td>Bare Soil</td><td>2</td></tr> <tr><td>Forest</td><td>3</td></tr> <tr><td>Infrastructure</td><td>5</td></tr> <tr><td>Maquis Garrigue</td><td>6</td></tr> <tr><td>Olives</td><td>7</td></tr> <tr><td>Other crops</td><td>8</td></tr> <tr><td>Dates</td><td>9</td></tr> <tr><td>Water</td><td>11</td></tr> <tr><td>Irrigated Orchard</td><td>100</td></tr> <tr><td>Irrigated Olives</td><td>700</td></tr> <tr><td>Other Irrigated Crops</td><td>800</td></tr> <tr><td>Irrigated Dates</td><td>900</td></tr> <tr><td>Rainfed Orchard</td><td>1000</td></tr> <tr><td>Rainfed Olives</td><td>7000</td></tr> <tr><td>Other Rainfed Crops</td><td>8000</td></tr> </tbody> </table>	Class name	Pixel Value	Orchard	1	Bare Soil	2	Forest	3	Infrastructure	5	Maquis Garrigue	6	Olives	7	Other crops	8	Dates	9	Water	11	Irrigated Orchard	100	Irrigated Olives	700	Other Irrigated Crops	800	Irrigated Dates	900	Rainfed Orchard	1000	Rainfed Olives	7000	Other Rainfed Crops	8000
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31 Table 6

Table 5. Land cover map confusion matrix

Land cover classes	Classification										Total
	Orchards	Bare soil	Forest	Bare soil	Maquis	Olive	Cultivated land	Dates	Water and wetland		
Orchards	75	0	13	0	0	10	8	0	0	106	
Bare soil	0	135	0	3	2	4	9	0	2	155	
Forest	8	0	175	0	13	1	5	3	0	205	
Bare soil	0	0	0	45	3	0	3	0	0	51	
Maquis	1	6	12	0	82	8	8	0	0	117	
Olive	5	6	2	0	12	164	20	0	0	209	
Cultivated land	21	3	6	1	8	11	445	0	0	495	
Dates	2	0	0	0	0	0	34	0	0	36	
Water and wetland	0	2	2	1	2	1	0	0	18	26	
Total	112	152	210	50	122	199	498	37	20	1400	

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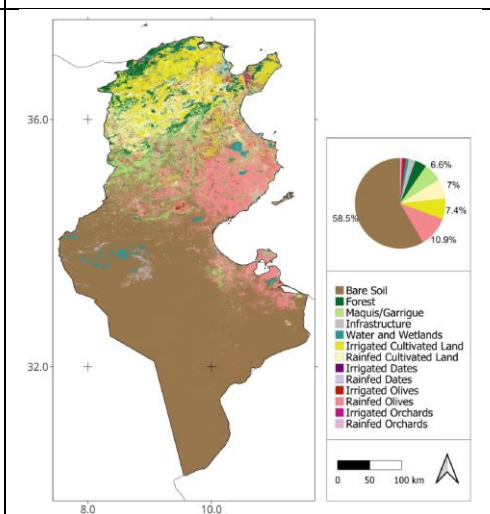
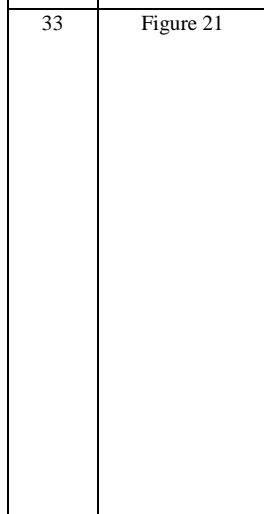
31 Table 7

Table 6. Producer, User and Overall Accuracy

Land cover classes	Producer Accuracy	User Accuracy
Orchards	70.8%	67.0%
Bare Soil	87.1%	88.8%
Forest	85.4%	83.3%
Bare soil	88.2%	90.0%
Maquis/Garrigue	70.1%	67.2%
Olive	78.5%	82.4%
Cultivated land	89.9%	89.4%
Dates	94.4%	91.9%
Water and wetland	69.2%	90.0%
<b>Overall Accuracy</b>	<b>83.8%</b>	

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34	Table 8	<p>Table 7. Table showing the land cover area of each class in the regions of Tunisia in km<sup>2</sup></p> <table border="1"> <thead> <tr> <th>Governorates</th> <th>Rainfed Orchards</th> <th>Bare Soil</th> <th>Forest</th> <th>Infrastructure</th> <th>Harsh Garrigue</th> <th>Rainfed Olive</th> <th>Rainfed Date</th> <th>Rainfed Water</th> <th>Irrigated Orchards</th> <th>Irrigated Date</th> <th>Irrigated Water</th> <th>Total area (km<sup>2</sup>)</th> </tr> </thead> <tbody> <tr><td>Ariana</td><td>5</td><td>5</td><td>27</td><td>95</td><td>22</td><td>14</td><td>77</td><td>0</td><td>23</td><td>0</td><td>0</td><td>466</td></tr> <tr><td>Baja</td><td>52</td><td>4</td><td>438</td><td>48</td><td>196</td><td>91</td><td>633</td><td>0</td><td>59</td><td>85</td><td>39</td><td>1706</td></tr> <tr><td>Bahariya</td><td>12</td><td>2</td><td>125</td><td>96</td><td>31</td><td>37</td><td>121</td><td>0</td><td>0</td><td>62</td><td>22</td><td>170</td></tr> <tr><td>Bizerte</td><td>53</td><td>5</td><td>774</td><td>114</td><td>55</td><td>36</td><td>388</td><td>13</td><td>123</td><td>88</td><td>24</td><td>2033</td></tr> <tr><td>Gabes</td><td>36</td><td>3775</td><td>28</td><td>131</td><td>363</td><td>758</td><td>184</td><td>0</td><td>0</td><td>21</td><td>13</td><td>1792</td></tr> <tr><td>Gafsa</td><td>25</td><td>1073</td><td>73</td><td>89</td><td>1526</td><td>422</td><td>885</td><td>0</td><td>0</td><td>3</td><td>11</td><td>7443</td></tr> <tr><td>Jendouba</td><td>32</td><td>2</td><td>1185</td><td>48</td><td>185</td><td>22</td><td>312</td><td>7</td><td>16</td><td>77</td><td>12</td><td>1254</td></tr> <tr><td>Kairouan</td><td>71</td><td>1113</td><td>318</td><td>329</td><td>1479</td><td>1584</td><td>492</td><td>0</td><td>23</td><td>96</td><td>241</td><td>441</td></tr> <tr><td>Kasserine</td><td>41</td><td>2886</td><td>636</td><td>232</td><td>2648</td><td>1482</td><td>392</td><td>0</td><td>1</td><td>54</td><td>188</td><td>3382</td></tr> 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<tr><td>Tunis</td><td>15</td><td>1236</td><td>24</td><td>68</td><td>24</td><td>48</td><td>12</td><td>18</td><td>283</td><td>2</td><td>4</td><td>1768</td></tr> <tr><td>Tunis</td><td>8</td><td>1</td><td>24</td><td>105</td><td>0</td><td>7</td><td>41</td><td>0</td><td>51</td><td>2</td><td>6</td><td>44</td></tr> <tr><td>Zaghwan</td><td>12</td><td>69</td><td>475</td><td>131</td><td>371</td><td>172</td><td>381</td><td>0</td><td>18</td><td>21</td><td>67</td><td>787</td></tr> <tr><td>Tunisia total area (km<sup>2</sup>)</td><td>597</td><td>88697</td><td>6480</td><td>3554</td><td>10027</td><td>16492</td><td>10613</td><td>273</td><td>1746</td><td>829</td><td>1237</td><td>11181</td></tr> <tr><td>Tunisia total area (%)</td><td>0.4%</td><td>58.5%</td><td>4.2%</td><td>2.3%</td><td>6.6%</td><td>10.9%</td><td>7.6%</td><td>0.2%</td><td>1.2%</td><td>0.5%</td><td>0.8%</td><td>100%</td></tr> </tbody> </table>	Governorates	Rainfed Orchards	Bare Soil	Forest	Infrastructure	Harsh Garrigue	Rainfed Olive	Rainfed Date	Rainfed Water	Irrigated Orchards	Irrigated Date	Irrigated Water	Total area (km <sup>2</sup> )	Ariana	5	5	27	95	22	14	77	0	23	0	0	466	Baja	52	4	438	48	196	91	633	0	59	85	39	1706	Bahariya	12	2	125	96	31	37	121	0	0	62	22	170	Bizerte	53	5	774	114	55	36	388	13	123	88	24	2033	Gabes	36	3775	28	131	363	758	184	0	0	21	13	1792	Gafsa	25	1073	73	89	1526	422	885	0	0	3	11	7443	Jendouba	32	2	1185	48	185	22	312	7	16	77	12	1254	Kairouan	71	1113	318	329	1479	1584	492	0	23	96	241	441	Kasserine	41	2886	636	232	2648	1482	392	0	1	54	188	3382	Kebili	39	20485	59	140	59	233	13	238	495	2	7	21784	Kif	5	393	558	137	736	51	282	0	7	6	12	1210	Manouba	4	287	22	198	488	1165	386	0	16	2	118	186	Medenine	25	2	81	58	41	37	288	0	0	34	37	346	Medouna	3	4819	12	218	229	2285	285	0	105	0	1	0	Mohamed	3	18	28	212	148	328	63	0	54	0	91	46	Nabul	75	4	482	288	117	88	283	16	18	214	71	1129	Sfax	13	1293	24	264	396	683	286	1	38	0	89	18	Sidi Bou Said	46	2823	183	131	1124	2286	427	0	79	13	173	165	Siliana	18	382	725	148	748	141	1542	0	6	11	19	3686	Sousse	9	347	49	388	416	484	479	0	268	16	107	170	Tataouine	1	35736	2	32	42	381	36	0	0	0	0	36433	Tunis	15	1236	24	68	24	48	12	18	283	2	4	1768	Tunis	8	1	24	105	0	7	41	0	51	2	6	44	Zaghwan	12	69	475	131	371	172	381	0	18	21	67	787	Tunisia total area (km <sup>2</sup> )	597	88697	6480	3554	10027	16492	10613	273	1746	829	1237	11181	Tunisia total area (%)	0.4%	58.5%	4.2%	2.3%	6.6%	10.9%	7.6%	0.2%	1.2%	0.5%	0.8%	100%	<table border="1"> <thead> <tr> <th>Governorates</th> <th>Rainfed Orchards</th> <th>Bare Soil</th> <th>Forest</th> <th>Infrastructure</th> <th>Harsh Garrigue</th> <th>Rainfed Olive</th> <th>Other Rainfed Crops</th> <th>Irrigated Dates</th> <th>Water</th> <th>Irrigated Orchards</th> <th>Irrigated Olive</th> <th>Other Irrigated Crops</th> <th>Total area (km<sup>2</sup>)</th> </tr> </thead> <tbody> <tr><td>Ariana</td><td>5</td><td>5</td><td>27</td><td>95</td><td>22</td><td>14</td><td>77</td><td>0</td><td>21</td><td>0</td><td>0</td><td>0</td><td>466</td></tr> <tr><td>Baja</td><td>52</td><td>4</td><td>438</td><td>48</td><td>196</td><td>91</td><td>633</td><td>0</td><td>59</td><td>85</td><td>39</td><td>1706</td><td>1678</td></tr> <tr><td>Bahariya</td><td>12</td><td>2</td><td>125</td><td>96</td><td>31</td><td>37</td><td>121</td><td>0</td><td>0</td><td>62</td><td>22</td><td>170</td><td>687</td></tr> <tr><td>Bizerte</td><td>53</td><td>5</td><td>774</td><td>114</td><td>55</td><td>36</td><td>388</td><td>16</td><td>123</td><td>88</td><td>24</td><td>2033</td><td>3692</td></tr> <tr><td>Gabes</td><td>36</td><td>3775</td><td>28</td><td>131</td><td>363</td><td>758</td><td>184</td><td>0</td><td>0</td><td>21</td><td>13</td><td>16</td><td>1792</td></tr> <tr><td>Gafsa</td><td>25</td><td>1073</td><td>73</td><td>89</td><td>1526</td><td>422</td><td>885</td><td>0</td><td>0</td><td>3</td><td>11</td><td>4</td><td>7443</td></tr> <tr><td>Jendouba</td><td>32</td><td>2</td><td>1185</td><td>48</td><td>185</td><td>22</td><td>312</td><td>7</td><td>16</td><td>77</td><td>12</td><td>1254</td><td>1313</td></tr> <tr><td>Kairouan</td><td>71</td><td>1113</td><td>318</td><td>329</td><td>1479</td><td>1584</td><td>492</td><td>1</td><td>21</td><td>96</td><td>241</td><td>441</td><td>4524</td></tr> <tr><td>Kasserine</td><td>41</td><td>2886</td><td>636</td><td>232</td><td>2648</td><td>1482</td><td>392</td><td>0</td><td>1</td><td>54</td><td>188</td><td>3382</td><td>8118</td></tr> <tr><td>Kebili</td><td>39</td><td>20485</td><td>59</td><td>140</td><td>59</td><td>233</td><td>13</td><td>238</td><td>495</td><td>2</td><td>7</td><td>0</td><td>21784</td></tr> <tr><td>Kif</td><td>5</td><td>393</td><td>558</td><td>137</td><td>736</td><td>51</td><td>282</td><td>0</td><td>7</td><td>6</td><td>12</td><td>1210</td><td>5112</td></tr> <tr><td>Manouba</td><td>4</td><td>287</td><td>22</td><td>198</td><td>488</td><td>1165</td><td>386</td><td>0</td><td>16</td><td>2</td><td>118</td><td>186</td><td>2887</td></tr> <tr><td>Medenine</td><td>25</td><td>2</td><td>81</td><td>58</td><td>41</td><td>37</td><td>288</td><td>0</td><td>0</td><td>34</td><td>37</td><td>346</td><td>1133</td></tr> <tr><td>Medouna</td><td>3</td><td>4819</td><td>12</td><td>218</td><td>229</td><td>2285</td><td>285</td><td>0</td><td>105</td><td>0</td><td>1</td><td>0</td><td>9875</td></tr> <tr><td>Mohamed</td><td>3</td><td>18</td><td>28</td><td>212</td><td>148</td><td>328</td><td>63</td><td>0</td><td>54</td><td>0</td><td>91</td><td>46</td><td>1888</td></tr> <tr><td>Nabul</td><td>75</td><td>4</td><td>482</td><td>288</td><td>117</td><td>88</td><td>283</td><td>16</td><td>18</td><td>214</td><td>71</td><td>1129</td><td>19</td></tr> <tr><td>Sfax</td><td>13</td><td>1293</td><td>24</td><td>264</td><td>396</td><td>683</td><td>286</td><td>1</td><td>38</td><td>0</td><td>89</td><td>18</td><td>6886</td></tr> <tr><td>Sidi Bou Said</td><td>46</td><td>2823</td><td>183</td><td>131</td><td>1124</td><td>2286</td><td>427</td><td>0</td><td>79</td><td>13</td><td>173</td><td>165</td><td>0</td></tr> <tr><td>Siliana</td><td>18</td><td>382</td><td>725</td><td>148</td><td>748</td><td>141</td><td>1542</td><td>0</td><td>6</td><td>11</td><td>19</td><td>3686</td><td>4648</td></tr> <tr><td>Sousse</td><td>9</td><td>347</td><td>49</td><td>388</td><td>416</td><td>484</td><td>479</td><td>0</td><td>268</td><td>16</td><td>107</td><td>170</td><td>2651</td></tr> <tr><td>Tataouine</td><td>1</td><td>35736</td><td>2</td><td>32</td><td>42</td><td>381</td><td>36</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>36433</td></tr> <tr><td>Tunis</td><td>15</td><td>1236</td><td>24</td><td>68</td><td>24</td><td>48</td><td>12</td><td>18</td><td>283</td><td>2</td><td>4</td><td>0</td><td>1768</td></tr> <tr><td>Tunis</td><td>8</td><td>1</td><td>24</td><td>105</td><td>0</td><td>7</td><td>41</td><td>0</td><td>51</td><td>2</td><td>6</td><td>44</td><td>296</td></tr> <tr><td>Zaghwan</td><td>12</td><td>69</td><td>475</td><td>131</td><td>371</td><td>172</td><td>381</td><td>0</td><td>18</td><td>21</td><td>67</td><td>787</td><td>2891</td></tr> <tr><td>Tunisia total area (km<sup>2</sup>)</td><td>597</td><td>88697</td><td>6480</td><td>3554</td><td>10027</td><td>16492</td><td>10613</td><td>273</td><td>1746</td><td>829</td><td>1237</td><td>11181</td><td>151645</td></tr> <tr><td>Tunisia total area (%)</td><td>0.4%</td><td>58.5%</td><td>4.2%</td><td>2.3%</td><td>6.6%</td><td>10.9%</td><td>7.6%</td><td>0.2%</td><td>1.2%</td><td>0.5%</td><td>0.8%</td><td>7.4%</td><td>100%</td></tr> </tbody> </table>	Governorates	Rainfed Orchards	Bare Soil	Forest	Infrastructure	Harsh Garrigue	Rainfed Olive	Other Rainfed Crops	Irrigated Dates	Water	Irrigated Orchards	Irrigated Olive	Other Irrigated Crops	Total area (km <sup>2</sup> )	Ariana	5	5	27	95	22	14	77	0	21	0	0	0	466	Baja	52	4	438	48	196	91	633	0	59	85	39	1706	1678	Bahariya	12	2	125	96	31	37	121	0	0	62	22	170	687	Bizerte	53	5	774	114	55	36	388	16	123	88	24	2033	3692	Gabes	36	3775	28	131	363	758	184	0	0	21	13	16	1792	Gafsa	25	1073	73	89	1526	422	885	0	0	3	11	4	7443	Jendouba	32	2	1185	48	185	22	312	7	16	77	12	1254	1313	Kairouan	71	1113	318	329	1479	1584	492	1	21	96	241	441	4524	Kasserine	41	2886	636	232	2648	1482	392	0	1	54	188	3382	8118	Kebili	39	20485	59	140	59	233	13	238	495	2	7	0	21784	Kif	5	393	558	137	736	51	282	0	7	6	12	1210	5112	Manouba	4	287	22	198	488	1165	386	0	16	2	118	186	2887	Medenine	25	2	81	58	41	37	288	0	0	34	37	346	1133	Medouna	3	4819	12	218	229	2285	285	0	105	0	1	0	9875	Mohamed	3	18	28	212	148	328	63	0	54	0	91	46	1888	Nabul	75	4	482	288	117	88	283	16	18	214	71	1129	19	Sfax	13	1293	24	264	396	683	286	1	38	0	89	18	6886	Sidi Bou Said	46	2823	183	131	1124	2286	427	0	79	13	173	165	0	Siliana	18	382	725	148	748	141	1542	0	6	11	19	3686	4648	Sousse	9	347	49	388	416	484	479	0	268	16	107	170	2651	Tataouine	1	35736	2	32	42	381	36	0	0	0	0	0	36433	Tunis	15	1236	24	68	24	48	12	18	283	2	4	0	1768	Tunis	8	1	24	105	0	7	41	0	51	2	6	44	296	Zaghwan	12	69	475	131	371	172	381	0	18	21	67	787	2891	Tunisia total area (km <sup>2</sup> )	597	88697	6480	3554	10027	16492	10613	273	1746	829	1237	11181	151645	Tunisia total area (%)	0.4%	58.5%	4.2%	2.3%	6.6%	10.9%	7.6%	0.2%	1.2%	0.5%	0.8%	7.4%	100%
Governorates	Rainfed Orchards	Bare Soil	Forest	Infrastructure	Harsh Garrigue	Rainfed Olive	Rainfed Date	Rainfed Water	Irrigated Orchards	Irrigated Date	Irrigated Water	Total area (km <sup>2</sup> )																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Bahariya	12	2	125	96	31	37	121	0	0	62	22	170																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Bizerte	53	5	774	114	55	36	388	13	123	88	24	2033																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Gabes	36	3775	28	131	363	758	184	0	0	21	13	1792																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Gafsa	25	1073	73	89	1526	422	885	0	0	3	11	7443																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Jendouba	32	2	1185	48	185	22	312	7	16	77	12	1254																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Kairouan	71	1113	318	329	1479	1584	492	0	23	96	241	441																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Kasserine	41	2886	636	232	2648	1482	392	0	1	54	188	3382																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Kif	5	393	558	137	736	51	282	0	7	6	12	1210																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Manouba	4	287	22	198	488	1165	386	0	16	2	118	186																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Medouna	3	4819	12	218	229	2285	285	0	105	0	1	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Nabul	75	4	482	288	117	88	283	16	18	214	71	1129																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Sfax	13	1293	24	264	396	683	286	1	38	0	89	18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Sidi Bou Said	46	2823	183	131	1124	2286	427	0	79	13	173	165																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Siliana	18	382	725	148	748	141	1542	0	6	11	19	3686																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Sousse	9	347	49	388	416	484	479	0	268	16	107	170																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Zaghwan	12	69	475	131	371	172	381	0	18	21	67	787																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Tunisia total area (km <sup>2</sup> )	597	88697	6480	3554	10027	16492	10613	273	1746	829	1237	11181																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Tunisia total area (%)	0.4%	58.5%	4.2%	2.3%	6.6%	10.9%	7.6%	0.2%	1.2%	0.5%	0.8%	100%																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Governorates	Rainfed Orchards	Bare Soil	Forest	Infrastructure	Harsh Garrigue	Rainfed Olive	Other Rainfed Crops	Irrigated Dates	Water	Irrigated Orchards	Irrigated Olive	Other Irrigated Crops	Total area (km <sup>2</sup> )																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Ariana	5	5	27	95	22	14	77	0	21	0	0	0	466																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Baja	52	4	438	48	196	91	633	0	59	85	39	1706	1678																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Bahariya	12	2	125	96	31	37	121	0	0	62	22	170	687																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Bizerte	53	5	774	114	55	36	388	16	123	88	24	2033	3692																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Gabes	36	3775	28	131	363	758	184	0	0	21	13	16	1792																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Gafsa	25	1073	73	89	1526	422	885	0	0	3	11	4	7443																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Jendouba	32	2	1185	48	185	22	312	7	16	77	12	1254	1313																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Kairouan	71	1113	318	329	1479	1584	492	1	21	96	241	441	4524																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Kasserine	41	2886	636	232	2648	1482	392	0	1	54	188	3382	8118																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Kebili	39	20485	59	140	59	233	13	238	495	2	7	0	21784																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Kif	5	393	558	137	736	51	282	0	7	6	12	1210	5112																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Manouba	4	287	22	198	488	1165	386	0	16	2	118	186	2887																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Medenine	25	2	81	58	41	37	288	0	0	34	37	346	1133																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Medouna	3	4819	12	218	229	2285	285	0	105	0	1	0	9875																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Mohamed	3	18	28	212	148	328	63	0	54	0	91	46	1888																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Nabul	75	4	482	288	117	88	283	16	18	214	71	1129	19																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Sfax	13	1293	24	264	396	683	286	1	38	0	89	18	6886																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Sidi Bou Said	46	2823	183	131	1124	2286	427	0	79	13	173	165	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Siliana	18	382	725	148	748	141	1542	0	6	11	19	3686	4648																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Sousse	9	347	49	388	416	484	479	0	268	16	107	170	2651																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Tataouine	1	35736	2	32	42	381	36	0	0	0	0	0	36433																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Tunis	15	1236	24	68	24	48	12	18	283	2	4	0	1768																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Tunis	8	1	24	105	0	7	41	0	51	2	6	44	296																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Zaghwan	12	69	475	131	371	172	381	0	18	21	67	787	2891																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Tunisia total area (km <sup>2</sup> )	597	88697	6480	3554	10027	16492	10613	273	1746	829	1237	11181	151645																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Tunisia total area (%)	0.4%	58.5%	4.2%	2.3%	6.6%	10.9%	7.6%	0.2%	1.2%	0.5%	0.8%	7.4%	100%																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
35	discussions of table 8	<p>Finally, considering date cultivation this appears to occupy a smaller agricultural area than the other classes. Specifically, it is represented by less than 1 percent of the area. Roughly 10 percent of dates are irrigated while 90 percent are rainfed. In particular, 60 percent of date agriculture is located in Kebili, the south-eastern region of Tunisia, which exemplifies the crop's suitability for being farmed in arid and semi-arid climates. It should be noted that these areas are often within oases, which indicates that water availability is high and therefore most of the fields are irrigated. However, no information about water management is present in the South of Tunisia. Date palm varieties in Tunisia are known to be water intensive (Ismail and Hassine, 2021). Perhaps, given that the data used for irrigation management is not very up to date, further analysis may be necessary for this class.</p>	<p>Finally, considering date cultivation this appears to occupy a smaller agricultural area than the other classes. Specifically, it is represented by less than 1 percent of the area. In particular, 56 percent of the date crop is located in Kebili, a southeastern region of Tunisia, exemplifying the crop's suitability for cultivation in arid and semi-arid climates. Date palm varieties in Tunisia are known to be water-intensive, therefore, date cultivation areas are often located within oases, where water availability is ensured.</p>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
35	C. Future developments	<p>Future developments are expected, especially regarding crop type mapping. In this context, the agricultural area identified in this land cover will be used as a mask to proceed with the differentiation of specific crops. In this regard, field surveys have been planned between December 2023 and March 2024 that will make it possible to collect the necessary information required by the classifiers' training.</p>	<p>Future developments are expected, especially regarding crop type mapping. In this context, the agricultural area identified in this land cover will be used as a mask to proceed with the differentiation of specific crops. In this regard, field surveys have been planned between December 2023 and March 2024 that will make it possible to collect the necessary information required by the classifiers' training. Furthermore, improvements are expected in mapping the irrigation water management of crops. Specifically, a classification based on evapotranspiration is expected to identify irrigated from rainfed areas.</p>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									