Indra Espacio S.A.
Mar Egeo 4 • Polígono Industrial nº 1
SAN FERNANDO DE HENARES
28830 MADRID
Tel. +34 916 269 000
Fax +34 916 268 890

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Initial GMES Service for Geospatial Reference Data Access

Verification and validation test plan D8.1

	Name	Signature	Date
Prepared	Project team		30/09/2011
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Authorized	Antonio Garzón		30/09/2011

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1.1	23/11/2010	All	Full update
1.2	10/12/2010	2 & 3.1	Test description and performance criteria

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1. INTRODUCTION

This document describes the software verification and validation test plan for “GMES Service for Geospatial Reference Data Access” project.

1.1 OBJECTIVE

This document aims at providing a test plan including the test cases procedures that have to be followed for validating the client web based application.

It describes as well the QC procedures applied to the production of the data layers: EU-DEM and Hydrography.

1.2 SCOPE

The scope of this document is to present the test plan and test cases procedures for a complete validation of the application

1.3 APPLICABLE DOCUMENTS

AD-01	Call for Tenders No ENTR/2009/27
AD-02	Proposal Nr. 1143-09/IE

1.4 REFERENCE DOCUMENTS

N/A

1.5 ACRONYMS AND TERMS

CSW	Catalogue Service
EU-DEM	European Union. Digital elevation Model
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service

2. SOFTWARE VERIFICATION AND VALIDATION PROCESS PLANNING

The validation test plan is established to demonstrate that the client web based application and the middleware services meet the requirements under the expected environmental and operational conditions. The V&V of the application can be summarized below:

- The unit/integration and validation testing will be performed first on the development platform.
- The validation testing at production platform tests the real performance of the system.
- The client web based application and middleware services acceptance test may be conducted in the presence of the client.

For testing the middleware services, the Apache JMeter tool will be used. Apache JMeter is an open source software, a 100% pure Java desktop application designed to load test functional behavior and measure performance. The following figure shows an example of the JMeter tool:

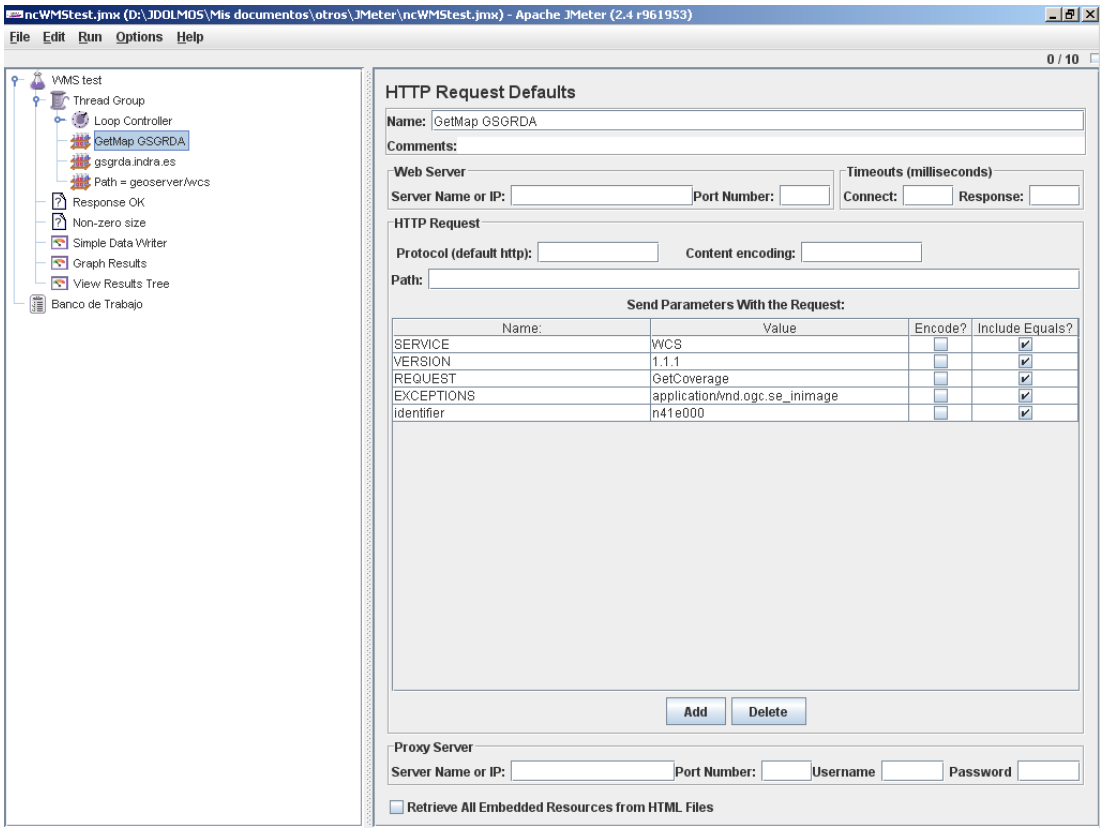


Figure 2-1 JMeter screen example

With this tool, we can configure several test cases to check the performance and capacity of the middleware services (see Section 3).

In the following, the performance requirements are summarized:

- View services: For a 470 Kilobytes image (e.g. 800x600 pixels with a colour depth of 8 bits), the response time for sending the initial response to a Get Map Request shall be maximum 5 seconds in normal situation.
- Downloading services: Response time is the time measured on the server, in which the service operation returned the first byte of the result according to the following table:

Function	**Description**
Get Download Service Metadata	3 seconds in normal situations
Get Spatial Objects	30 second initial response, then the service shall maintain a sustained response > 0,5 MB/s, alternatively 500 spatial objects/s in normal situations
Describe Spatial Object Types	10 seconds initial response, then the service shall maintain a sustained response > 0,5 MB/s, alternatively the attribute values of 500 spatial object types per s in normal situations
Define Query	Performance criteria are not applicable.

- Discovery services: The time for sending initial response to service request in normal situation shall be 3 seconds. This time includes sending Discovery service errors or exceptions. For the Discovery Service, this time shall allow to send 1 metadata record.

Regarding the capacity, the following requirements defined by INSPIRE will be satisfied:

- View services: The minimum number of served simultaneous service requests to a view service according to the performance quality of service shall be 20 per second.
- Downloading services: The capacity of an INSPIRE service is given by 10 connections per second.
- Discovery services: The minimum number of simultaneous service requests served according to the performance requirement shall be 30 per second.

3. SOFTWARE VALIDATION TEST CASE SPECIFICATION

In this section, a complete set of test cases for verifying and validating the middleware services performance and the client web based application is presented.

3.1 MIDDLEWARE SERVICES

In this section, the test cases for verifying and validating the middleware service performance are presented.

3.1.1 WMS Performace test case

- Test case identifier: GSGRDA-TC-01
- Purpose: This test case checks the performance requirements of the WMS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-01	**WMS**	**TC-01**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the JMeter test application	The JMeter desktop-application is opened		
2.	Click on File -> Open and choose “WMStest.jmx” file	The test case is shown in the JMeter		
3.	Click on Run -> Start	The test begins to run. It is possible to follow the execution in “Graph results” and “View results tree”.		
4.	Open the file “ResultWMStest.jmx” with excel using logStylesheet.xsl style sheet	The result times are shown in excel fomat.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-01	**WMS**	**TC-01**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
5.	Check if the result are complaint with the requirements			
	Executed By:			

Table 3-1. WMS Performance test case

3.1.2 WFS Performace test case

- Test case identifier: GSGRDA-TC-02
- Purpose: This test case checks the performance requirements of the WFS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-02	**WFS**	**TC-02**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the JMeter test application	The JMeter desktop-application is opened		
2.	Click on File -> Open and choose “WFStest.jmx” file	The test case is shown in the JMeter		
3.	Click on Run -> Start	The test begins to run. It is possible to follow the execution in “Graph results” and “View results tree”.		
4.	Open the file “ResultWFStest.jmx” with excel using logStylesheet.xsl style sheet	The result times are shown in excel fomat.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-02	**WFS**	**TC-02**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
5.	Check if the result are complaint with the requirements			
	Executed By:			

Table 3-2. WFS Performance test case

3.1.3 WCS Performace test case

- Test case identifier: GSGRDA-TC-03
- Purpose: This test case checks the performance requirements of the WCS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-03	**WCS**	**TC-03**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the JMeter test application	The JMeter desktop-application is opened		
2.	Click on File -> Open and choose “WCStest.jmx” file	The test case is shown in the JMeter		
3.	Click on Run -> Start	The test begins to run. It is possible to follow the execution in “Graph results” and “View results tree”.		
4.	Open the file “ResultWCStest.jmx” with excel using logStylesheet.xsl style sheet	The result times are shown in excel fomat.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-03	**WCS**	**TC-03**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
5.	Check if the result are complaint with the requirements			
	Executed By:			

Table 3-3. WFS Performance test case

3.1.4 CSW Performace test case

- Test case identifier: GSGRDA-TC-04
- Purpose: This test case checks the performance requirements of the CSW middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-04	**CSW**	**TC-04**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the JMeter test application	The JMeter desktop-application is opened		
2.	Click on File -> Open and choose “CSWStest.jmx” file	The test case is shown in the JMeter		
3.	Click on Run -> Start	The test begins to run. It is possible to follow the execution in “Graph results” and “View results tree”.		
4.	Open the file “ResultCSWStest.jmx” with excel using logStylesheet.xsl style sheet	The result times are shown in excel fomat.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-04	**CSW**	**TC-04**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
5.	Check if the result are complaint with the requirements			
	Executed By:			

Table 3-4. CSW Performance test case

3.2 CLIENT WEB BASED APPLICATION

In this section, the test cases for verifying and validating the client web based application are presented.

3.2.1 General information test case

- Test case identifier: GSGRDA-TC-05
- Purpose: This test case validates the correct access to the general information of the client web based application.
- Procedure steps:

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-05	**General Information**	**TC-05**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the Client web based application in a web Browser	The home page is displayed		
2.	Click on “Project overview”	Web page showing a summary of the project.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-05	**General Information**	**TC-05**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
3.	Click on “Links”	Web page showing the links of the used standards and specifications.		
4.	Click on “Contact”	Web page showing the email address of the monitoring group.		
	Executed By:			

Table 3-5. General Information test case

3.2.2 WMS test case

- Test case identifier: GSGRDA-TC-06
- Purpose: This test case validates the correct functionality of the WMS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-06	**WMS**	**TC-06**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the Client web based application in a web Browser	The home page is displayed		
2.	Click on “Viewer”	The map viewer is displayed, showing the world map.		
3.	Click on the “+” top button on the map	The list of layers is displayed, showing the product layers available.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-06	**WMS**	**TC-06**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
4.	Click on “EU-DEM” check box	The EU-DEM layer is shown on the map.		
5.	Click on “River network” check box	The river network layer is shown on the map.		
6.	Click on zoom in button	The map is getting closer, showing more details of the layers		
	Executed By:			

Table 3-6. WMS test case

3.2.3 CSW test case

- Test case identifier: GSGRDA-TC-07
- Purpose: This test case validates the correct functionality of the CSW middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-07	**CSW**	**TC-07**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the Client web based application in a web Browser	The home page is displayed		
2.	Click on “Discovery”	Show the metadata catalogue web page.		
3.	Click on “Search”	The products metadata including EU-DEM and hydrographical ones are listed.		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-07	**CSW**	**TC-07**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
4.	Click on “Metadata” of one of the products.	The metadata of the selected product are displayed.		
	Executed By:			

Table 3-7. CSW test case

3.2.4 WCS test case

- Test case identifier: GSGRDA-TC-08
- Purpose: This test case validates the correct functionality of the WCS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-08	**WCS**	**TC-08**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the Client web based application in a web Browser	The home page is displayed		
2.	Click on “Download EU-DEM” link	The DEM interface is displayed		
3.	Click in the options list of the left column.	The element EU-DEM appears		
4.	Select a box over the graphical map, trying to leave covered areas inside	The latitude and longitude boxes change their values.		
5.	Click button “Add request to request list”	A description of the request is added to a list of request in the lower part of the page		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-08	**WCS**	**TC-08**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
6.	Click the button “Check out”	After a while a window appears, asking if the result has to be opened or saved.		
7.	Save the file and open it with a decompressor.	A zip file with several xml files are downloaded containing the requested information		
	Executed By:			

Table 3-8. WCS test case

3.2.5 WFS test case

- Test case identifier: GSGRDA-TC-09
- Purpose: This test case validates the correct functionality of the WFS middleware service.
- Procedure steps

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-09	**WFS**	**TC-09**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
1.	Open the Client web based application in a web Browser	The home page is displayed		
2.	Click on “Download Hydro” link	The Download Hydrographical product page is displayed		

TEST CASE PROCEDURE SPECIFICATION				
	Identifier	**Name**	**Test case**	**Type**
	GSGRDA-TC-09	**WFS**	**TC-09**	**Validation**
PROCEDURE				
#	**Step**	**Expected output**	**Result**	**Comments**
3.	Click in the options list of the left column.	Several layers appear		
4.	Select a box over the graphical map, trying to leave covered areas inside	The latitude and longitude boxes change their values.		
5.	Click button “Add request to request list”	A description of the request is added to a list of request in the lower part of the page		
6.	Click the button “Check out”	After a while a window appears, asking in the result has to be opened or saved.		
7.	Save the file and open it with a decompressor.	A zip file with several xml files are downloaded containing the requested information		
	Executed By:			

Table 3-9. WFS test case

4. HYDROGRAPHY LAYER

This section describes the Quality Control milestones established in the production chain of the Hydrography layer to assure quality in all the sub-processes. The QCs will be followed up by using checklists and reports for each QC milestone. The production chain schema in figure 1.5-1 shows where the different QC milestones are located.

4.1 QUALITY CONTROL PROCEDURES

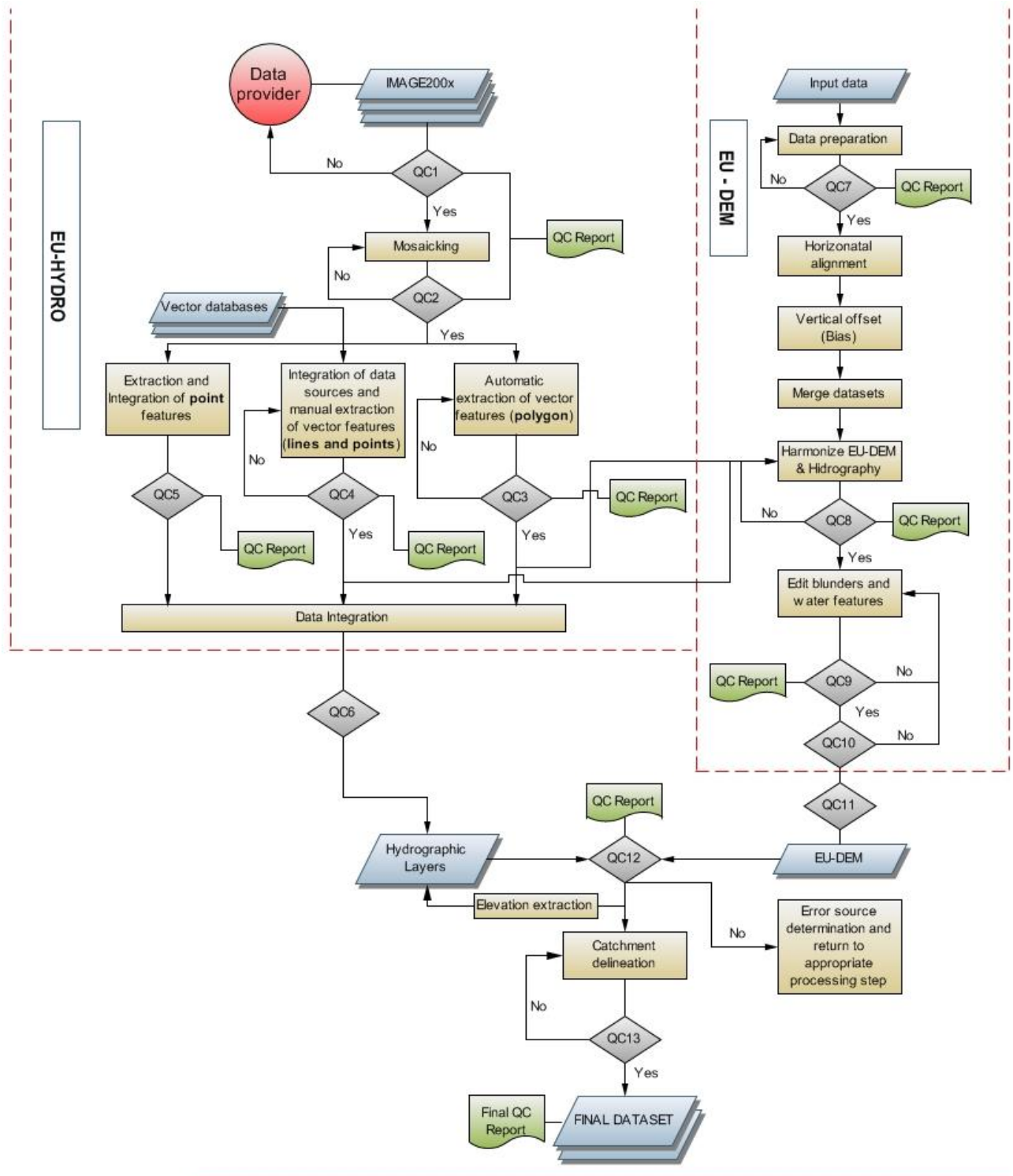


Figure 4-1. General QC Worklow. A more detail workflow of the EU – DEM workflow can be found in figures Figure 5-1 and Figure 5-2

4.1.1 Satellite Images and Mosaicking (QC1 & QC2)

Satellite images will be used as one of the main data sources for hydrological features extraction. Ideally, IMAGE 2006 and IMAGE2009 datasets will be used. These data sets have already gone through strict quality control procedures. However, in order to select the best choice of input images when several scenes are available over the same area, **100% of the provided imagery** will be checked for best characteristics in terms of cloud cover, season, radiometric quality and shadows. The outcome will be a set reasonable-quality satellite images. A cross-reference table for each production unit will be created in order to record the source images used for the data extraction.

When mosaicking is needed, the resulting mosaics will be visually checked for correct border matching and radiometric balancing.

Output: QC REPORT for each satellite image / mosaic.

Responsible: AGI

Non-approval procedure: Reporting to PO and search for alternative EO data.

QC Form:

Image ID:

Working Unit ID:

Yes	*No*	
☐	☐	The acquisition date of the image suits the needs for water body or streams delineation
☐	☐	All the necessary files are supplied in the delivery
☐	☐	The image metadata is supplied in the delivery
☐	☐	Coordinate system according to the specifications
☐	☐	The cloud cover does not interfere with water body or streams delineation
☐	☐	The radiometry of the bands does not present any anomaly
☐	☐	There are no bad lines in the data

4.1.2 Water bodies and wide streams (polygon features) (QC3)

Water bodies and rivers wide enough to be mapped as polygons will be extracted through a highly automated method. When available from existing datasets, they will be integrated in the dataset.

QC of the hydrography polygon features will be carried out as follows:

- **20% of vector polygons (or all of them if they are below 20 polygons)** for each processed image will be visually checked to fit the requirements of the data specification (geometry and attributes). If any mistake is found, it will be corrected and a new iteration will be performed with a new sample.

Sample selection will be taken randomly, but 50% of the sample will be based on rivers having the attribute “Name” and/or “LakID” filled.

- Deletion of “false” hydrography polygon features (shadows and other artefacts) from the processed datasets;
- Missing hydrography polygon features are delineated manually or the extracted ones manually corrected (if necessary);
- **Topology**: The following topological features will be checked:
    - Polygons can not overlap.
    - Boundaries of neighbouring polygons have the same set of coordinates, within the specified resolution.
- **Attributes** will be checked for:
    - Completeness: All those mandatory fields must be filled.
    - Value correctness: Those fields with fixed ranges of values or discrete concrete values will be checked for correctness. However, to avoid this type of error, the database is designed to work with value domains for such fields, so that values not considered to be correct can not be entered.
    - Coding specification correctness: Those fields which values are coded in a particular way (e.g. most IDs in ECRINS) will be checked for correctness.
    - Attribute integration: Those attributes that must be integrated directly from ECRINS (e.g. LakID) will be checked by spatially linking those attributed features from ECRINS with the corresponding ones from EU-HYDRO. In this way, table records will be easily compared and inconsistencies, omissions and commissions found, and therefore corrected.

Final result: All vector datasets for each image/mosaic checked for data content (no missing and no false/duplicated hydrography polygon features) and quality (geometric accuracy); false/duplicated hydrography area features deleted from the main database.

Output: QC REPORT for the area corresponding to the footprint of each satellite image / mosaic.

Responsible: AGI

Non-approval procedure: Return of incorrect datasets for further iterative processing with different empirical values, until hydrography polygon features fulfil the quality requirements.

QC Form:

Image ID:

Working Unit ID:

Yes	*No*	
☐	☐	Visually inspected for missing features
☐	☐	Sample do not contain any delineation error or occurrence error
☐	☐	Topology correct. If not, specify type of problem.
☐	☐	Attribute values correct. If not, specify type of problem.

Comments:

4.1.3 Line network (polyline features) (QC4)

The line network will be extracted manually from the satellite imagery and topographic maps. For those countries/areas for which there is available, accessible and suitable digital data, they will be integrated guaranteeing homogeneity with the rest of the layer. Junction points of the hydrography network aggregated into a separate database layer (point features).

Euro-Regional Map (1:250,000) and ECRINS vector data will be used as reference material for identification of missing objects and flow directions of streams;

Attributes of all hydrography objects will be extracted from GEONAMES database, Euro-Regional Map database, and any other suitable database available.

QC of the hydrography line features will be carried out as follows:

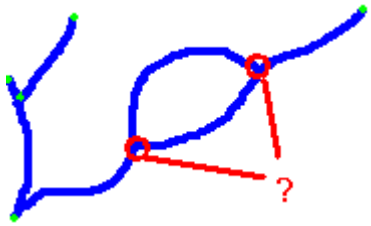
- **20% of vector data for each image/mosaic (or all of them if they are below 20 lines)** will be visually checked to fit the specification (geometry and attributes). If any mistake is found, it will be corrected and a new iteration will be performed with a new sample.

  Sample selection will be taken randomly, but 50% of the sample will be based on rivers having the attribute “Name” and/or “River_ID” filled.

- **Topology**:

The following topological features will be checked:

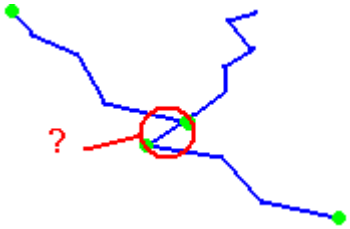
- Null length polylines: Null length polylines have no length but still remain in the dataset (typical error in ArcGIS geodatabase)
- Multipart polylines: Those composed of more than one polyline and are invalid network elements.



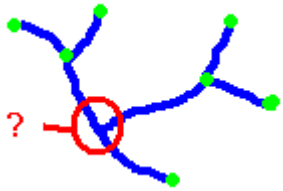
- Self-intersecting polylines: When a polyline crosses itself.

- Closed polylines: Polylines that start and end at the same point.

- Small lines composed of 2 vertices smaller than a given distance: Small polylines composed of only two vertices may be errors.

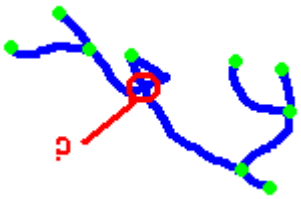


- Disconnected polylines: Those polylines that intersect another one but not a node, thus disrupting the connectivity of the network.

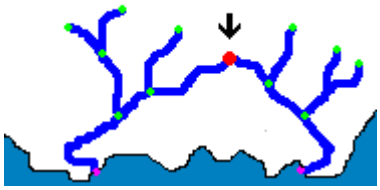


- Doubled-digitised polylines: Typical digitising error or external data integration.

- Intersecting polylines: Polylines should only intersect at nodes.



- Sources within network: Nodes within the network that are acting as sources for more than one catchment.



- Lines will not have pseudo nodes. Exceptions: cross-boundary lines.
- **Attributes** will be checked for:
    - Completeness: All those mandatory fields must be filled.
    - Value correctness: Those fields with fixed ranges of values or discrete concrete values will be checked for correctness. However, to avoid this type of error, the database is designed to work with value domains for such fields, so that values not considered to be correct can not be entered.
    - Coding specification correctness: Those fields which values are coded in a particular way (e.g. most IDs in ECRINS) will be checked for correctness.
    - Attribute integration: Those attributes that must be integrated directly from ECRINS (e.g. River_ID) will be checked by spatially linking those attributed features from ECRINS with the corresponding ones from EU-HYDRO. In this way, table records will be easily compared and inconsistencies, omissions and commissions found, and therefore corrected.

*Final result***:** All vector datasets for each image/mosaic checked for thematics (no missing and no false/duplicated hydrography line features) and quality (geometric accuracy and correct attributes); all correct datasets assembled into a seamless vector database.

Output: QC REPORT for the area corresponding to the footprint of each satellite image / mosaic. Comments will be stored and delivered in a separate vector data layer.

Responsible: AGI

Rejection procedure: If vector datasets fail to pass the quality control, instructions for AGI DPT for solving unclear cases and avoid mistakes will be prepared, incorrect vector datasets with error indication returned to AGI DPT for additional identification and correction of hydrography features and attributes.

QC Form:

Image ID:

Working Unit ID:

Yes	*No*	
☐	☐	Visually inspected for missing features
☐	☐	Sample do not contain any delineation error or occurrence error
☐	☐	Topology correct. If not, specify type of problem.
☐	☐	Attribute values correct. If not, specify type of problem.

Comments:

4.1.4 Point features (QC5)

Point features other than nodes will be integrated from existing databases or collected manually if visible in the imagery.

QC of the hydrography line features will be carried out as follows:

- Since the only point data foreseen to be integrated is the layer “dams”, from ECRINS, **100% of vector data for each image/mosaic (or all of them if they are below 20 lines)** will be automatically checked, in order to ensure all the points snap with the line network and or water bodies. Attributes will be kept the same as in the ECRINS’ layer.

Final result: Vector dataset for each image/mosaic checked for data content (no missing and no false/duplicated hydrography point features) and quality (geometric accuracy); false/duplicated features deleted from the main database.

Output: QC REPORT for the area corresponding to the footprint of each satellite image / mosaic.

Responsible: AGI

Non-approval procedure: Return of incorrect datasets for further iterative processing.

QC Form:

Image ID:

Working Unit ID:

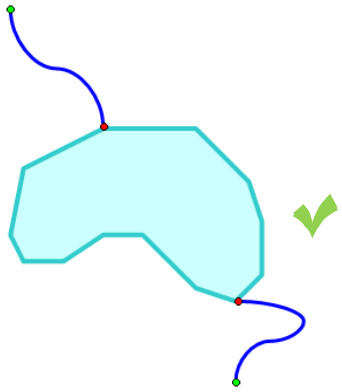
Yes	*No*	
☐	☐	Visually inspected for missing features

Comments:

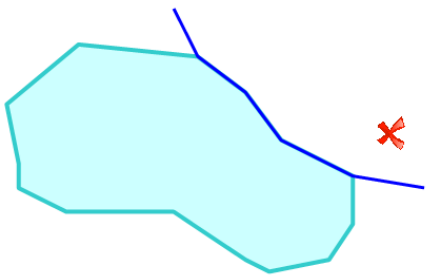
4.2 INTEGRATION OF POLYGON AND LINE LAYERS (QC6)

Polygon, line and point layers will be integrated and harmonised to fulfil the following **topological** conditions:

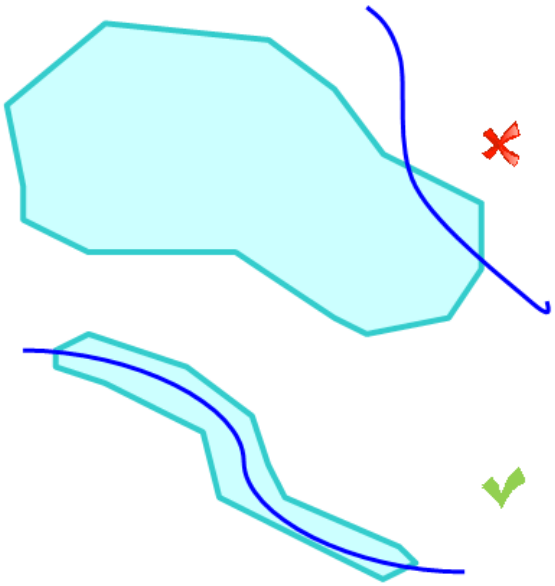
- End or start line nodes will touch the boundary of water bodies when streams end or start at water bodies.



- Lines will not be tangent to water bodies.



- Lines will not cross water bodies unless they are the centre line of them.



Final result: All vector datasets will fit the topological rules above mentioned.

Output: QC REPORT for the area corresponding to the footprint of each satellite image / mosaic.

Responsible: AGI

Non-approval procedure: Return of incorrect datasets for further processing.

QC Form:

Image ID:

Working Unit ID:

Yes	*No*	
☐	☐	End or start line nodes touch the boundary of water bodies when streams end or start at water bodies.
☐	☐	Lines are not tangent to water bodies.
☐	☐	Lines do not cross water bodies unless they are the centre line of them.

Comments:

5. EU – DEM

This section describes the internal QA/QC procedures implemented by Intermap to provide adequate confidence that production of the EU-DEM will fulfill the quality related requirements as described in the technical proposal for the *Initial GMES Service for Geospatial Reference Data Access* project.

Quality control emphasizes testing of products to uncover defects, and reporting to management who make the decision to allow or deny the release, whereas quality assurance attempts to improve and stabilize production, and associated processes, to avoid, or at least minimize, issues that led to the defects in the first place.

Proposed methodological production approach for the EU-DEM:

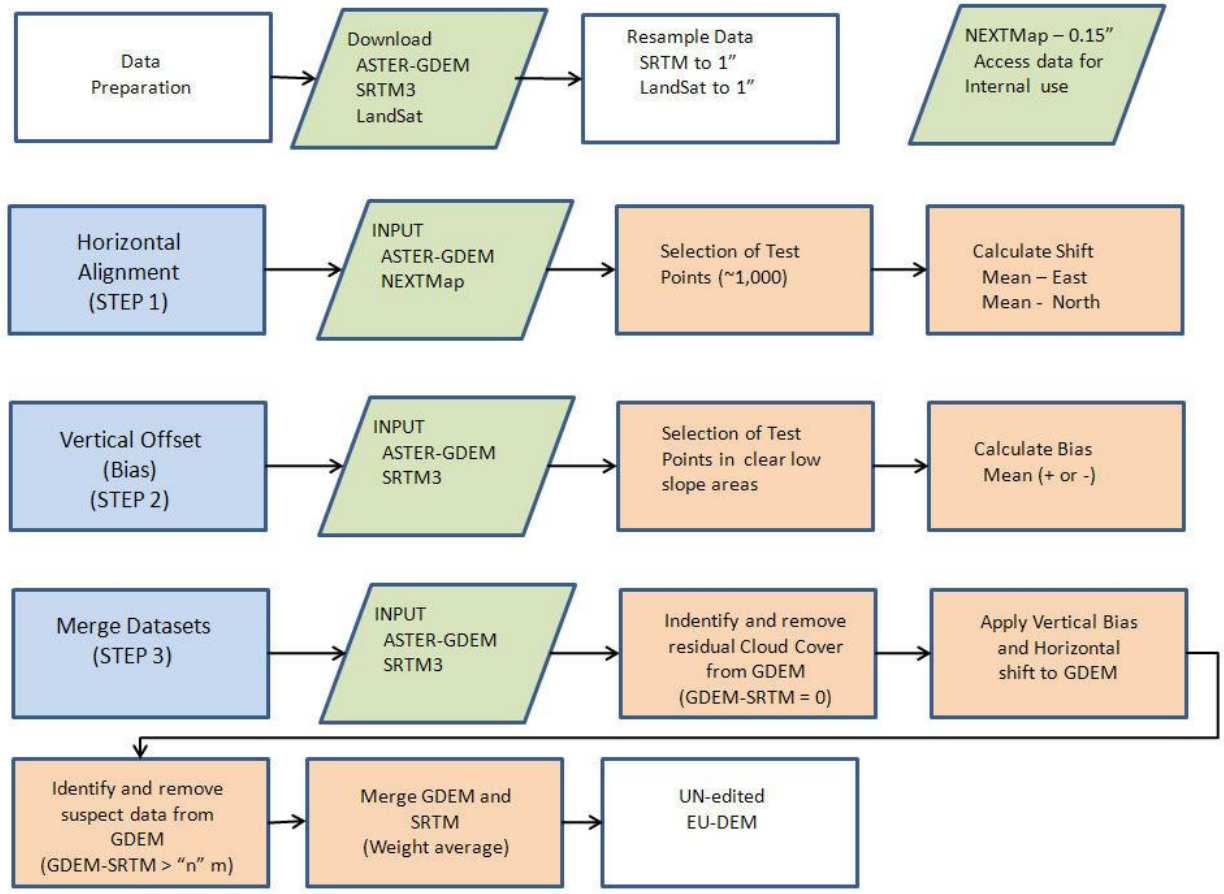


Figure 5-1 EU – DEM Methodological approach

Proposed workflow of the validation process:

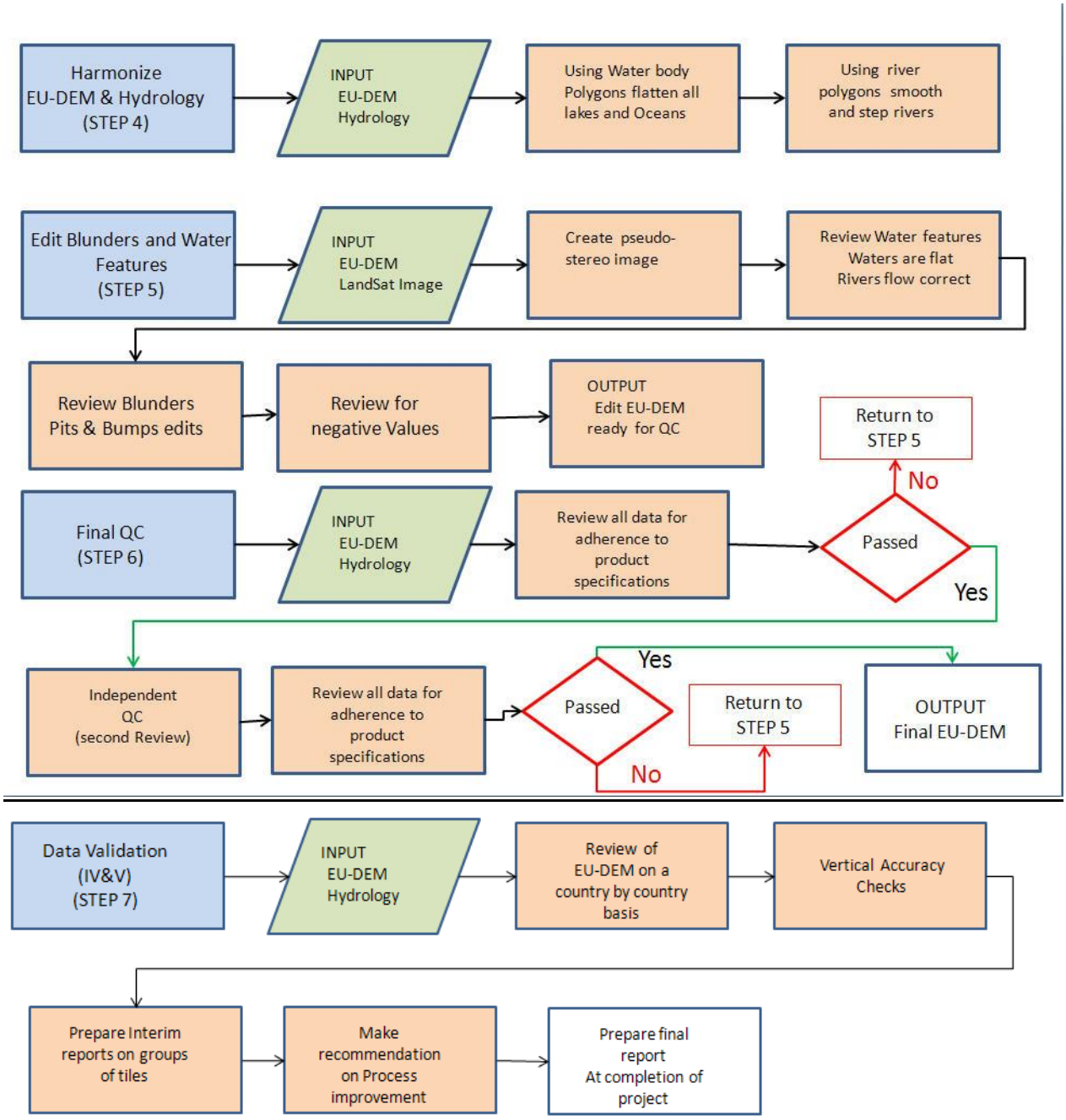


Figure 5-2 EU – DEM Validation process workflow.

5.1 QUALITY CONTROL PROCEDURES

5.1.1 Data Preparation (QC7)

- After all required input data (GDEM, SRTM, Landsat/IMAGE) have been obtained or downloaded they will be checked for correctness and completeness;
- Manually identify a large sampling of points coincident in the NEXTMap and the GDEM tiles and measure their horizontal offset - if a single global horizontal offset can be determined, then shift the GDEM data accordingly
- Manually identify a large sampling of points coincident in the SRTM and the GDEM tiles (in low/flat areas) and measure their vertical offset - if a single global vertical offset can be determined, then shift the GDM data accordingly
- In all GDEM tiles above 60° N voids will be interpolated unless an alternate and suitable source of data to SRTM will be provided;
- In all GDEM tiles below 60° N identify areas where residual clouds have not been properly in-filled by SRTM data (significant vertical difference) and void them out;

Responsible: Intermap

Quality control team: Data Preparation Team.

Input form consortium partners: IMAGE data (if possible); DEM data for areas above 60°N

Quality control: All unedited EU-DEM tiles will be checked by the Data PreparationTeam.

Final result: Input data tiles will be loaded into GIS software to ensure data was shifted by the correct amount horizontally and vertically, the data are complete, voids were interpolated appropriately (above 60°N) or created (below 60°N).

Non-approval procedure: Return to production team for correction.

5.1.2 Data processing (QC8)

- Burn in water elevations using external hydrography vector data
    - Oceans set to 0
    - Lakes set to constant elevation based on an averaged, minimum value of the surrounding lake shoreline
    - Double line drainage set to stepped elevations where each elevation must be lower than the surrounding shoreline

- Single line drainage is to be left alone

- After Data Preparation process of merging both DSMs to produce a hybrid DEM each unedited EU-DEM tile will be checked for completeness and edge issues.
- Return of incorrect datasets for additional processing;
- A Country Introduction Report will be produced for each country outlining issues, terrain and water features that Production team should be aware of.
- Unedited EU-DEM tiles will be delivered to Production for editing.

Responsible: Intermap

Quality control team: Data Preparation Team

Input from consortium partners: Quality Controlled hydrography layer from AGI

Quality control: All unedited EU-DEM 1° tiles will be checked by the Data Preparation Team

Final result: All EU-DEM 1° tiles are checked for completeness, major issues and that the automated tools worked properly (e.g. water flattening).

Non-approval procedure: Return to production team for correction.

5.1.3 Data Editing Quality Control (QC9)

- After editing according to product specifications a quality control check will occur on each edited EU-DEM tile;
- Return of incorrect datasets for additional editing to the original editors;
- Quality control operator points are returned to the editor;
- Completed EU- DEM tiles are delivered to the Independent Quality Control (IQC) Team.

Responsible: Intermap.

Quality control team: Production Quality Control Team.

Input from consortium partners: none.

Quality control: All edited EU-DEM 1° tiles will be checked by the Production Quality Team.

Final result: All EU DEM datasets for each tile are checked for inherence to product specification. This includes missing hydrography features, edge ties and pits/bumps. All corrected EU-DEM 1° tiles will be delivered to the Independent Quality Check Team.

Non-approval procedure: Return to production team for correction.

5.1.4 Independent Quality Control (IQC) (QC10)

- Quality control of edited EU- DEM data for each tile;
- Return of incorrect datasets for additional editing to the Production Quality Control Team;
- Quality control operator points and quality feedback are returned the Quality Control Team;
- Completed EU-DEM 1° tiles are delivered to the Data Delivery Team.

*Responsible***:** Intermap

Quality control team: Independent Quality Control Team

Input from consortium partners: none

Quality control: Al EU edited tiles will be checked by the Production Quality Team

Final result: All EU- DEM datasets for each tile are checked for inherence to product specifications. This includes missing hydrography features, edge ties and pits/bumps. All corrected DEM 1° tiles will be delivered to the Data Delivery Team. An IQC acceptance report will be produced for each country.

Non-approval procedure: Return to production team for correction.

5.1.5 Independent Data Validation (IVV) (QC11)

- A country check with quality control specialist prepares operational instructions for processing the identified errors;
- Any non-conforming errors will be fixed by production;
- An interim report will be made on each country with a final report produced at the completion of each project.

Responsible: Intermap

Quality control team: Data Validation/Testing Team

Input form consortium partners: Access to additional reference material

Quality control: A global check of each country will occur which will focus on identifying issues with large water bodies, data completeness, VCP checks and comparison to other reference datasets. Review of Improvement Opportunities will occur if appropriate.

Final result: All countries are checked and valid errors are identified and corrected. An interim and final report will be delivered. The fully QCed EU-DEM will be released and delivered in 1° x 1° tiles in BIL format (ETRS89, EVRS, geographic CRS)

5.1.6 Catchment delineation (QC13)

This section is still under discussion, as it has not been possible to test methods due to the lack of an EU-DEM dataset large enough to create catchments.

6. FINAL VERIFICATION

6.1 VERIFICATION OF DATA HARMONIZATION (Q12)

In order to guarantee adequate fitting and overlapping of both EU – DEM and Hydrography dataset, a verification of both databases will be performed. As there is no quantitative method to assess this concept, visual inspection will be done using spatial analysis tools such us hillshade-effect models and altitude colouring for the DEM. This additional data will help visual inspection introducing a better perception of the 3D space, so that rivers and relieve can be visualised in a more realistic way.

In addition, river network will be checked against EU-DEM in order to ensure downstream flow.

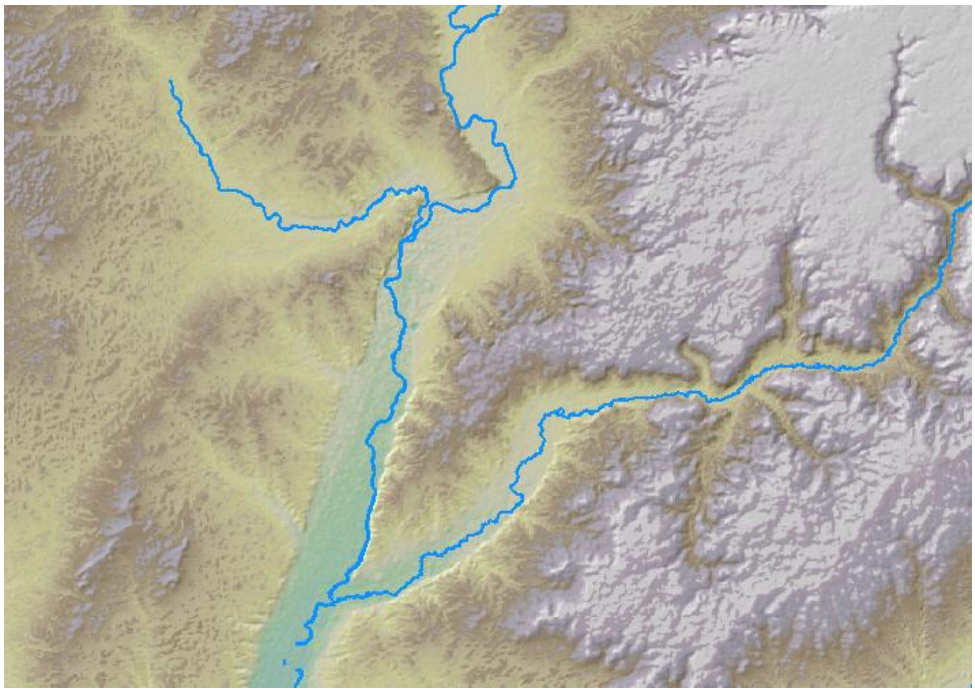


Figure 6-1 EU – Hillshade effect and coloured DEM with river network on top.

Responsible: INDRA

Quality control team: INDRA QC Team.

Input from consortium partners: EU – DEM and Hydrology layers.

Quality control: Visual check.

Final result: All countries are checked and valid errors are identified.

Non-approval procedure: Return to production team for correction.

6.2 VERIFICATION OF QUALITY CONTROL PROCESS

In order to ensure the completion of all the QC procedures Indra will review that all the steps throughout the internal procedures at Intermap and AGI are completed and a database with the reports will be maintained.

Responsible: INDRA

Quality control team: INDRA QC Team.

Input from consortium partners: EU – DEM and Hydrology QC reports

Quality control: Database report

Final result: Complete QC Reports database.

Non-approval procedure: Return to production team for correction.

Annex A: Quality Control Forms

1. QUALITY CONTROL FORMS

This annex presents the quality control forms to be used during the production and harmonization of both DEM and hydrography layers by the production teams.

TILE INFORMATION	
Working Unit ID	N40E00
Country	

Hydrography

QC3	Water bodies and wide streams (polygon features)						
Responsible	AGI						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

	Yes		No	
Visually inspection for missing features	☐	√	☐	X
Sample do not contain any delineation error or occurrence error	☐	√	☐	X
Polygons larger than MMU	☐	√	☐	X
Topology is correct. If not, specify type of problem	☐	√	☐	X
Topology problems:				
Attribute values correct. If not, specify type of problem	☐	√	☐	X
Comments:				

QC4	Line network (polyline features)						
Responsible	AGI						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

	Yes		No	
Visually inspection for missing features	☐	√	☐	X
Sample do not contain any delineation error or occurrence error	☐	√	☐	X

Distance between vertices sorter than 5m	☐ X	☐ √
Topology is correct. If not, specify type of problem	☐ √	☐ √
Null length polylines	☐ X	☐ √
Multi-part polylines	☐ X	☐ √
Self-intersecting polylines	☐ X	☐ √
Closed polylines	☐ X	☐ √
Small lines composed of 2 vertices smaller than a given distance	☐ X	☐ √
Disconnected polylines	☐ X	☐ √
Doubled-digitised polylines	☐ X	☐ √
Intersecting polylines	☐ X	☐ √
Sources within network	☐ X	☐ √
Comments:		

QC5	Point features						
Responsible	AGI						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

	Yes	No
Visually inspection for missing features	☐ √	☐ X
No duplicate points	☐ √	☐ X
Attribute values correct. If not, specify type of problem	☐ √	☐ X
Comments:		

QC6	Integration of polygon and line layers	
Responsible	AGI	
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy

	Yes	No

End or start line nodes the boundary of water bodies when streams end or start at water bodies.	☐ √	☐ X
Lines are tangent to water bodies.	☐ X	☐ √
Lines do not cross water bodies unless they are the centre line of them	☐ √	☐ X
Points (from the point layer) do not touch lines or polygons	☐ X	☐ √
Comments:		

DEM

QC7	Data preparation						
Responsible	IM						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

FINAL VERIFICATION

QC12	Verification of data harmonisation						
Responsible	INDRA						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

	Yes	No
Verification OK	☐ √	☐ X
Comments:		

QC13	Catchment delineation						
Responsible	INDRA						
External QC	INDRA (*Name Surname*)	Date: dd/mm/yy	Passed:	Y	☐	N	☐

	Yes	No
QC under discussion	☐ √	☐ X

Comments: