The Fourteenth International Conference on Advanced Geographic Information Systems, Applications, and Services
GEOProcessing 2022
June 26, 2022 to June 30, 2022 - Porto, Portugal

Functional Quality:

A Use-case Oriented Data Quality Evaluation

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June 29 - Porto, Portugal

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Professional Experience

- Professor of Cartography (Ujaen.es).
- Head of the Cartographic Engineering Research Group (Ujaen.es).
- Head of the Master's Degree of Science in Quality Assessment and Management of Geographical Information.
- International consultant.

Areas of interest & Publications

- Data quality (geospatial, metadata, linked data, etc.).
- Process control.
- Standardization in Geomatics.
- GIS & Remote Sensing.
- More than 100 publications in journals, conferences and book chapters.

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Juan Francisco Reinoso-Gordo

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Professional Experience

- Associate Professor at University of Granada (Spain)
- Department of Architectural and Civil Engineering Graphic Expression
- Researcher in the Cartographic Engineering Research Group at University of Jaén (Spain)
- Researcher in Survey and Modelling Lab of Architectural Heritage at University of Granada (Spain)

Areas of interest & Publications

- Digital elevation models
- Cartographic Generalization
- Heritage digital documentation by Photogrammetry, scanner laser and survey
- Heritage building information modelling (HBIM)
- Virtual and augmented stereoscopic reality
- More than 70 manuscripts in journals, congresses and book chapters, 33 of them in JCR papers

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Cartographic Engineering Research Group
TEP-164

Main research activities

- GIS: Applications to cartographic production, environment, resources and management.
- Cadaster and Valuation: Implementation of cadasters, valuation methodologies, large cadastral projects, LADM.
- Cartographic Production: Capture, generalization and integration of spatial data.
- Quality and standardization: Data quality, metadata and processes, BIM, standardization.
- Geodesy and Geophysics: Geoid and advanced GNSS processing.
- Photogrammetry and Remote Sensing: Applications to the environment, agriculture and engineering, heritage, etc.

On going projects:

- **Functional Quality for DEM in Engineering** 2020-2023. FJ. Ariza-López
- GRC-MS (Galileo Reference Center - Member States; International Consortium of 19 European partners, H2020 Project and € +1.67 M eligible costs): Work Package 3.5: OS Interoperability with other GNSS and Work Package 6: Scientific Support. J. Zurutuza
- GISCAD-OV (Galileo Improved Services for Cadastral Augmentation Development On-field Validation; 14 European partners, H2020 Project ID : 870231; Grant € 2.6M). J. Zurutuza
- JRC/IPR/2019/OP/2595 – Copernicus emergency management service (EMS) validation. TRACASA. F.J. Ariza-López
- Desarrollo del derrotero digital inteligente de las costas españolas (DDIE) M. Ureña

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Acknowledgment

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AGENCIA ESTATAL DE INVESTIGACIÓN

PID2019-106195RB-I00/AEI/10.13039/501100011033
https://coello.ujaen.es/investigacion/web_giic/funquality4dem/

Introduction

What is the user really interested in?

Technical aspects such as:

- Quality of materials.
- Systems reliability.
- Types of metal alloys.
- Manufacturing and assembly tolerances.
- etc.

Applied aspects such as

- Real consumption,
- Maintenance cost
- Security
- Trunk volume
- etc.

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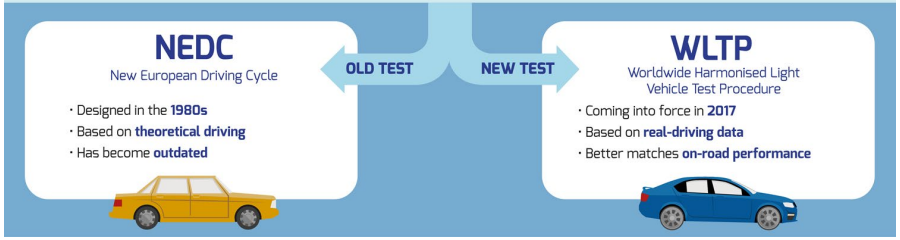
Introduction



The New European Driving Cycle (**NEDC**) was designed in 1997 to assess the emission levels of car engines and fuel economy in passenger cars. The NEDC, which is supposed to represent the typical usage of a car in Europe. It consists of four repeated ECE-15 urban driving cycles (UDC) and one Extra-Urban driving cycle (EUDC).

The **WLTP** (World harmonized Light-duty vehicles Test Procedure) (2015) is a global harmonized standard for determining the levels of pollutants, CO2 emissions and fuel consumption of traditional and hybrid cars, as well as the range of fully electric vehicles. The new WLTP procedure relies on the new driving cycles to measure mean fuel consumption.

A car is driven on public roads, in real situation. Cars are fitted with a portable emission measuring system and are driven for a maximum of 2 hours traveling up to 60 km/h in urban conditions; up to 90 km/h in rural conditions; and 145 km/h, in motorway conditions, at temperatures between – 7 ° C and 35 ° C, and at an altitude of up to 1300 m.

Introduction

WILL WLTP END THE DISCREPANCY BETWEEN THE LABORATORY AND ON-ROAD PERFORMANCE OF CARS?

Even though the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) will provide a far more realistic representation of conditions encountered on the road than the old NEDC lab test (New European Driving Cycle), it will not cover all possible variations. Moreover, each individual driver will continue to have a different driving style: one driver might accelerate faster, take corners faster or brake more suddenly than another who might drive more conservatively.

Given that driving behaviour, traffic and weather conditions will continue to differ from one country to another, there will still be a difference between emissions measured in lab conditions and the real world. However, as there is no single real-world emission value, only values obtained by standardised laboratory tests allow us to directly compare the emissions and fuel consumption of different car models from different car manufacturers.

The same is valid for geospatial data quality

https://www.wltpfacts.eu/wltp-discrepancy-laboratory-road-performance-cars/

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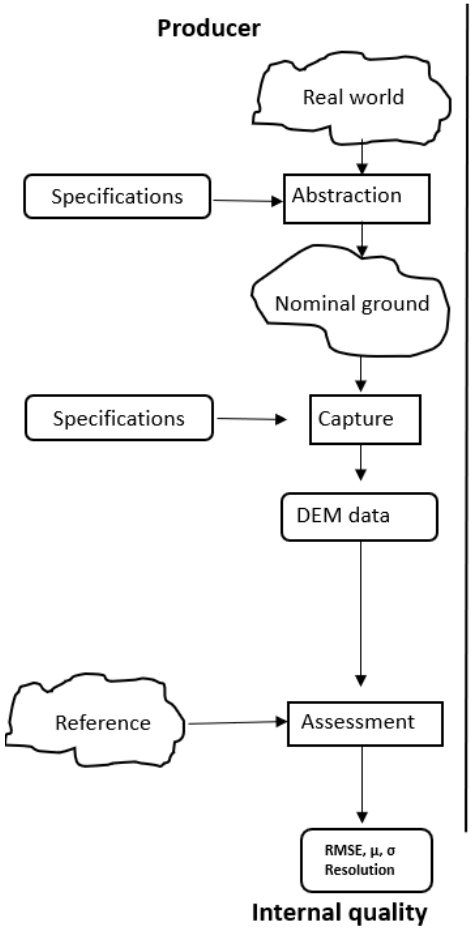
The concept

Layer #1

Internal quality

Data-centric



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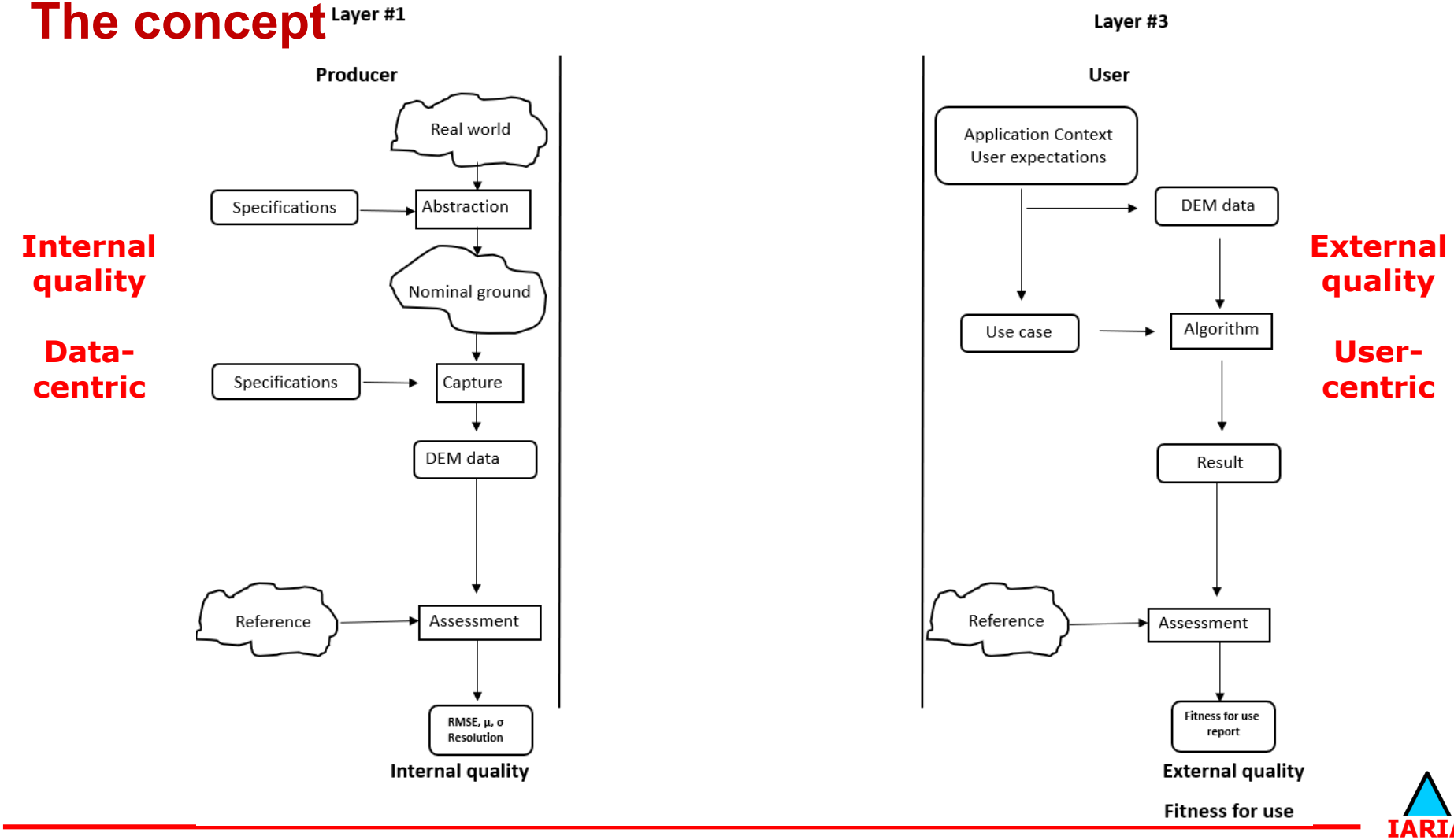
The concept



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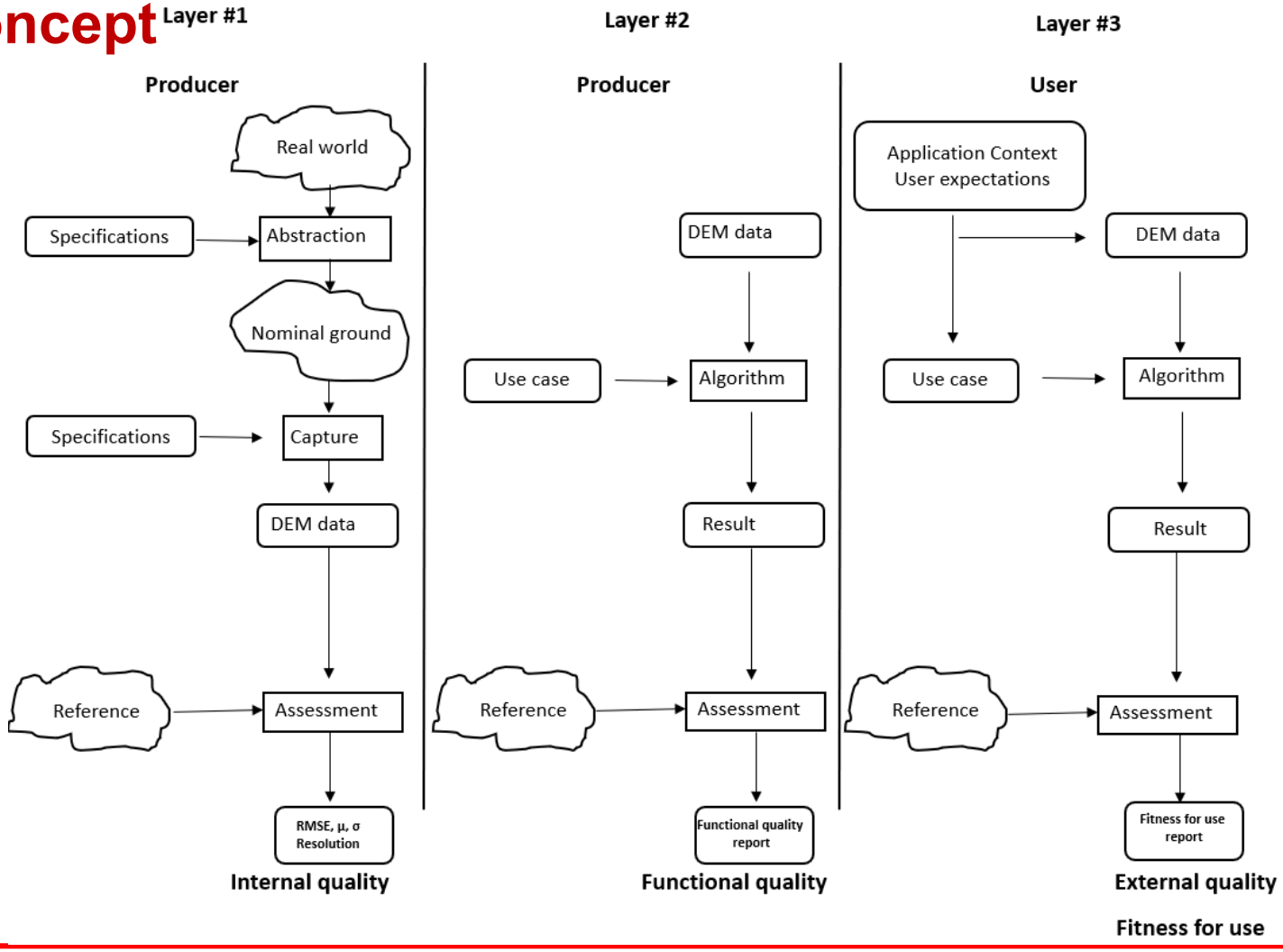
The concept



Internal quality

Data-centric

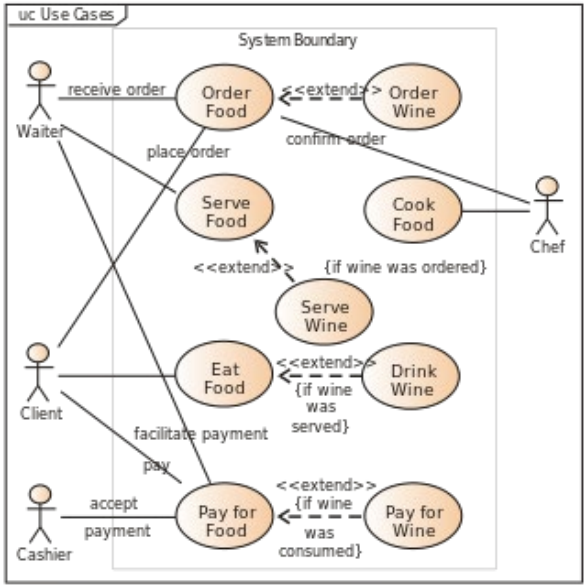
External quality

User-centric

IARIA

What is a use case

- A use case is a methodology used to identify, clarify and organize system requirements.
- A use case is a written description of how users will perform tasks. It outlines, from a user's point of view, a system's behavior as it responds to a request. Each use case is represented as a sequence of simple steps, beginning with a user's goal and ending when that goal is fulfilled.



https://en.wikipedia.org/wiki/Use_case

Use cases and algorithms

- Smith (2005). Presents five use cases: glacial geomorphological mapping, search for blandings, winter snow accumulation, soil erosion estimation and river characterization.
- The RISE project (Brönner, 2007). Includes several use cases related to hydrology but only one elevation use case scenario. In this case, it is focused on the comparison of a real drainage network with a theoretical one.
- Inspire (2013). There is a technical guideline with data specifications on elevation where specific use cases of DEMs appear. These are high level use cases that cover only four specific scopes: two of the use cases are related to hydrological applications (Flood mapping and Maintenance of fairways), while the third use case is the application of elevation data as input for other data production (Orthoimagery production); the last use case (elevation mapping) is focused on the generation of DEMs, so that is not a proper application of DEMs.

Use cases are not a new idea
Linking use cases and algorithms is new

Use cases and algorithms

Table 9 – MR2: Calculations (Q5)

Calculation	%
Height	75.5
Slope	71.6
Aspect	52.9
Drainage delineation	51.0
Contours	48.0
Flow Accumulation	46.1
View-shed analysis	44.1
Catchment Area	36.3
Channel detection	33.3
Curvature	29.4
Indexes (TWI, CTI)	28.4
Concavity & Convexity	26.5
Ridge detection	26.5
Roughness	27.5
Model parameter generation	23.5
Cost analysis	10.8
Hillshade	3.0
Others	11.0

% for each option. Number of respondents = 102, number of responses = 675

DEMs: An Approach to Users and Uses from the Quality Perspective. International Journal of Spatial Data Infrastructures Research Vol 13 (2018)

https://ijsdir.sadl.kuleuven.be/index.php/ijsdir/article/view/469

Example

Use case name	Determination of a hydrographic basin.
Abstract	The user wishes to generate a river basin or set of sub-basins from a DEM data set and a specific algorithm.
Algorithm	{Single flow direction / multiple flow direction / Triangular form-based multiple flow / …}
Use	The result of the processing is a polygonal enclosure(s) that is(are) used to establish areas of interest for further analysis.
Requirements	Fidelity of the results: • 2D Positional accuracy of boundaries. • Accuracy of area estimation. • Level of area overlay. • … • Etc.

Key Performance Indexes (KPIs) from a "fitness for use" perspective

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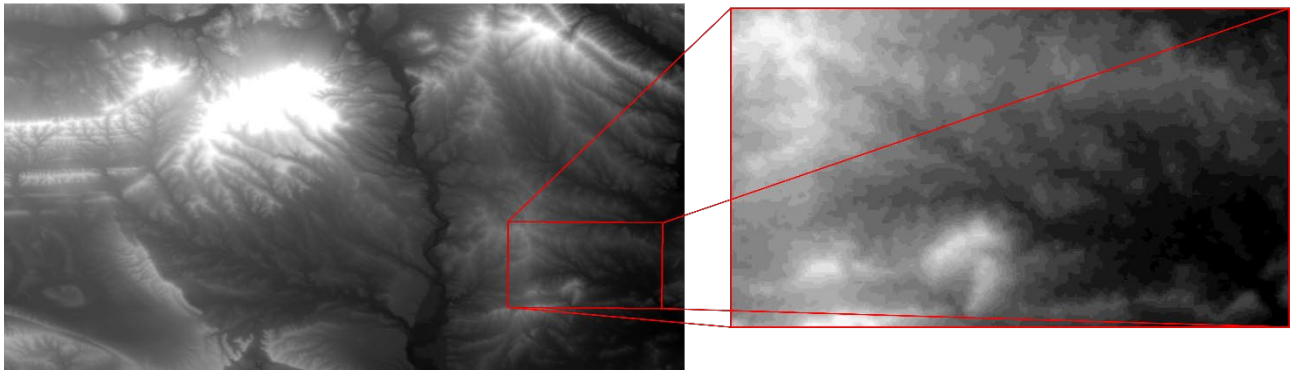
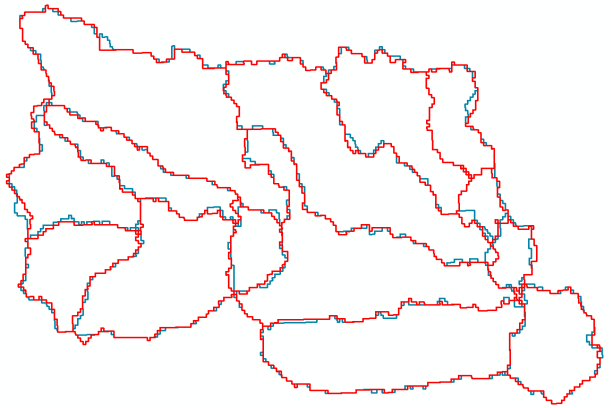
Example



Facts	Measures	Results
2D Positional accuracy of boundaries	Buffer width (95%) (m)	40
Accuracy of area estimation	Bias in the area estimation (ha)	0,099
	Standard deviation (ha)	2,290
Level of area overlay	Mean overlay agreement (%)	95,54
	Standard deviation of the mean overlay agreement (%)	0,033



Future steps

- Consult users to identify as many use cases as possible.

  Please, send your use case suggestions to this email:

  fjariza@ujaen.es

- Consult users to define use cases in the best way.
- Consult users to establish the most appropriate requirements and measures (key performance indexes) for each use case.

  Please, help us in this survey:

  https://docs.google.com/forms/d/1HpXeiSD4-gfKahHOCfWibqWu_7S0N2Z09e5yTstelko

- Analyze the possibility of generating a single index from the suggested measures to evaluate all requirements.

Conclusion

- The main contribution of this work is conceptual: The need of a new level of quality assessment (functional quality) has been justified.
- This new level of evaluation is intermediate between quality, as it is currently understood and materialized by producers, and quality in the sense of “fitness for use”.
- Functional quality links geospatial data with its processes, so it offers a way that is much closer to users and can help producers to be more attentive to user’s needs.
- We request the help of users of DEM data to be able to move forward well oriented to propose this type of quality report.
- In the near future we will continue to develop complete illustrative examples and show the advantages of the use of the functional quality.

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