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WORLD HERITAGE ONLINE MAP PLATFORM

Technical note on the provision of geospatial data

Contents

About the World Heritage Online Map Platform (WHOMP)

UNESCO's World Heritage Online Map Platform (WHOMP) is a Geographic Information System (GIS) developed with the support of the Government of Flanders (Belgium), aiming at the creation of a comprehensive and accessible geodatabase for World Heritage properties worldwide. This platform is hosted and managed by UNESCO which ensures that the data presented correspond exactly to the boundaries of the World Heritage properties and their buffer zones as inscribed in the World Heritage List, including any changes adopted by the World Heritage Committee after the initial inscription of a property.

The World Heritage Online Map Platform is a monitoring tool to better manage and protect World Heritage properties. The Platform primarily serves States Parties to the World Heritage Convention, World Heritage site managers, World Heritage site communities and other heritage and non-heritage stakeholders (i.e., developers and urban planners). It is also intended to become an indispensable monitoring tool for the Advisory Bodies to the World Heritage Committee and for UNESCO as Secretariat to the World Heritage Convention.

In the pilot of the platform, properties' georeferenced boundaries and buffer zones are stored, filtered, processed, and visualized[1] over various basemaps fitting different purposes. The user can also add new layers of data, make annotations, perform measurements and comparisons, obtain and transform coordinates, among other basic operations. This platform provides a basis for more advanced remote sensing capabilities in the future, overlaying geospatial datasets on potential impacts on the Outstanding Universal Values of the properties.

Georeferenced boundaries are associated to existing UNESCO databases. Nomination dossiers,

Advisory Body evaluations, relevant World Heritage Committee decisions, state of conservation reports, mission reports and other documents are linked to the platform to provide a comprehensive overview of properties. Thus, this tool constitutes a single-access, open-to-all instrument with reliable and constantly updated geospatial data that can be used for monitoring, analysis and decision-making.

This technical note demonstrates how States Parties may provide suitable geospatial data for the abovementioned purposes. It serves as a set of practical guidelines to facilitate the creation of data and its integration into the World Heritage Online Maps Platform.

1 In the pilot of the platform, the layers of boundaries and buffer zones cannot be downloaded in common formats (i.e., KML or SHP files). Only online consultation is possible.

Guiding principles

- **States Parties are invited to submit GIS files of their properties at the time of inscription, as well as with the new maps submitted when requesting a boundary modification.** When boundary modifications are approved by the World Heritage Committee, the World Heritage Centre will contact the concerned State(s) Party(ies) to update the corresponding geospatial data, if not provided with the request.

- The layers of the boundaries of the property and its buffer zone (if any) must accurately reflect the most recent maps adopted by the World Heritage Committee, including minor or major boundary modifications. Bear in mind that domestic boundaries of the sites may not correspond to the area that has been effectively inscribed as World Heritage (i.e., area covered by a local, provincial or national natural park may be bigger or smaller than what has been inscribed on the World Heritage List).

- When submitting data of the World Heritage sites, your State Party is consenting to their display on the World Heritage Online Maps Platform, hosted on the website of the World Heritage Convention. The files are verified against the maps adopted by the World Heritage Committee to make sure they reflect the boundaries of the property and buffer zone (if any) as inscribed. If the layers present discrepancies, the State Party will be contacted by the Project Team to rectify the data.

- The publication of the World Heritage boundaries and buffer zones does not imply the expression of any opinion whatsoever of the World Heritage Committee or UNESCO concerning the legal status of any country, territory, city or area or of its boundaries.

- The layers must be developed in collaboration with and in full agreement with all relevant rightsholders of the property.

- Where a property is transboundary or transnational, the layers of its boundaries should be provided as a single geospatial file, produced in collaboration and in agreement with all concerned States Parties. The same applies to the layers of its buffer zones (if any).

- No internal divisions (i.e., cadastral or provincial borders) have to be demarcated within the GIS polygons.

- The geospatial data must be produced at an appropriate scale to ensure precision of the layers: different scales are needed, for example, if a cultural World Heritage property consisting of a building is digitized than if it is a natural World Heritage covering several hectares

Basic GIS glossary

Attribute table		A database organized in the form of a table presenting non-spatial information (i.e., text or numerical) about the geographic features that are contained in a given GIS layer. In the table, a column stands for a specific field or attribute (area, population, etc.), whereas each row entry represents (and is linked to) a feature of the layer[2].
Coordinate Reference System (CRS)		A coordinate-based system serving as a framework to locate features on Earth's surface. Every CRS includes a mathematic model of the Earth and a specific map projection.
Digital platform		Electronic stage used to visualize, manage and communicate digital media, including GIS-based data, often publicly.
Digitizing		The process of converting geographic raster data into vector data using GIS tools and software. The most common and accessible digitizing method is heads-up digitizing, through which geographic features represented in the raster or basemap are manually traced on the computer screen to create vector data.
Geographic Information System (GIS)		A system of integrated geographic and non-geographic data and tools permitting to create, manage, visualize, analyse, model and export information concerning spatial positions on Earth's surface.
Metadata		Information provided about a particular set of data (i.e., source of the data, creation date, credits, limitations of use, etc.).
Raster images		Data based on pixels containing unique values (usually colour or tonal information, but also other type of non-discrete data like elevation or temperatures) which, together, form an image. The higher is an image's resolution –number of pixels per inch forming the image–, the better will be its quality. Satellite or aerial views, digital images or scanned paper maps are examples of raster data.
Vector data		Dataset representing geographic features in the form of points, lines, and polygons tied to coordinates.

2 This concept should not be confused with attributes conveying the Outstanding Universal Value of a World Heritage property, such as those listed in paragraph 82 of the Operational Guidelines for the implementation of the World Heritage Convention.

How to digitize World Heritage boundaries

For the purposes of the World Heritage Online Maps Platform, vector layers containing the polygons of the boundaries of the properties and their buffer zones (if any) are required. These must correspond strictly to the boundaries most recently adopted by the World Heritage Committee, either at the time of the initial inscription of the property on the World Heritage List, or when approving subsequent minor or significant boundary modifications[3]. Given that the precise delimitation of the World Heritage properties is a requirement for their inscription as per the Operational Guidelines, it is not in the scope of this document to elaborate on boundaries demarcation, inasmuch as these already exist. Rather, the guidelines will focus on how to create precise vector data to populate the platform.

To digitize raster maps, first it will be necessary to **georeference** them, that is, to link the image to coordinates in a GIS software based on a specific **coordinate reference system** (CRS). Therefore, points on the raster image –data that is being georeferenced– will be coordinated with points on a geographically referenced dataset –a basemap, which is an already georeferenced database.

In this section, we will take as an example the map of the **Speyer Cathedral** (Germany) to present two ways of georeferencing a raster map, to subsequently create the polygon by heads-up digitization:

A. Through the use of **coordinates**

B. Through the use of **ground control points**

As to GIS software, the most widely used are QGIS and ArcGIS Pro. These programmes present different user interfaces, in particular regarding their georeferencing tools. Although the examples cited below are georeferenced using ArcGIS Pro 3.0.3 and the images illustrating these guidelines show the interface of this software, the procedures and concepts are sought to be explained in such a way that they can be applicable to other programmes. Mentions to QGIS functionalities refer to the versions 3.28 onwards.

3 The maps of the World Heritage properties as adopted by the World Heritage Committee can be consulted on the World Heritage List's webpage.

A. Georeferencing a raster map through the use of coordinates

The map below (Figure 1) shows the boundaries of the Speyer Cathedral property. This raster map includes a coordinate grid based on a CRS that is clearly indicated (ETRS89 / UTM zone 32N, EPSG 25832). In this case, **the coordinate grid will allow us to link the raster map to coordinates.** The objective is to digitize the World Heritage boundaries, to create the vector layer that will be submitted to the platform.

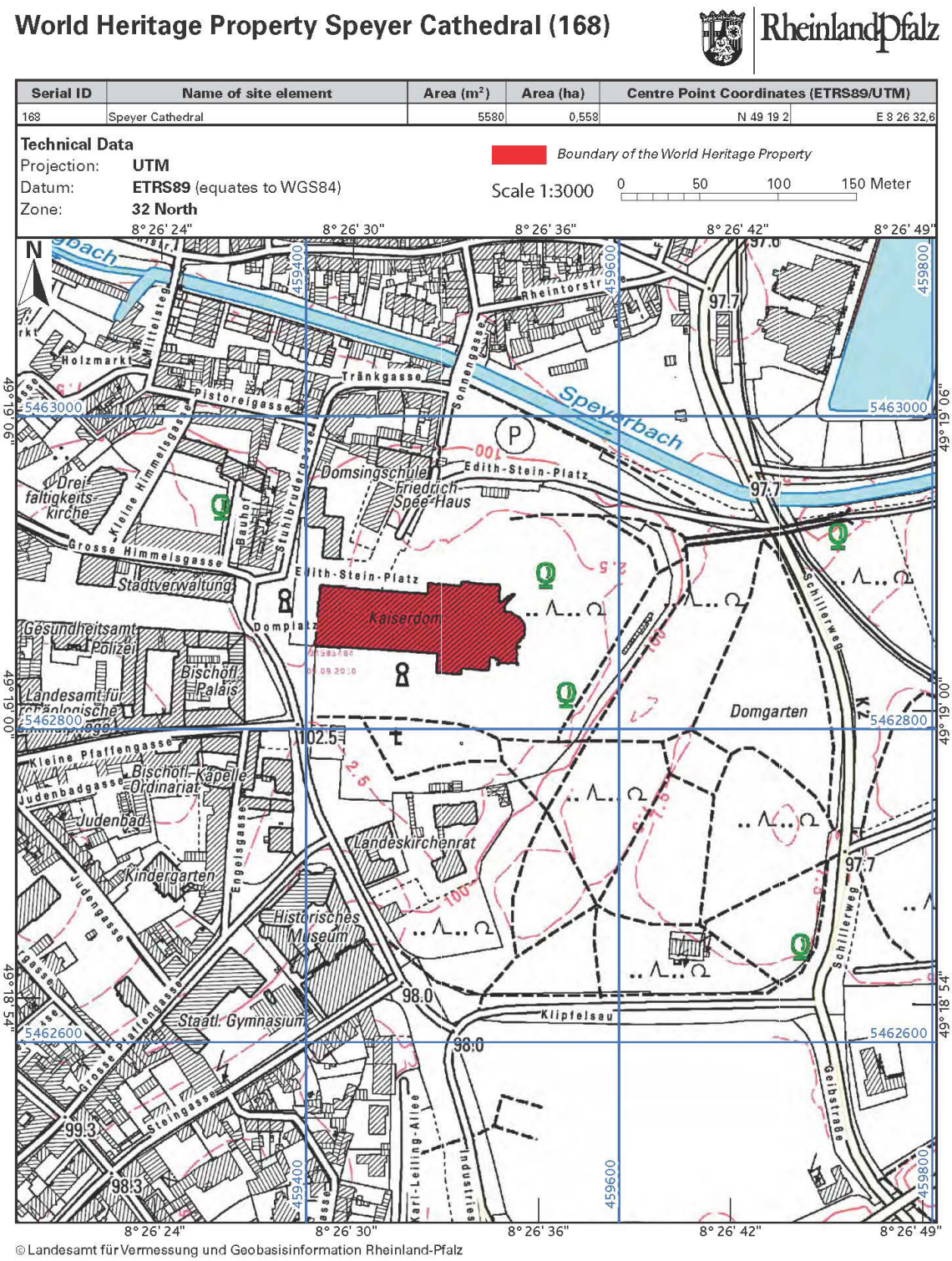


Figure 1. Map of the Speyer Cathedral.

The following process was undertaken to digitize the map of this site:

1. Load the raster map to the canvas of a geospatial software. Since the map is not georeferenced yet, a message can appear indicating that the CRS of this file is unknown.

2. Move, resize, rotate, and align the raster so it overlays (or approaches) the area it represents. The selection of a suitable basemap (in this case, satellite imagery) is important.

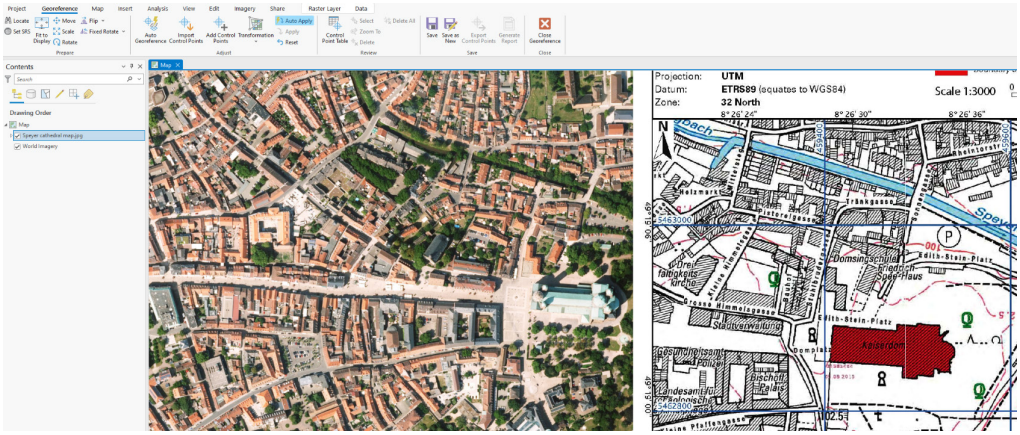


Figure 2. The Speyer Cathedral on the raster image (red polygon on the right), next to the same building on the satellite view basemap.

3. Using the georeferencing tool provided in the software, click on one of the intersections between the X and Y axes of the coordinate grid of the raster map (preferably, by its corners). You will then be able to enter the latitude and longitude, be it as decimal degrees, or degrees, minutes and seconds, or other units (Figure 3). This will be our first control point. **Make sure that the CRS of the coordinate grid in the raster and the one selected when entering the coordinates on the georeferencing tool are the same.** Also note that more than one coordinate grid can be featured in a map: in the Speyer Catheral map used as an example, the coordinates in WGS84 are also indicated, although there is only one coordinate grid.

Figure 3. Captured image after inserting the coordinates (highlighted in yellow) of the intersections of the cartesian axes of the grid into the georeferencing tool.

4. Repeat this operation for at least a total of three control points. Depending on the georeferencing algorithm used (polynomial, projective, spline, etc.), more or less control points might be needed. **Pay attention to the transformation settings**: QGIS uses a linear transformation type as preset, which does not actually modify the raster but just repositions it. Using the Helmert transformation type leads to much more precise results, since it executes basic rotation and scaling transformations. Polynomial 1 to 3 algorithms are the most widely used and they require from 3 to 10 control points. For scanned maps, the thin plate spline algorithm is recommended. A wider range of transformation types is available depending on the different software used.

5. Once enough control points/coordinates have been entered, check if the map is correctly placed by comparing the features on the map and on the basemap. You can increase or decrease the transparency of the newly georeferenced raster image for verification against the basemap (Figure 4).

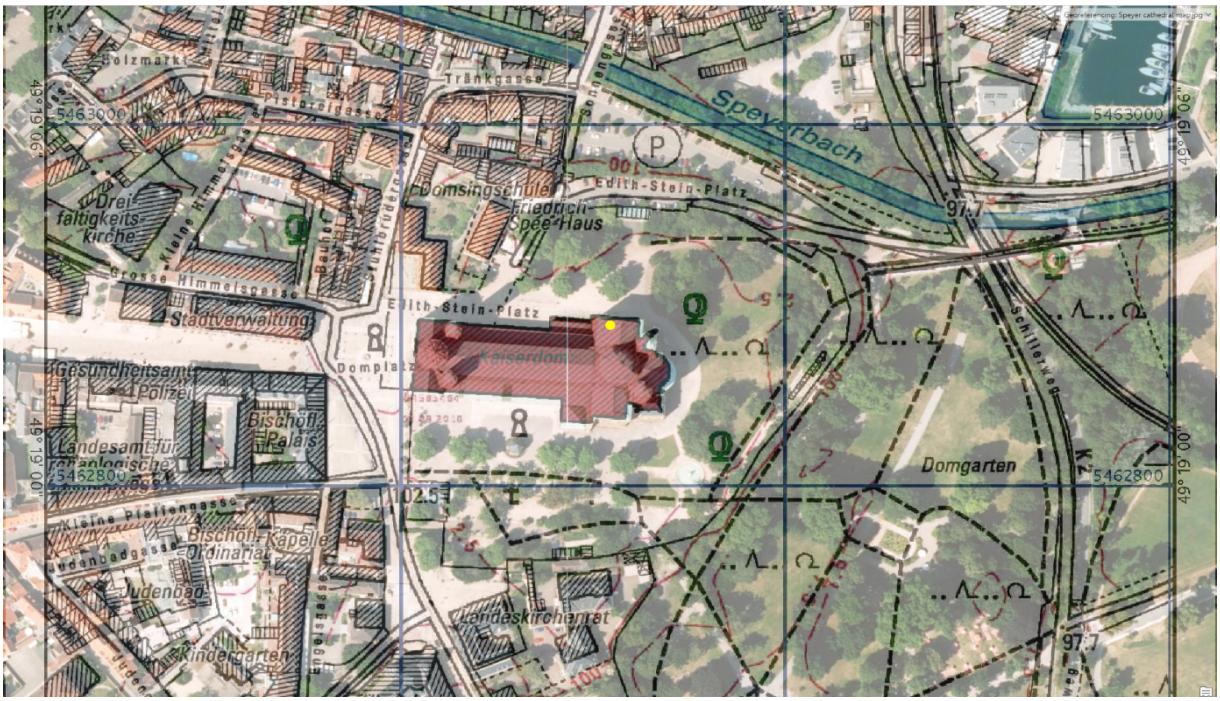


Figure 4. The Speyer Cathedral in the raster image is correctly placed over the feature it represents.

6. Once assured that the map is correctly georeferenced, digitize the polygon of the property using the heads-up method. A new **polygon-type vector layer** (not a polyline-type layer) has to be created by tracing the boundaries of the World Heritage property on the raster map, with reference to the underlying imagery. When creating the new layer, and before starting to draw the polygon, you will be asked to create the fields for the attribute table. Refer to the "Attribute table and metadata" section below to include the fields required for the purposes of this project.

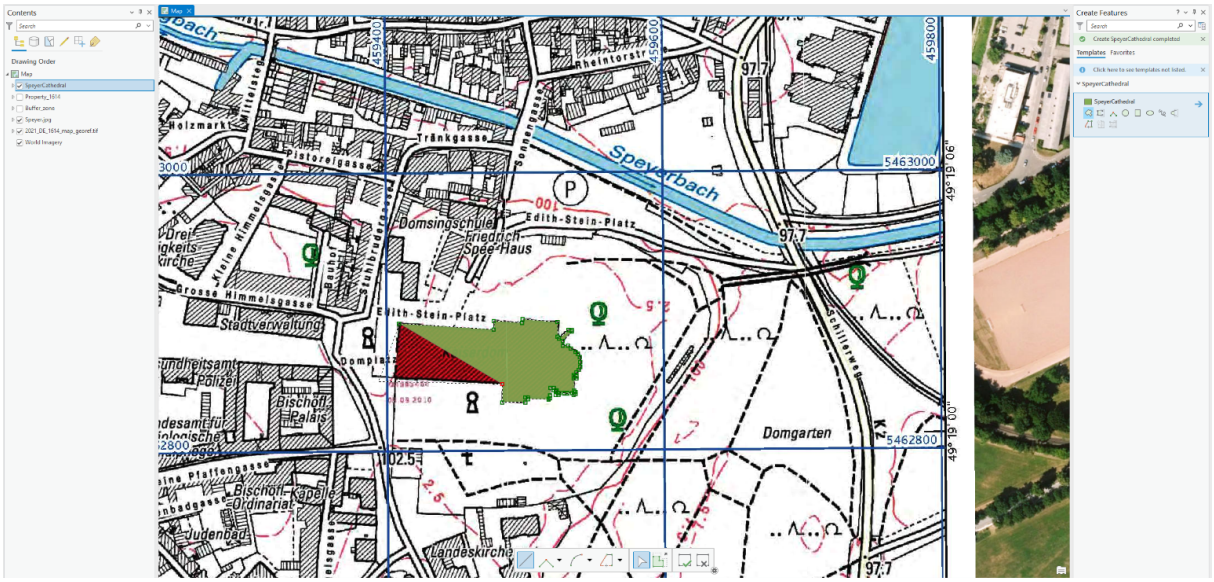


Figure 5. Captured image after carefully creating the polygon through a series of vertexes following the limits of the World Heritage property.

7. Select an appropriate zoom level to draw the polygon of the World Heritage property[4] and create it by clicking on each of the feature's vertexes.

8. Save the changes made and the file in a suitable format as explained in the "How to submit your data" section below. The polygon of the World Heritage property has been created. Proceed likewise for the other component parts in case of serial properties (each as a separate feature **within the same layer**) and, if any, for the buffer zone (**in a separate layer**). When creating the buffer zone layer, remember to clip the polygon of the property's boundaries from it, so that the area of the property is not included in the polygon of the buffer zone (see "Buffer zone layers" section below). In ArcGis Pro, you can use the "Continue feature" editing tool; in QGIS, this can be done through the Clipper plugin.

9. If the component part comprises more than one feature, or if the buffer zone is composed by a series of non-contiguous areas protecting one component part, these should then be part of the same feature or entity in the layer –a multipart feature referencing to only one row in the attribute table (see "Serial and/or transnational properties" and "Buffer zone layers" below). **In ArcGIS Pro:** create the first polygon of the multipart feature, right-click on the last vertex and then click on "Finish Part". You will then draw the next polygons, and when the task is finished, right-click on the last vertex and then click on "Finish". **In QGIS:** create the features and then unify them with the "Collect Geometries" function (Vector > Geometry Tools > Collect Geometries).

Figure 6. The polygon-type vector layer has been created.

4 While positional accuracy refers to the correctness of the geographic position of the features (the degree to which features in the map match the real world), precision refers to the "fineness" of the measurement (if the level of the measurement is appropriate). Thus, the scale in which the procedure of digitizing a World Heritage property is undertaken is very important to ensure precision.

B. Georeferencing a raster map with ground control points

1. Similar to the previous case, the raster file has to be loaded to the canvas of the selected geospatial software. The basemap can be a highly detailed Open Street Map or satellite imagery, so to allow easy identification of features on it. Place the raster over the area of interest.

2. By means of the georeferencing tool, select from the raster map some easily identifiable features that could be used as control points. These should be recognizable both in the raster image and on the basemap, to ensure that the same geographic location is selected: corners of buildings, monuments, landmarks, intersection of streets, etc. Click first on the raster (source) and then on the same object on the basemap (target). Make sure to click the closest you can on the selected feature by using appropriate zooming, both on the raster and the basemap.

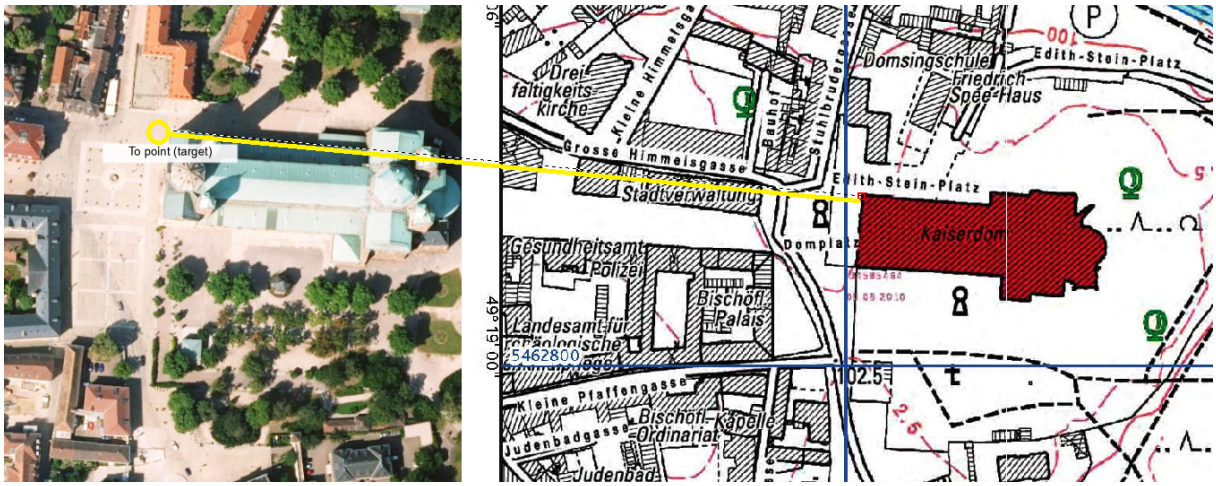


Figure 7. Connection line between the raster being georeferenced and target point in basemap highlighted in yellow.

3. Repeat this operation for at least three control points. Depending on the georeferencing algorithm used (polynomial, projective, spline, etc.), more or less control points might be needed. Make sure that these control points are fairly spread across the raster map, ideally one by every corner of the image, plus one by its centre. Increasing or decreasing the transparency of the raster layer, or hiding/unhiding it, can be useful (see Figure 8).

Figure 8. Sample image using the corner of a building as a control point. The control point selected on the raster was first clicked, followed by the same point on the basemap.

4. The raster should now be correctly overlaid and aligned with the area of interest. To verify, compare the features on the map and on the basemap to see if they match.

5. The boundaries of the World Heritage property can now be digitized following the steps 6, 7, 8 and 9 of the previous example.

Attribute table and metadata

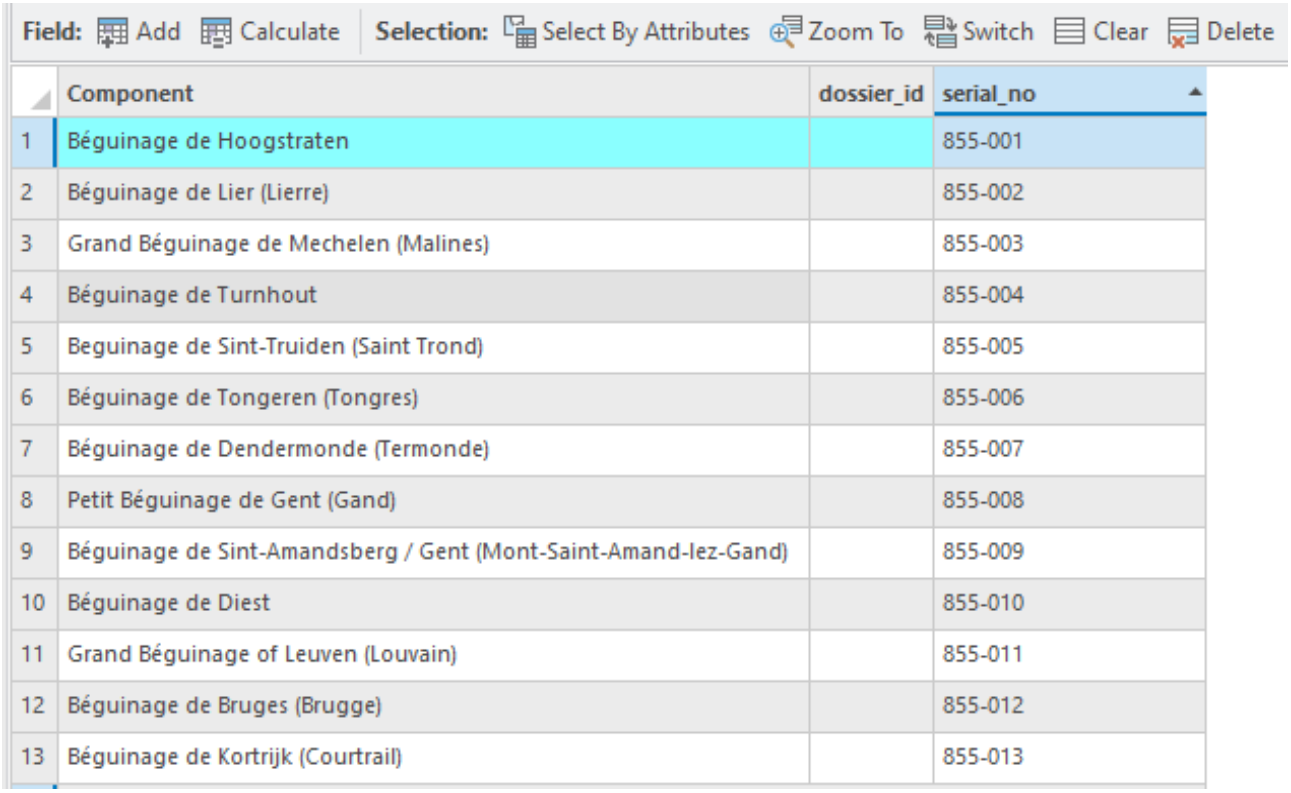
The non-geographic information of the property to be displayed on the platform (area in hectares, year of inscription, etc.) will be drawn from the nomination dossier submitted by the State Party at the time of inscription on the World Heritage List and as published on the World Heritage List's webpage. Nevertheless, for the smooth integration of the layers to the geodatabase when the World Heritage Centre undertakes the data joining, three specific fields are required in the attribute table of the shapefiles of both the boundaries of the property and buffer zone. These fields are the following:

1. Name of the component part

2. *dossier_id* field (integer, length of 10 characters): this field is to be left empty (<Null> value).

3. *serial_no* field (text string, length of 15 characters). For serial properties, this field must be filled in with the serial number of each component; for properties that are not serial, the field is to be left empty (<Null> value).

Below is an example of the attribute table of the boundaries layer of the Flemish Béguinages property (Belgium), fulfilling the technical requirements for the World Heritage Online Maps Platform:



	Component	dossier_id	serial_no
1	Béguinage de Hoogstraten		855-001
2	Béguinage de Lier (Lierre)		855-002
3	Grand Béguinage de Mechelen (Malines)		855-003
4	Béguinage de Turnhout		855-004
5	Beguinage de Sint-Truiden (Saint Trond)		855-005
6	Béguinage de Tongeren (Tongres)		855-006
7	Béguinage de Dendermonde (Termonde)		855-007
8	Petit Béguinage de Gent (Gand)		855-008
9	Béguinage de Sint-Amandsberg / Gent (Mont-Saint-Amand-lez-Gand)		855-009
10	Béguinage de Diest		855-010
11	Grand Béguinage of Leuven (Louvain)		855-011
12	Béguinage de Bruges (Brugge)		855-012
13	Béguinage de Kortrijk (Courtrail)		855-013

Figure 9. Attribute table of the Flemish Béguinages property's boundaries layer.

Also, indicate in the **metadata**, and not in the attribute table, the CRS used (i.e., WGS 84 - EPSG:4326), the scale at which the layer has been created and the creation date of the layer. Additional metadata is welcome but not required.

Serial and/or transnational properties[5]

For serial properties that are not transboundary, all the component parts should be included in the same polygon-type layer, and not be sent as different files. **Every feature in the layer must correspond to a component**. For example, the Maulbronn Monastery Complex (Germany) comprises 20 component parts: in consequence, the boundaries' layer should have a total of 20 features (this can be easily verified by counting the entries on the attribute table).

This also applies to the buffer zones of serial properties: they should all be included in the same layer, *other than the layer of the property's boundaries* (see "Buffer zone layers" below). The buffer zone must be divided per the component they are encompassing or are related to. Taking again the example of the Maulbronn Monastery Complex, it has only two buffer zones, one of them surrounding most of the component parts: the buffer zone layer should then have only two features (two rows in the attribute table).

If the buffer zone is composed of a series of non-contiguous areas protecting one component part, these should then be part of the same feature in the layer, relating to the component part they are encompassing, like in Figure 10 and 11 (Fort site and civil settlement of Niederbieber component of The Frontiers of the Roman Empire property [Germany and the United Kingdom and Northern Ireland]).

If this multipart feature is selected, the entry for these three areas, all related to a single component part (Fort site and civil settlement of Niederbieber component, in this example), should read in the attribute table of the buffer zone later as shown in Figure 12.

The name of the component part they are related to, as well as its serial number, should be indicated in the attribute table (see "Attribute table and metadata" section).

For transboundary properties, States Parties are strongly encouraged to cooperate to consolidate and send the dataset for all components of the property. If not feasible, each State Party may alternatively submit the layers of the component(s) on its territory.

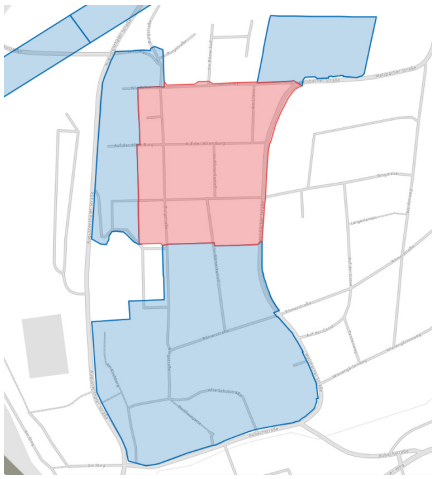


*Figure 10. Three non-contiguous areas form the buffer zone (blue) of the **Fort site and civil settlement of Niederbieber** component of the **Frontiers of the Roman Empire** property (red).*

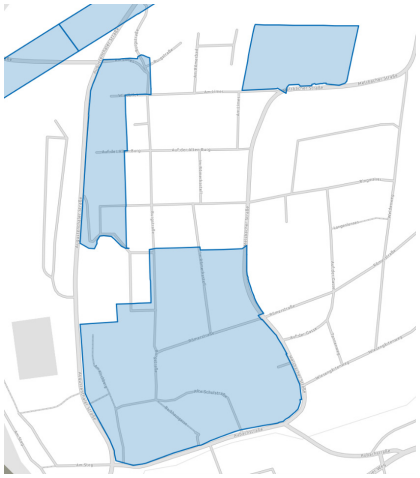


Figure 11. Image displaying the buffer zone only. These three non-contiguous areas match the buffer zone of this component part and need to be part of the same feature within the buffer zone layer (only one entry in the attributes table).

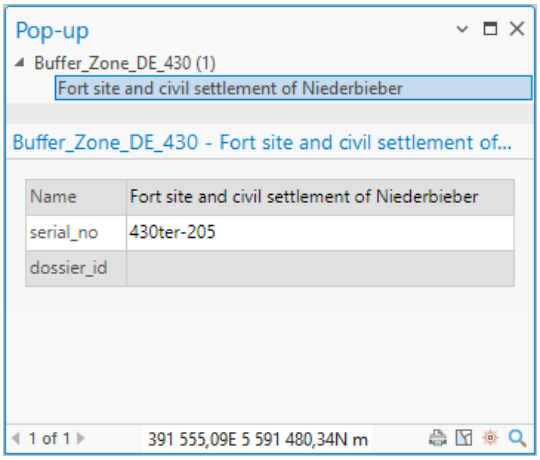


Figure 12. All the three areas are only one feature in the buffer zone layer, as reflected in the attribute table.

5 A World Heritage property is considered as "transboundary" when located on the territory of all concerned States Parties having adjacent borders. A "serial" World Heritage property includes two or more component parts related by clearly defined links and may occur on the territory of a single State Party or within the territory of different States Parties, which need not be contiguous and is nominated with the consent of all States Parties concerned. For more information, please see section III.C of the Operational Guidelines for the Implementation of the World Heritage Convention.

Buffer zone layers

- Buffer zones must be submitted in a separate layer, and not included in the one containing the boundaries of the property. Thus, a maximum of two layers could be submitted per property.
- Likewise, buffer zones of serial sites must be all included in one single layer (not one layer per component part).
- Do not include local, national or regional buffer zones, protection zones or areas of restricted use other than the one adopted by the World Heritage Committee.
- When creating the property's boundaries and buffer zone's layers, please ensure that the area of the property itself is not included in the polygon of the buffer zone. For example, Figure 13 shows the polygons of both the Historic Centre of Brugge World Heritage property (Belgium) and its buffer zone, while Figure 14 only shows the buffer zone.

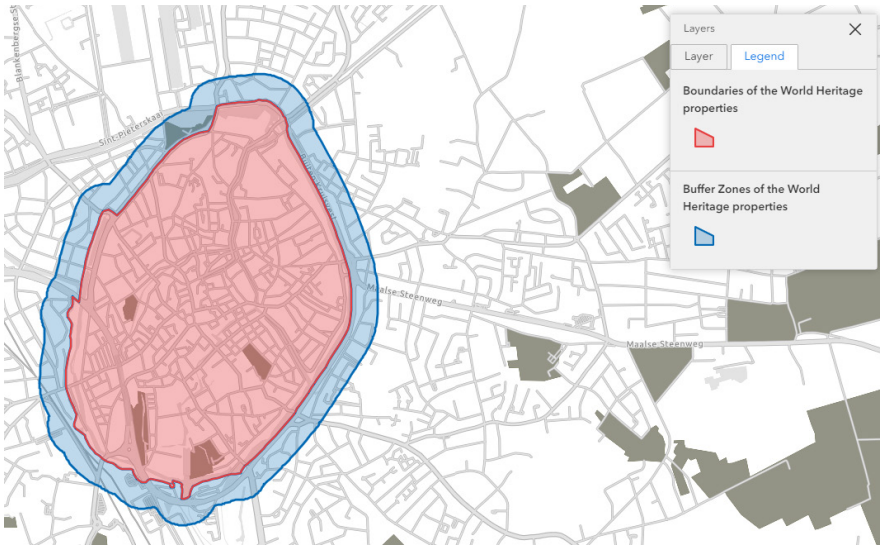


Figure 13. Historic Centre of Brugge property (red) and its buffer zone (blue).

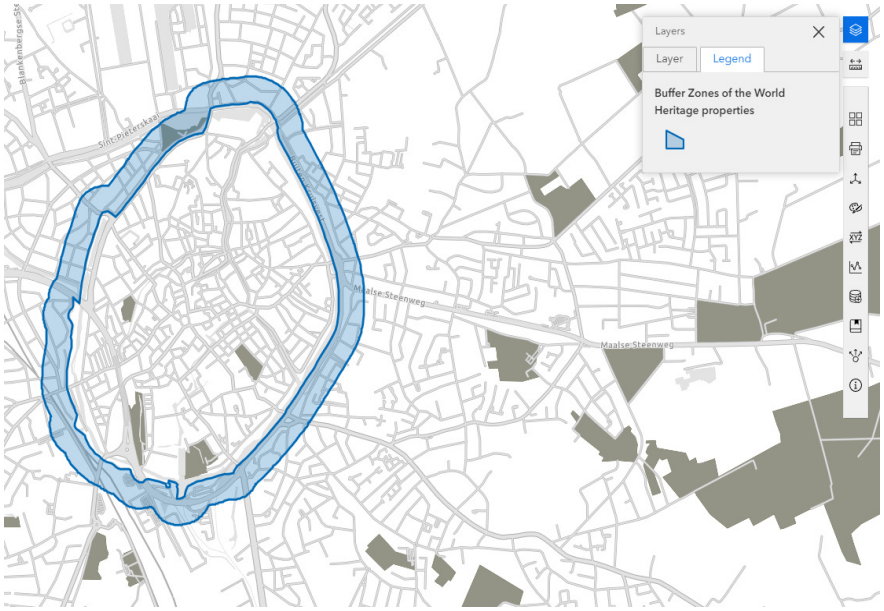


Figure 14. If only the buffer zone polygon is displayed and the property's polygon is hidden, an empty area left by the layer of the property will be visible (a "donut-shaped" buffer zone polygon).

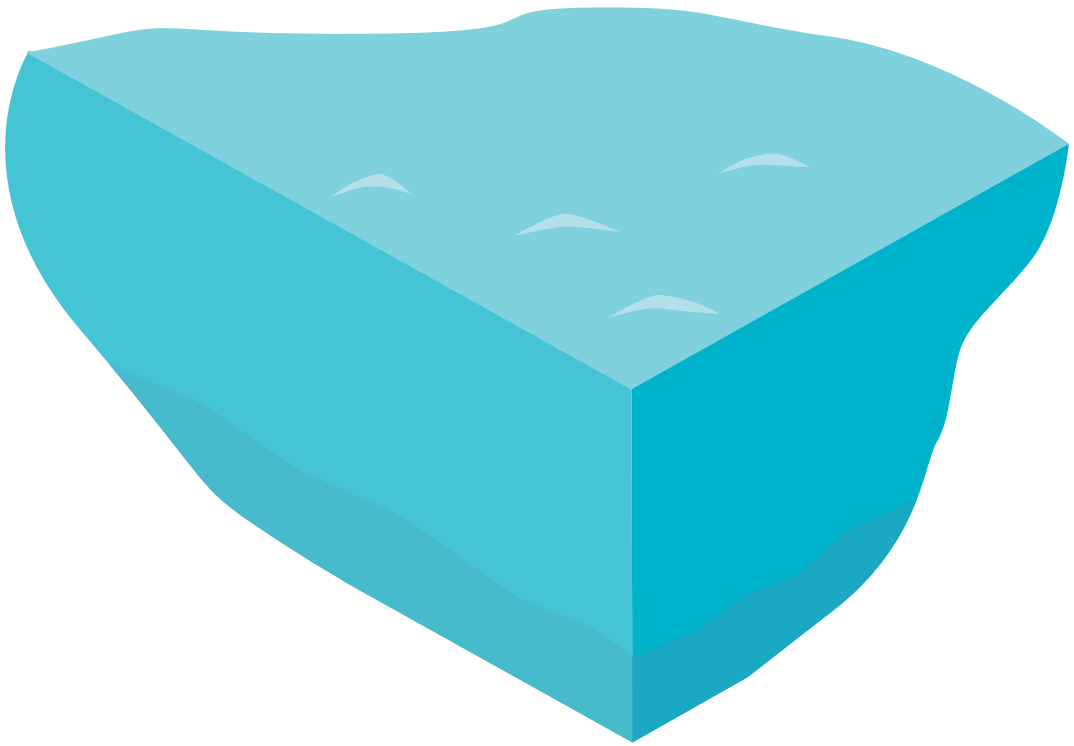
How to submit your data

- Common GIS file formats (OGC GML, GeoJSON, etc.) are accepted, with a preference for ESRI Shapefiles compressed as a single .zip or .rar file. For ESRI Shapefiles, please submit a single .zip or .rar file per World Heritage property, including all linked .shp, .shx, .dbf and .prj files for each layer.
- Include only one property per layer, and not all the properties in the same one.
- Avoid sending additional layers of features (buildings, landmarks, etc.) that are found within the property's boundaries or buffer zones' layer.
- To facilitate the processing of the geospatial files by the World Heritage Centre, kindly name the files as follows:

    1. Start by *Property_ for the boundaries of the site and Buffer_Zone_ for the buffer zone's layers*
    2. Indicate the Country ISO2 code (i.e., BE for Belgium)
    3. Indicate the property's ID number as set out in the World Heritage List (i.e., "Property_BE_857.zip" for the boundaries of the World Heritage property "**La Grand-Place, Brussels**")

Contact us

The World Heritage Online Maps Platform project team remains at your disposal for any further guidance that may be required. Please do not hesitate to contact us at wh-gis@unesco.org for any queries you may have while preparing data for submission, as well as suggested improvements to the platform or this technical note. The UNESCO World Heritage Centre thanks you for your contribution to this innovative and promising project.



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