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Grid Computing Enabled Web Processing Service

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June 16-17, 2008

Agenda

1. OGC Web Processing Service (WPS)
2. Introduction to Grid Computing
3. Grid Computing Enabled WPS
4. Demo Scenario
5. Summary and Outlook

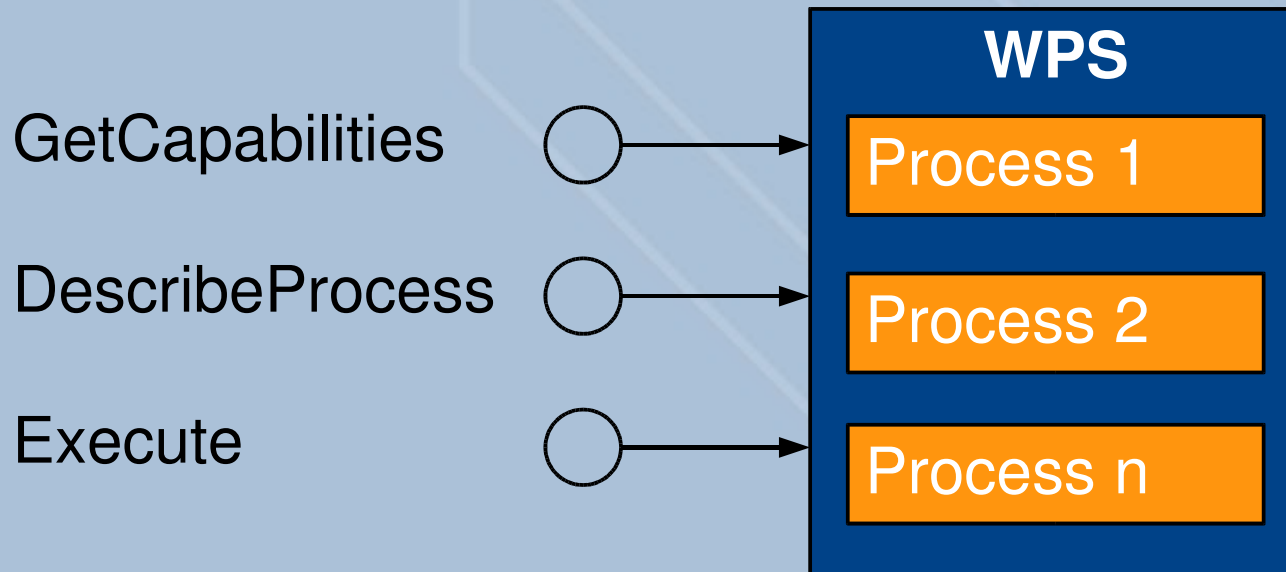
OGC Web Processing Service (WPS)

Introduction

- OGC Standard since late 2007 (Version 1.0.0, OGC 05-007r7)
- A standardized interface to publish and perform geospatial processes over the web

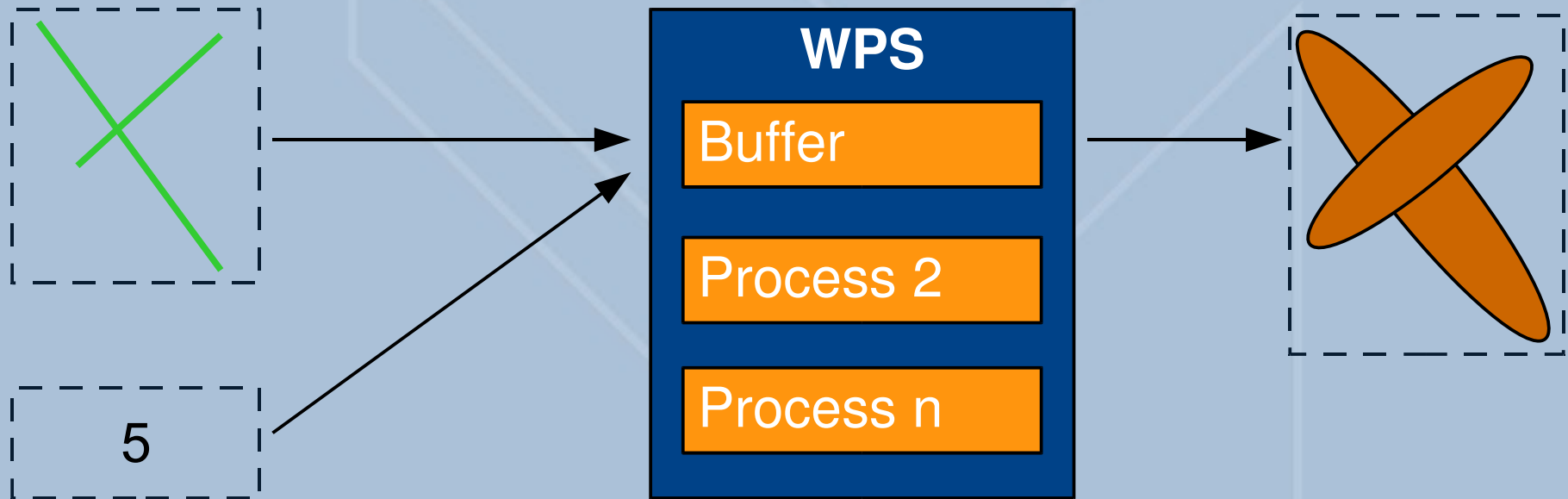
OGC Web Processing Service (WPS)

Operations



OGC Web Processing Service (WPS)

Example



Agenda

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2. Introduction to Grid Computing
3. Grid Computing Enabled WPS
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Introduction to Grid Computing

- Abstract Definition

- A 'Grid' is a network of spatial distributed (computation or data) resources, which is accessible via open and standardized interfaces.
- 3-Point-Checklist of Ian Foster (2002). A GRID is a system that:
 1. coordinates resources that are not subject to a centralized control
 2. using standard, open, general-purpose, protocols and interfaces
 3. delivers nontrivial qualities of service

- Pragmatical Definition

- A group of computers that can be viewed as a single computer
- Solve problems that were normally infeasible to solve due to computing and data-integration restrictions
- Functionality of Grid is offered by Grid-Middleware
 - OpenSource/Community (mostly Linux-based)
 - Globus Toolkit, Unicore, gLite
 - MS Compute Cluster Server (Windows)

Introduction to Grid Computing

- Typical Applications
 - Computational Science
 - Finance Business
 - etc.
- Vision
 - Power Grid as analogy
- Reality
 - Depends on underlying Operating System (OS)
 - Technical Limitations (Data movement, Security, etc.)
- Related Methods and Technologies
 - Cluster Computing
 - Desktop Grid Computing
 - Pervasive Computing
 - Cloud Computing
 - etc.



Agenda

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3. **Grid Computing Enabled WPS**
4. Demo Scenario
5. Summary and Outlook

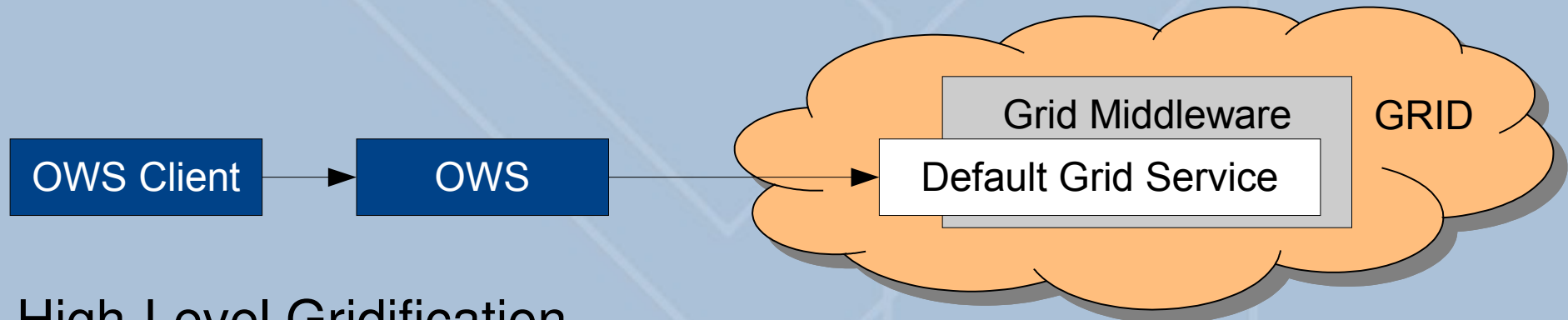
Grid Computing Enabled WPS

Gridification

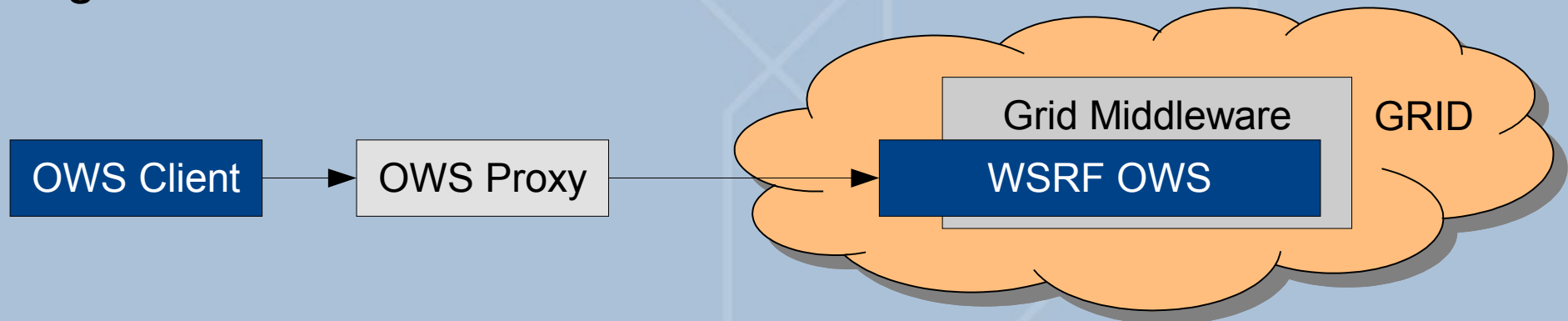
The term 'Gridification' means the adaption of existing applications and services to a grid environment.

Two kinds of Gridification of OGC Web Services (OWS)

- Low-Level Gridification



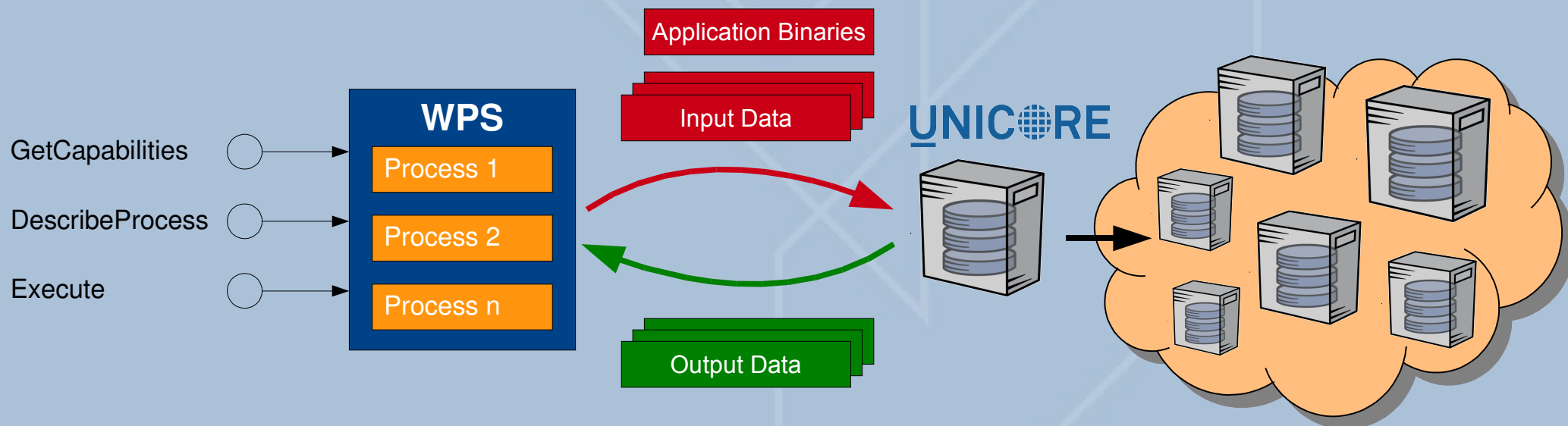
- High-Level Gridification



Grid Computing Enabled WPS

Architecture of Low-Level Gridified WPS

1. Divide problem into smaller sub-problems
2. Copy application binaries to grid nodes (moving code)
3. Copy input data to grid nodes (moving data)
4. Start parallel computation of sub-problems
5. Fetch and merge output data



Grid Computing Enabled WPS

Algorithm Development in 52° North WPS-G

1. Implement IGridAlgorithm Interface

```
package org.n52.wps.grid;

import java.util.List;

public interface IGridAlgorithm
{
    /* run algorithm */
    ProcessOutput run(ProcessInput pInput);

    /* divide input data into n chunks */
    List<ProcessInput> divide(ProcessInput pInput, int pCount);

    /* merge the n results of distributed processes */
    ProcessOutput merge(List<ProcessOutput> pOutput);
}
```

Grid Computing Enabled WPS

Algorithm Development in 52° North WPS-G

2. Create Process Description File

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:ProcessDescriptions version="1.0.0">
  <ProcessDescription wps:processVersion="2" statusSupported="true" storeSupported="true">
    <ows:Identifier>org.n52.wps.grid.algorithm.SimpleBufferAlgorithm</ows:Identifier>
    <ows:Title>Simple Buffer</ows:Title>
    <ows:Abstract>Create a buffer around a single polygon.</ows:Abstract>
    <DataInputs>
      <Input minOccurs="1" maxOccurs="1">
        <ows:Identifier>polygon</ows:Identifier>
        <ows:Title>Polygon to be buffered</ows:Title>
        <ows:Abstract>The Geometries to buffer</ows:Abstract>
        <ComplexData>
          <Default>
            <Format>
              <MimeType>text/XML</MimeType>
            </Format>
          </Default>
        </ComplexData>
      </Input>
    </DataInputs>
  </ProcessDescription>
</wps:ProcessDescriptions>
```

Grid Computing Enabled WPS

Algorithm Development in 52° North WPS-G

3. Create Application Description File

```
<?xml version="1.0" encoding="UTF-8"?>
<application>
  <app_name>org.n52.wps.grid.algorithm.SimpleBuffer</app_name>
  <version_num>1.0</version_num>
  <file_ref>
    <file_name>52n-wps-grid-1.0.0.jar</file_name>
  </file_ref>
  <file_ref>
    <file_name>52n-wps-server-1.0.0.jar</file_name>
  </file_ref>
  <file_ref>
    <file_name>gmlpacket-2.0-0.4.jar</file_name>
  </file_ref>
  (...)
</application>
```

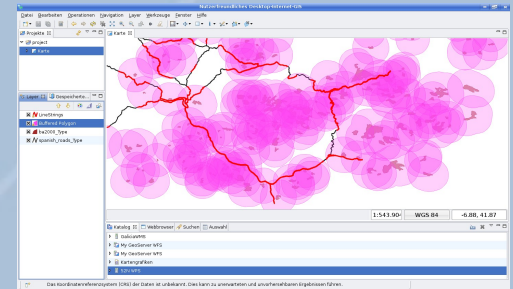
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Demo Scenario

Generate a readable map which indicates the impact of recent fire threats to a transport infrastructure. *

1. Import data of burnt areas (WFS)
2. Import data of spanish roads (WFS)
3. Create buffers around burnt areas (local calculation)
4. Intersect buffers with road data (distributed calculation) **

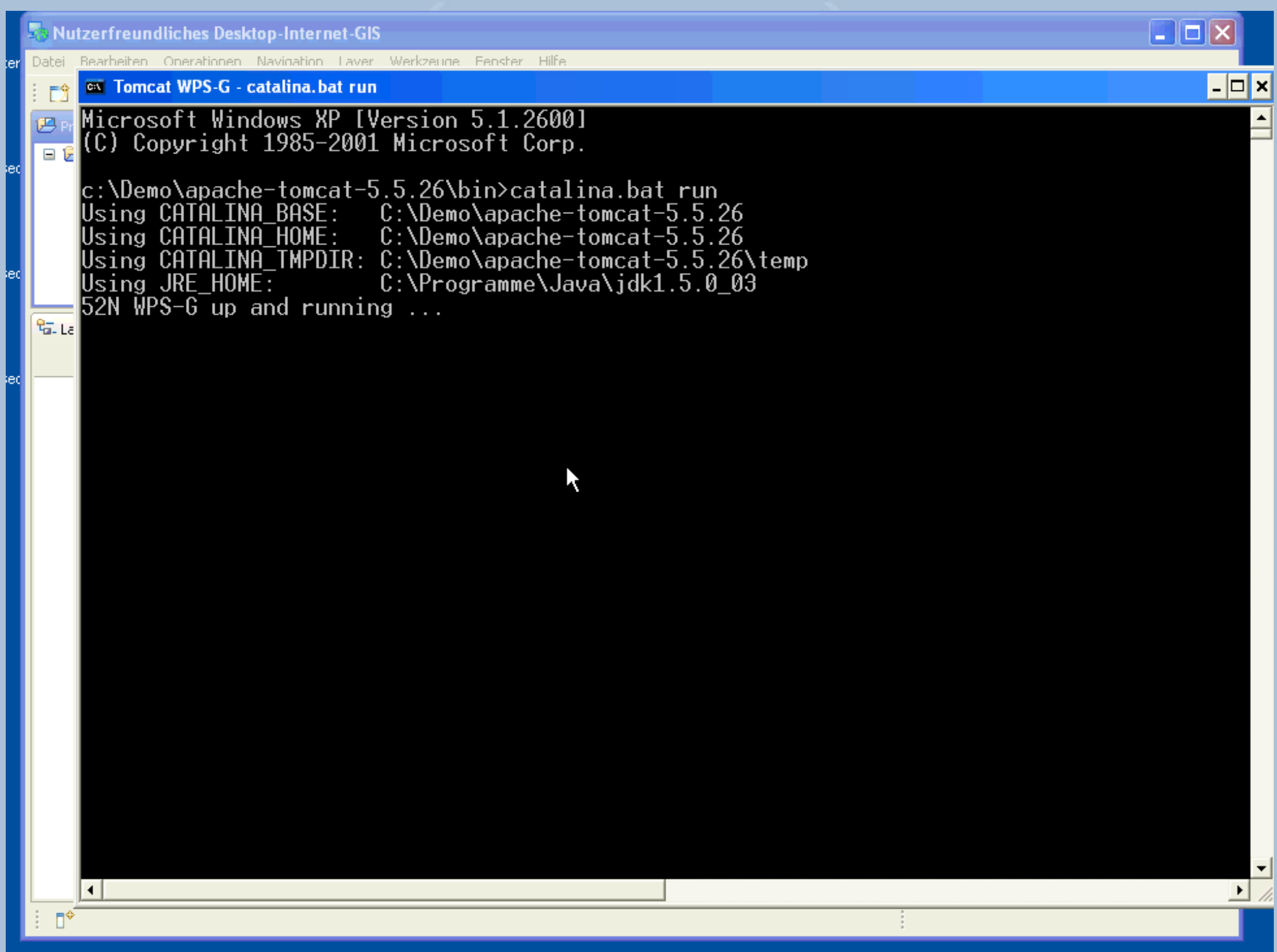


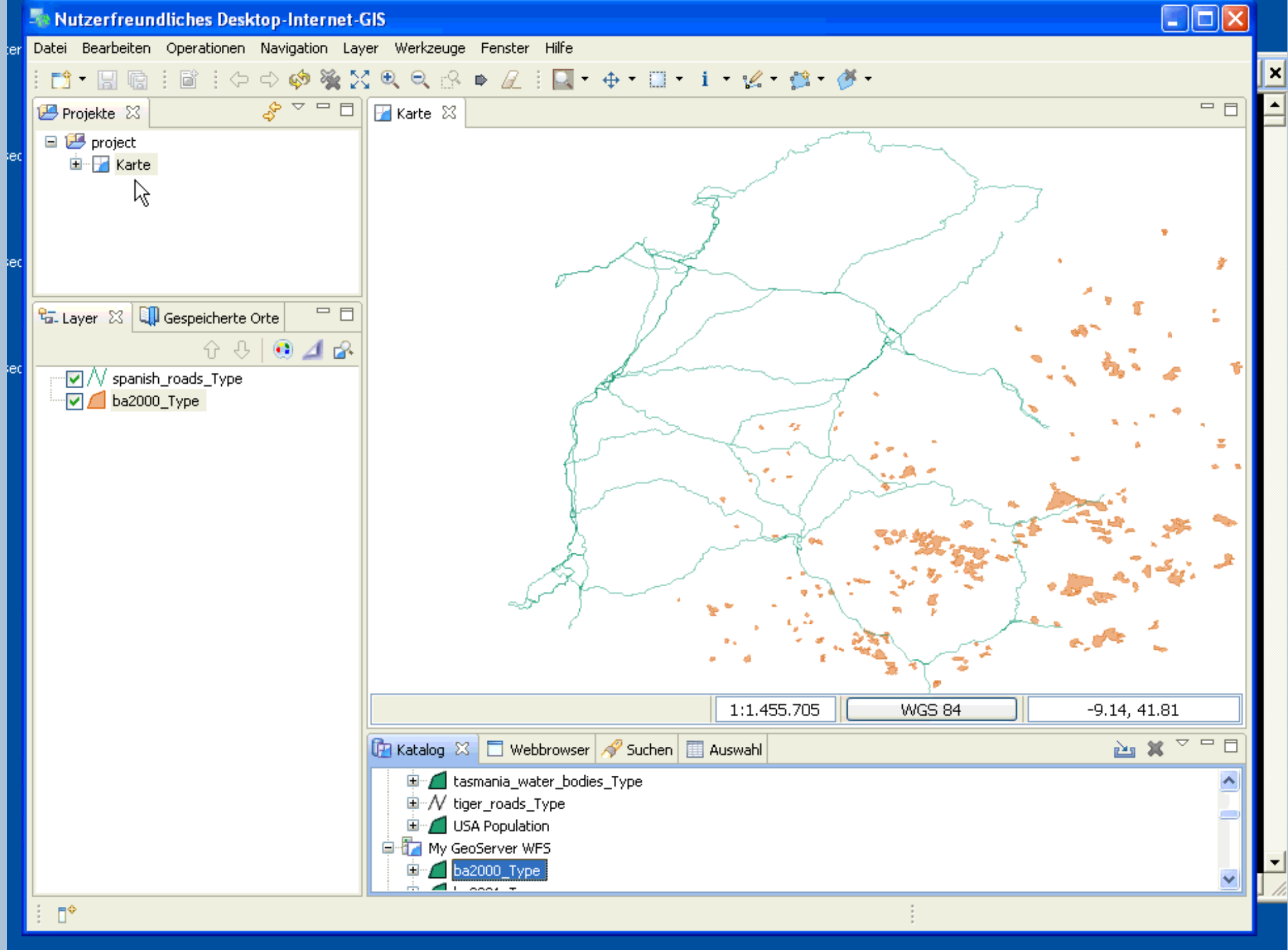
A screencast of this demo could be found at

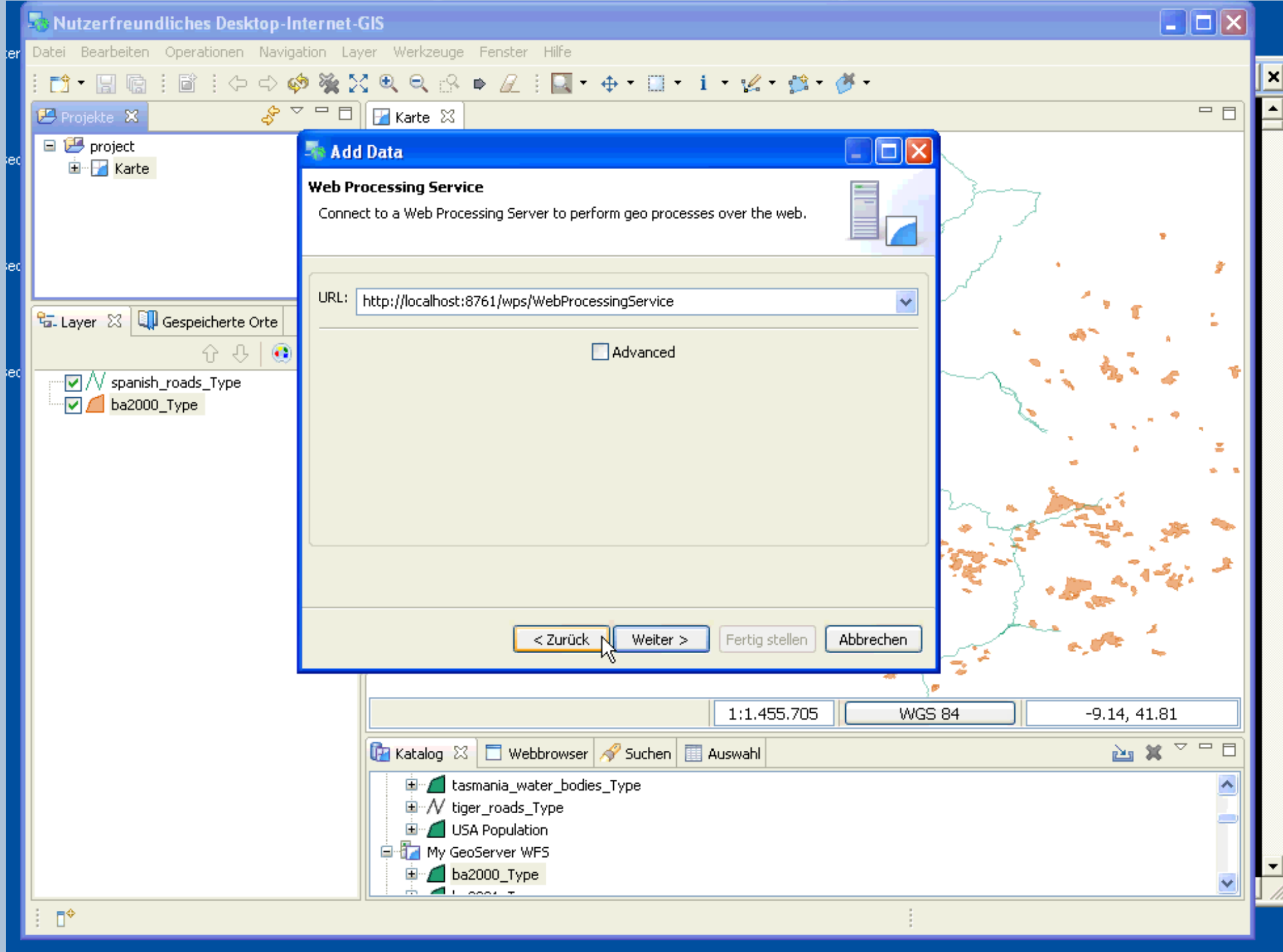
<http://www.unicore.eu/community/development/WPS-G/index.php>

* The chosen location is the North-West of Spain.

** Using the public available Unicore 6 Testgrid at Research Centre Jülich. The Testgrid should only be used for testing purposes. For more information have a look at <http://www.unicore.eu/testgrid>.







Nutzerfreundliches Desktop-Internet-GIS

Datei Bearbeiten Operationen Navigation Layer Werkzeuge Fenster Hilfe

Projekte Karte

project
Karte

Layer Gespeicherte Orte

spanish_roads_Type
ba2000_Type

Add Data

Web Processing Service

Select a Process

Choose Simple Buffer Algorithm

org.n52.wps.server.algorithm.SimpleBufferAlgorithm
org.n52.wps.grid.algorithm.SimpleBufferAlgorithm_GRID
org.n52.wps.server.algorithm.simplif.NDouglasPeuckerAlgorithm
org.n52.wps.grid.algorithm.IntersectionAlgorithm_GRID
org.n52.wps.server.algorithm.IntersectionAlgorithm

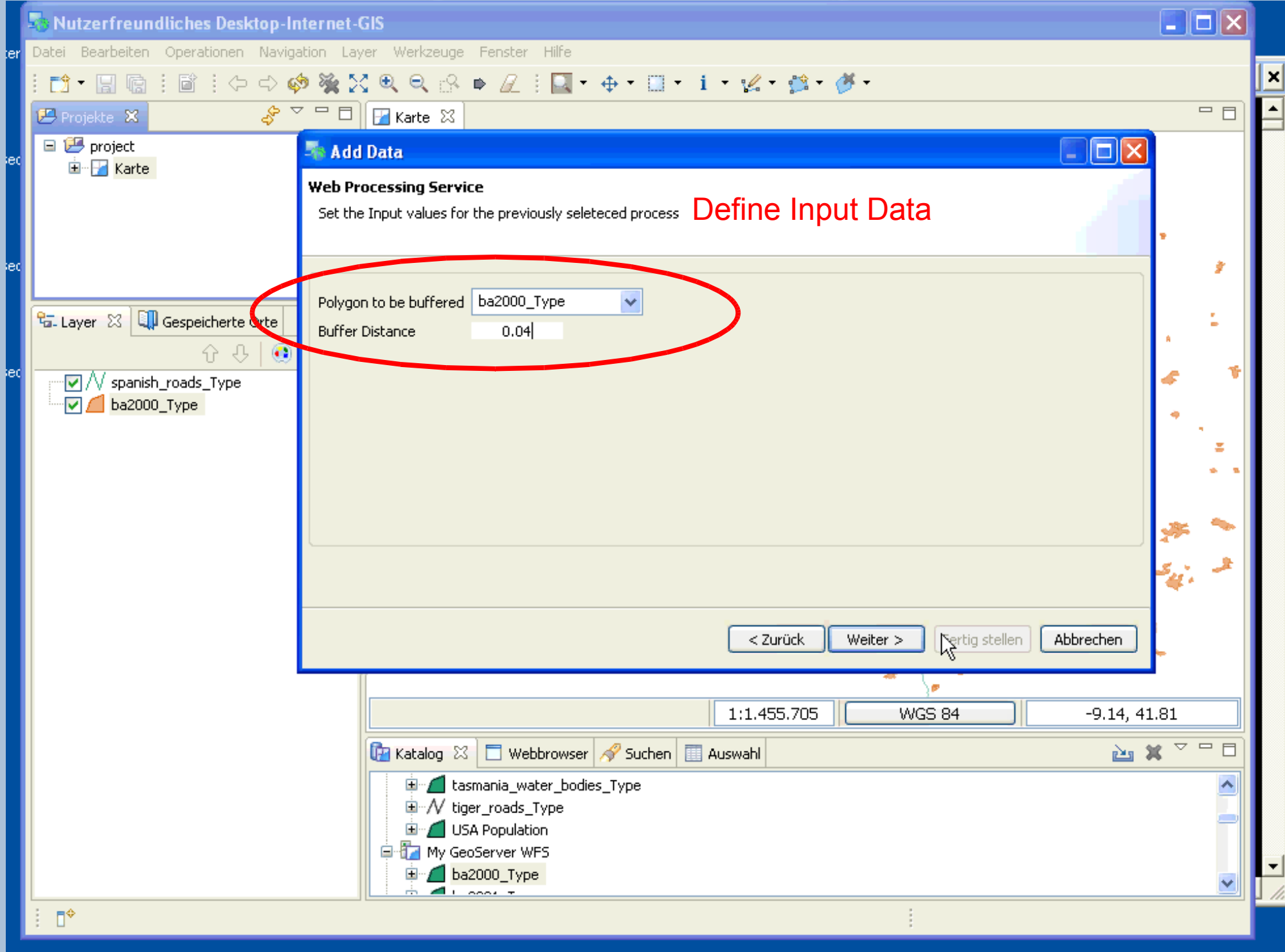
```
<xml-fragment statusSupported="true" storeSupported="tru
<ows:Identifier>org.n52.wps.server.algorithm.SimpleBuffer
<ows:Title>Create a buffer around a polygon. </ows:Title>
<ows:Abstract>Create a buffer around a single polygon. Ac
<ows:Metadata xlink:title="spatial"/>
<ows:Metadata xlink:title="geometry"/>
<ows:Metadata xlink:title="buffer"/>
<ows:Metadata xlink:title="GML"/>
<DataInputs>
<Input maxOccurs="1" minOccurs="1">
<ows:Identifier>data</ows:Identifier>
<ows:Title>Polygon to be buffered</ows:Title>
<ows:Abstract>The Geometries to buffer</ows:Abstract>
<ComplexData>
</ComplexData>
</Input>
</DataInputs>
</ows:Process>
```

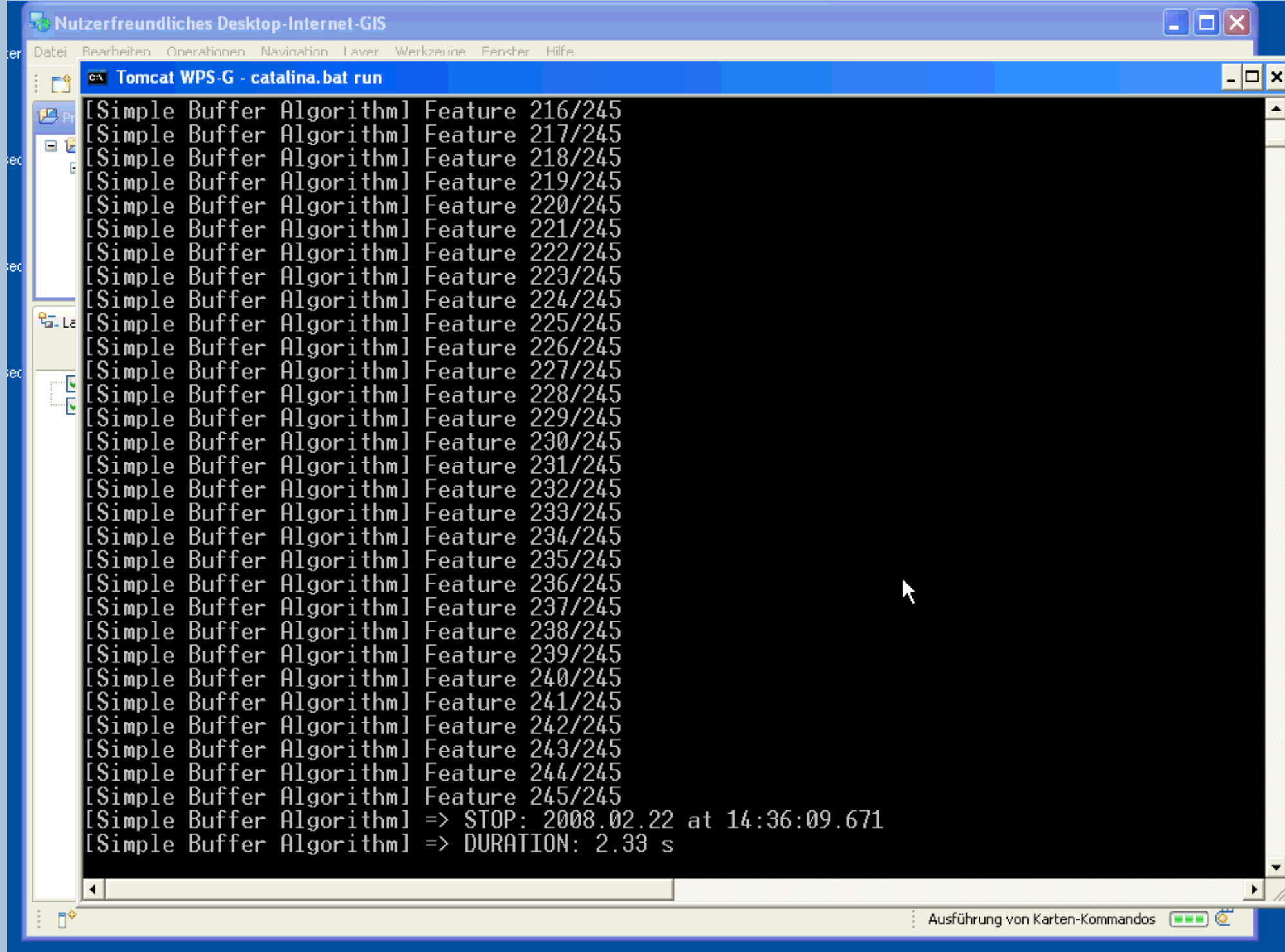
< Zurück Weit > Fertig stellen Abbrechen

1:1.455.705 WGS 84 -9.14, 41.81

Katalog Webbrowser Suchen Auswahl

tasmania_water_bodies_Type
tiger_roads_Type
USA Population
My GeoServer WFS
ba2000_Type





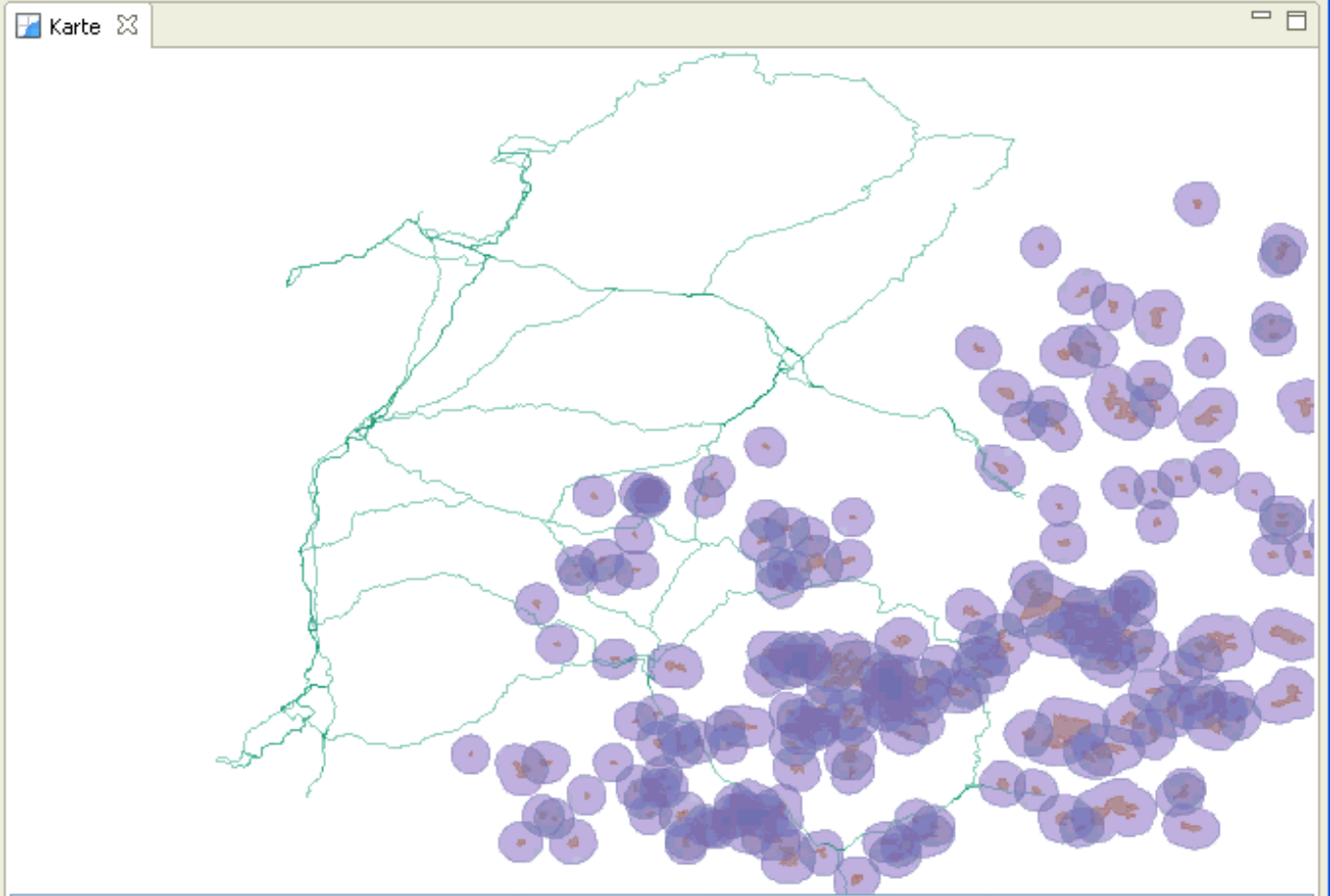


Projekte

- project
 - Karte

Layer | Gespeicherte Orte

- Buffered Polygon
- spanish_roads_Type
- ba2000_Type

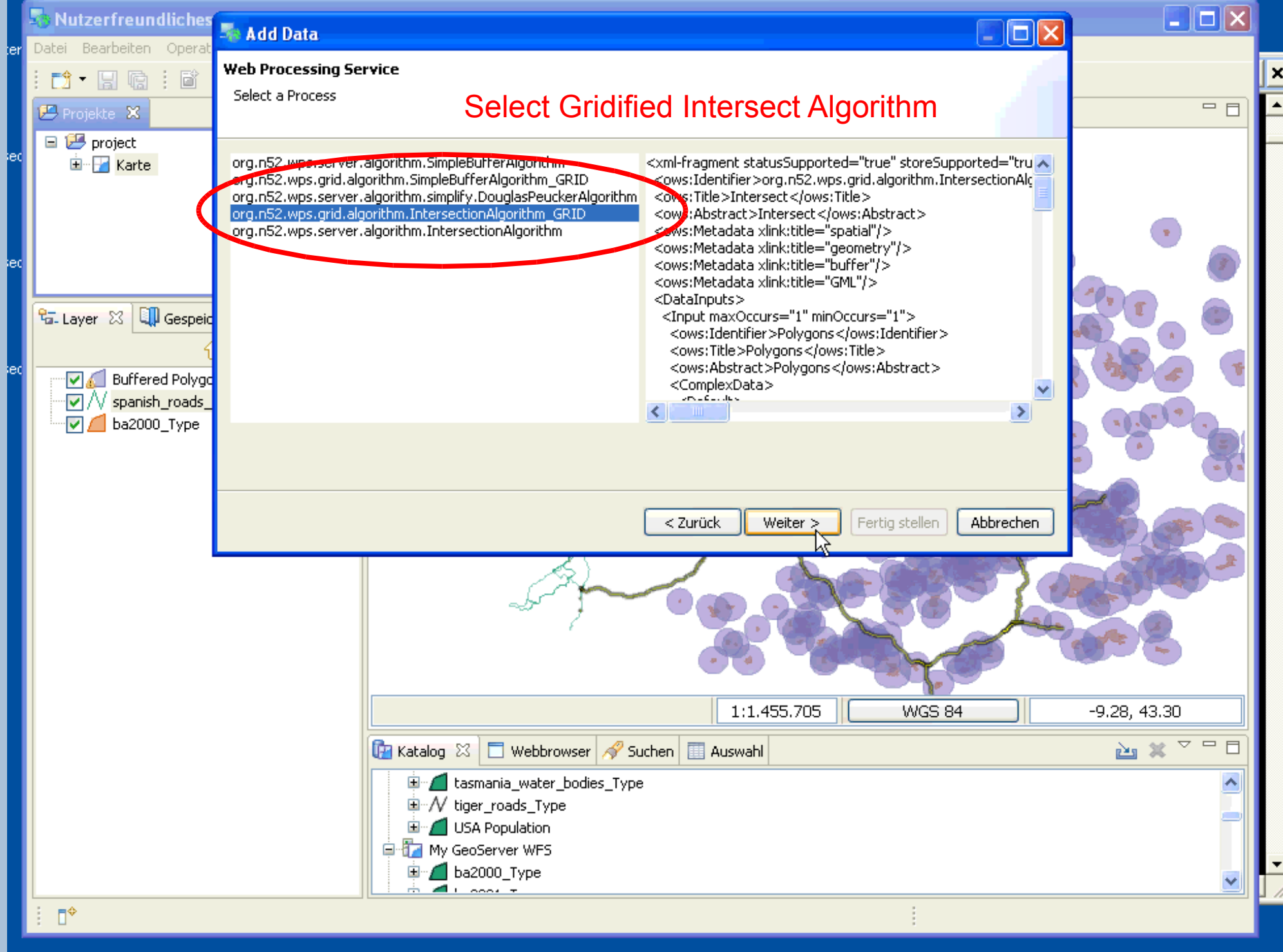


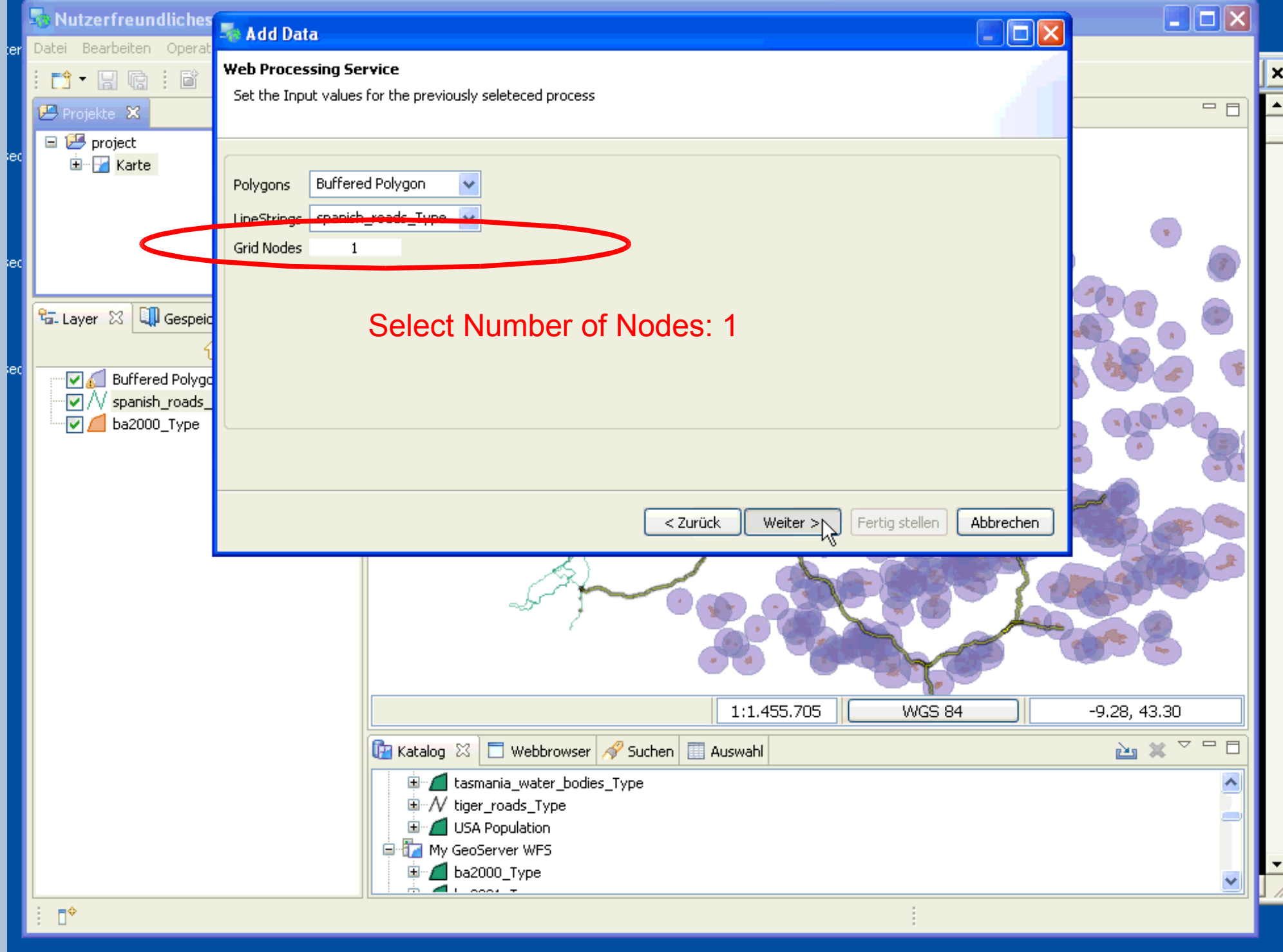
1:1.455.705 | WGS 84 | -9.33, 42.56

Katalog | Webbrowser | Suchen | Auswahl

- tasmania_water_bodies_Type
- tiger_roads_Type
- USA Population
- My GeoServer WFS
 - ba2000_Type

Das Koordinatenreferenzsystem (CRS) der Daten ist unbe... unerwarteten und unvorhersehbaren Ergebnissen führen.





Select Number of Nodes: 1

Tomcat WPS-G - catalina.bat run

```
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] found target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Sit
[UNICORE] create target system service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Si
[UNICORE] select storage management service at 'https://omiiei.zam.kfa-juelich.de:6000/Bra
[UNICORE] latest version of application file '52n-wps-grid-1.0-SNAPSHOT.jar' (1/13) [54339
[UNICORE] latest version of application file '52n-wps-io-1.0-SNAPSHOT.jar' (2/13) [38791 b
[UNICORE] latest version of application file '52n-wps-server-1.0-SNAPSHOT.jar' (3/13) [110
[UNICORE] latest version of application file '52n-wps-xml-1.0.0.jar' (4/13) [968558 bytel
[UNICORE] latest version of application file 'geoapi-nogenerics-2.1-M2.jar' (5/13) [333199
[UNICORE] latest version of application file 'gmlpacket-2.0-0.4.jar' (6/13) [552143 bytel
[UNICORE] latest version of application file 'gt2-api-2.3.1.jar' (7/13) [95313 bytel] alrea
[UNICORE] latest version of application file 'gt2-main-2.3.1.jar' (8/13) [1695366 bytel] al
[UNICORE] latest version of application file 'gt2-referencing-2.3.1-SNAPSHOT.jar' (9/13) [
[UNICORE] latest version of application file 'jts-1.8.jar' (10/13) [483862 bytel] already o
[UNICORE] latest version of application file 'log4j-1.2.14.jar' (11/13) [367444 bytel] alre
[UNICORE] latest version of application file 'stax-api-1.0.jar' (12/13) [25863 bytel] alrea
[UNICORE] latest version of application file 'xbean-2.2.0.jar' (13/13) [2664574 bytel] alre
[WPS-G] split 579 features into 1 chunk(s) with each 579 features
[JOB 1] create job definition document
[JOB 1] create job at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Site/services/JobManag
[JOB 1] submit input data [556883 bytel]
[JOB 1] submit job execution script
[JOB 1] => START: 2008.02.22 at 14:37:15.937
[JOB 1] => STOP: 2008.02.22 at 14:37:55.765
[JOB 1] => DURATION: 39.83 s
[JOB 1] fetch job output data
[WPS-G] concatenate 1 chunk(s)
```

Calculation Time: 39.82 s

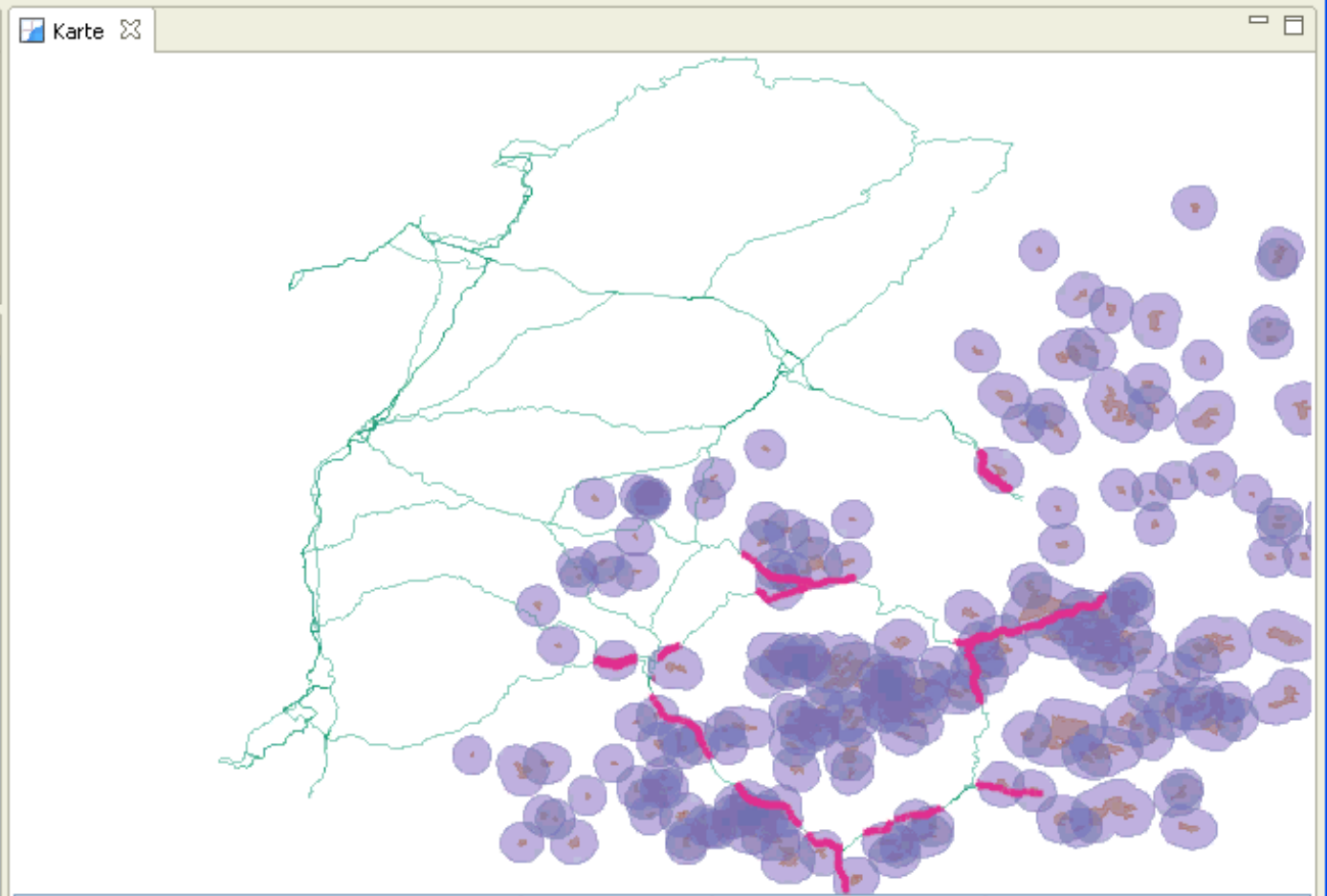


Projekte

- project
 - Karte

Layer Gespeicherte Orte

- LineStrings
- Buffered Polygon
- spanish_roads_Type
- ba2000_Type

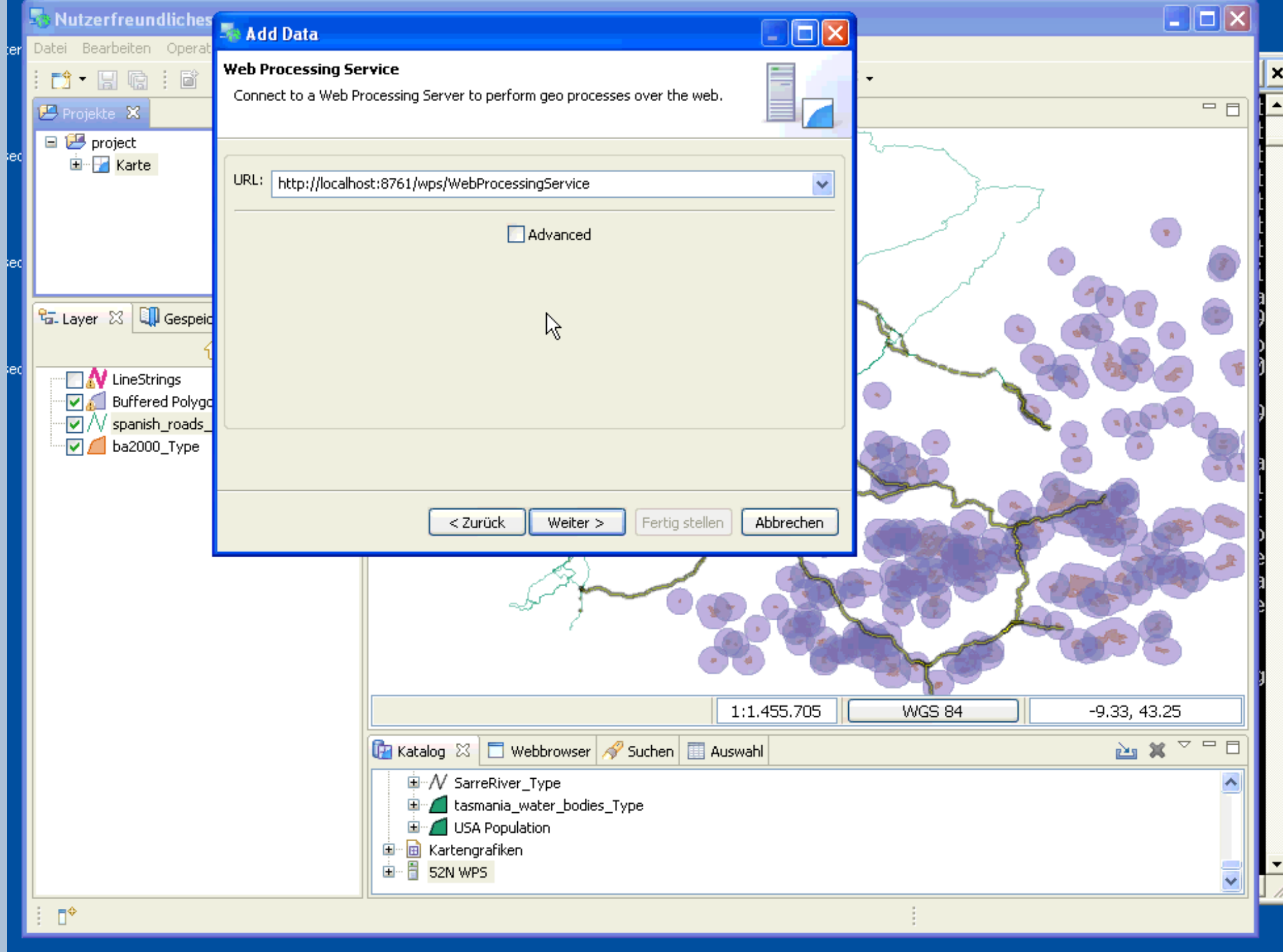


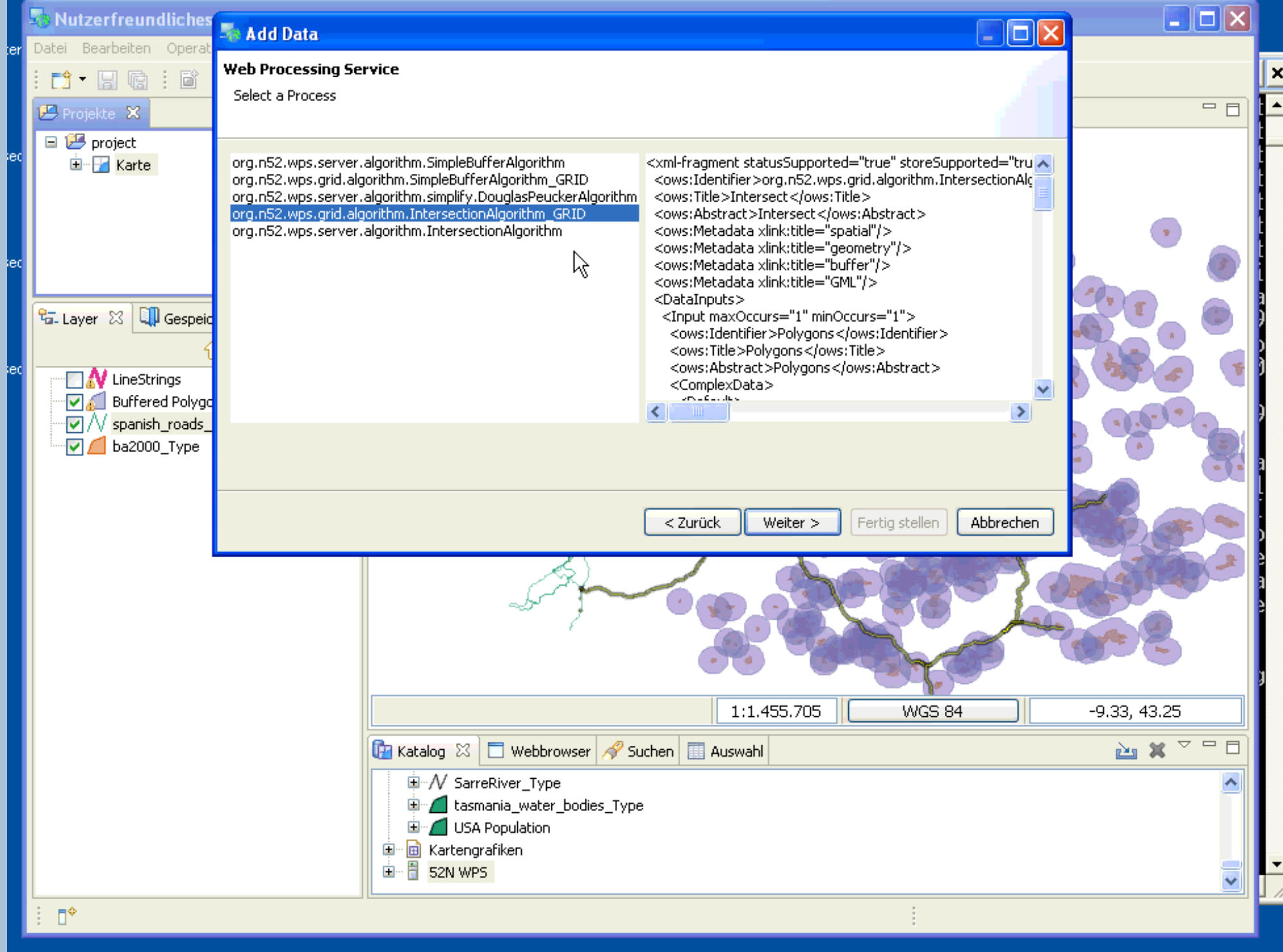
1:1.455.705 WGS 84 -9.31, 42.78

Katalog Webbrowsers Suchen Auswahl

- SarreRiver_Type
- tasmania_water_bodies_Type
- USA Population
- Kartengrafiken
- 52N WPS

Das Koordinatenreferenzsystem (CRS) der Daten ist unbe... unerwarteten und unvorhersehbaren Ergebnissen führen.





Add Data

Web Processing Service

Set the Input values for the previously selected process

Polygons Buffered Polygon

LineStrings spanish_roads_Type

Grid Nodes 2

Select Number of Nodes: 2

< Zurück Weiter Fertig stellen Abbrechen

1:1.455.705 WGS 84 -9.33, 43.25

Katalog Webbrowser Suchen Auswahl

- SarreRiver_Type
- tasmania_water_bodies_Type
- USA Population
- Kartengrafiken
- 52N WPS

Nutzerfreundliches Desktop-Internet-GIS

Tomcat WPS-G - catalina.bat run

```
[UNICORE] select storage management service at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Site/services/JobManagement'
[UNICORE] latest version of application file '52n-wps-grid-1.0-SNAPSHOT.jar' (1/13) [54339 bytes]
[UNICORE] latest version of application file '52n-wps-io-1.0-SNAPSHOT.jar' (2/13) [38791 bytes]
[UNICORE] latest version of application file '52n-wps-server-1.0-SNAPSHOT.jar' (3/13) [110339 bytes]
[UNICORE] latest version of application file '52n-wps-xml-1.0.0.jar' (4/13) [968558 bytes]
[UNICORE] latest version of application file 'geoapi-nogenerics-2.1-M2.jar' (5/13) [333199 bytes]
[UNICORE] latest version of application file 'gmlpacket-2.0-0.4.jar' (6/13) [552143 bytes]
[UNICORE] latest version of application file 'gt2-api-2.3.1.jar' (7/13) [95313 bytes] already exists
[UNICORE] latest version of application file 'gt2-main-2.3.1.jar' (8/13) [1695366 bytes] already exists
[UNICORE] latest version of application file 'gt2-referencing-2.3.1-SNAPSHOT.jar' (9/13) [110339 bytes]
[UNICORE] latest version of application file 'jts-1.8.jar' (10/13) [483862 bytes] already exists
[UNICORE] latest version of application file 'log4j-1.2.14.jar' (11/13) [367444 bytes] already exists
[UNICORE] latest version of application file 'stax-api-1.0.jar' (12/13) [25863 bytes] already exists
[UNICORE] latest version of application file 'xbean-2.2.0.jar' (13/13) [2664574 bytes] already exists
[WPS-G] split 579 features into 2 chunk(s) with each 289 features
[JOB 1] create job definition document
[JOB 2] create job definition document
[JOB 1] create job at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Site/services/JobManagement'
[JOB 2] create job at 'https://omiiei.zam.kfa-juelich.de:6000/Bravo-Site/services/JobManagement'
[JOB 1] submit input data [544037 bytes]
[JOB 2] submit input data [533592 bytes]
[JOB 1] submit job execution script
[JOB 2] submit job execution script
[JOB 1] => START: 2008.02.22 at 14:39:35.000
[JOB 2] => START: 2008.02.22 at 14:39:36.218
[JOB 2] => STOP: 2008.02.22 at 14:39:57.437
[JOB 2] => DURATION: 21.22 s
[JOB 1] => STOP: 2008.02.22 at 14:39:58.187
[JOB 1] => DURATION: 23.19 s
[JOB 2] fetch job output data
[JOB 1] fetch job output data
[WPS-G] concatenate 2 chunk(s)
```

Calculation Time: 23.19 s
Previously: 39.82 s

Renderere Karte

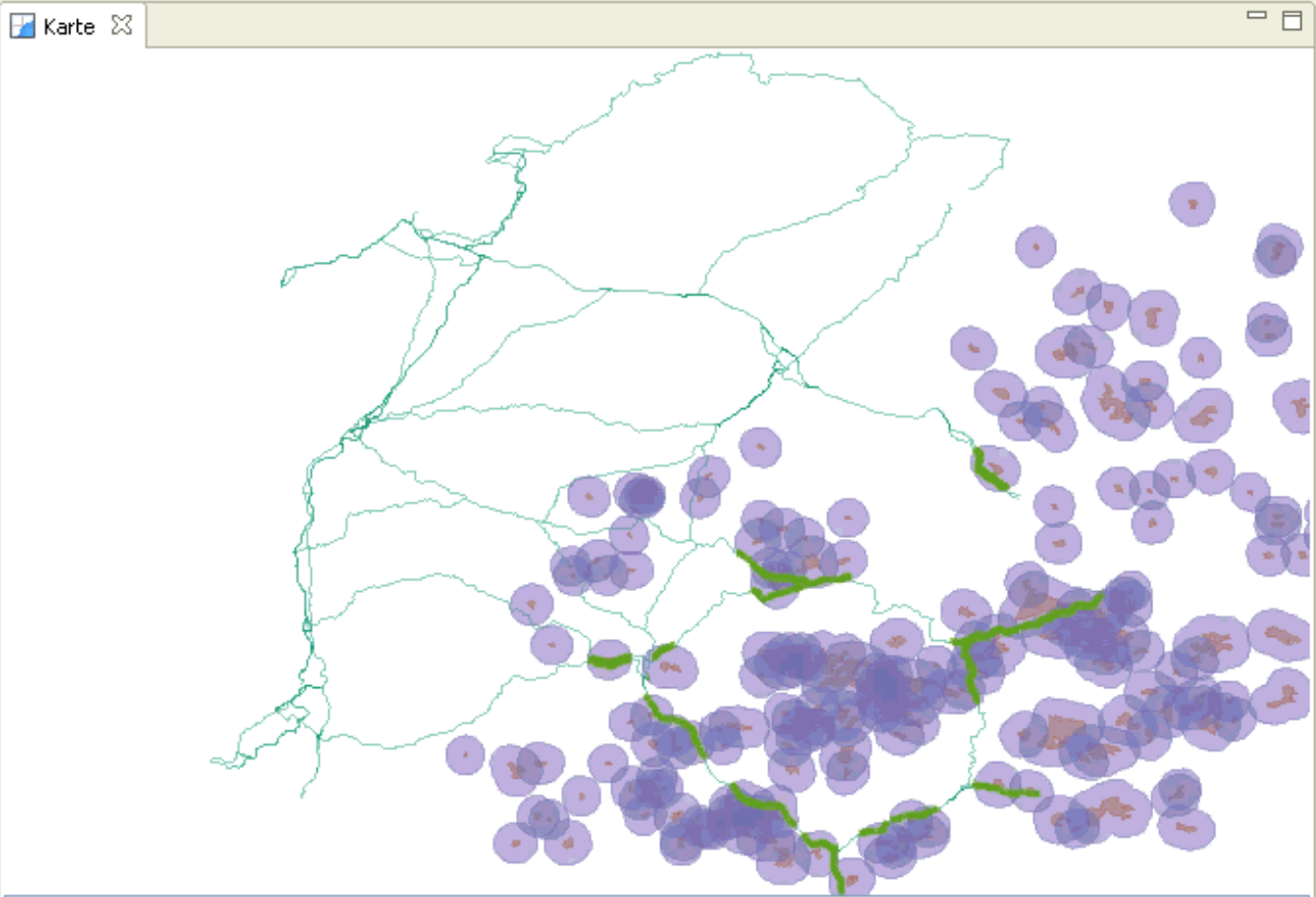


Projekte

- project
 - Karte

Layer Gespeicherte Orte

- LineStrings
- LineStrings
- Buffered Polygon
- spanish_roads_Type
- ba2000_Type



1:1.455.705 WGS 84 -9.30, 42.44

Katalog Webbrowser Suchen Auswahl

- SarreRiver_Type
- tasmania_water_bodies_Type
- USA Population
- Kartengrafiken
- 52N WPS

Das Koordinatenreferenzsystem (CRS) der Daten ist unbe... unerwarteten und unvorhersehbaren Ergebnissen führen.

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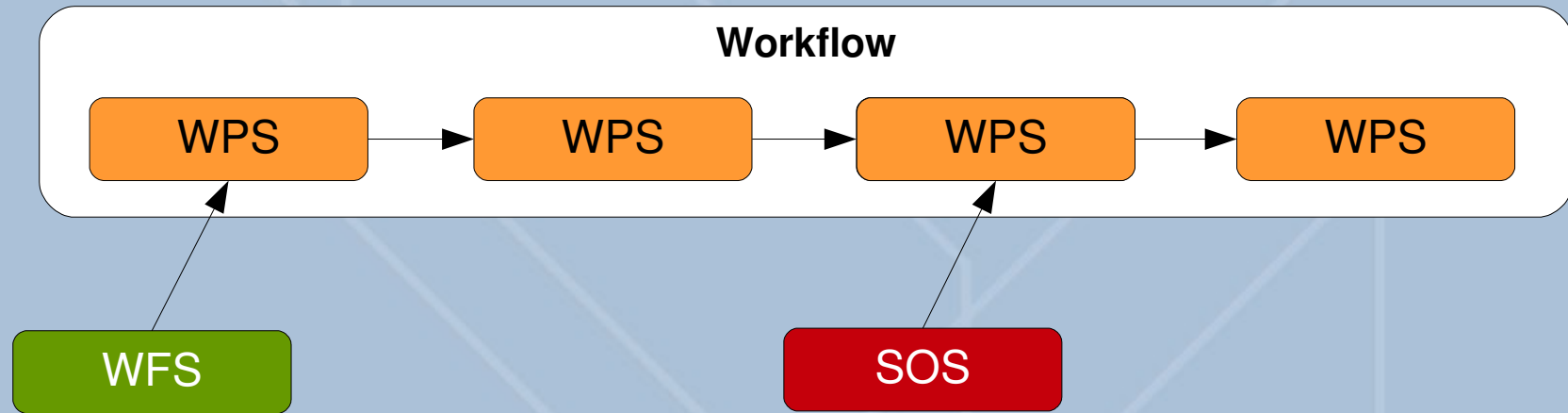
Summary and Outlook

52° North WPS-G

- Proof-of-concept implementation of grid-enabled WPS
- Connection to other grid-middlewares could easily be done
- (+) Grid Computing is a good choice to achieve high performance
- (+) Grid Computing is a good choice for outsourcing calculations
- (-) Moving Code
- (-) Moving Data

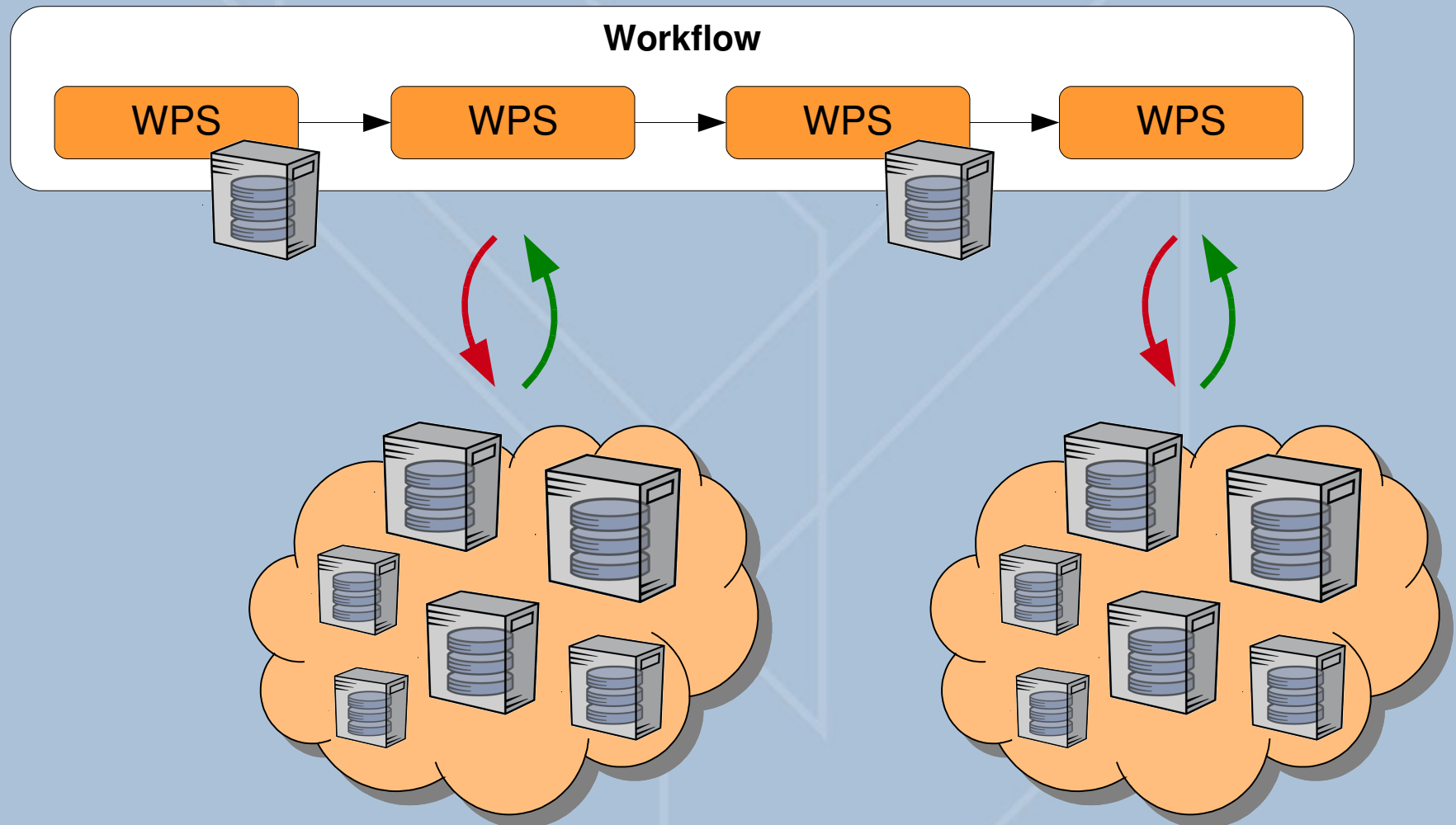
Summary and Outlook

Orchestration of WPS



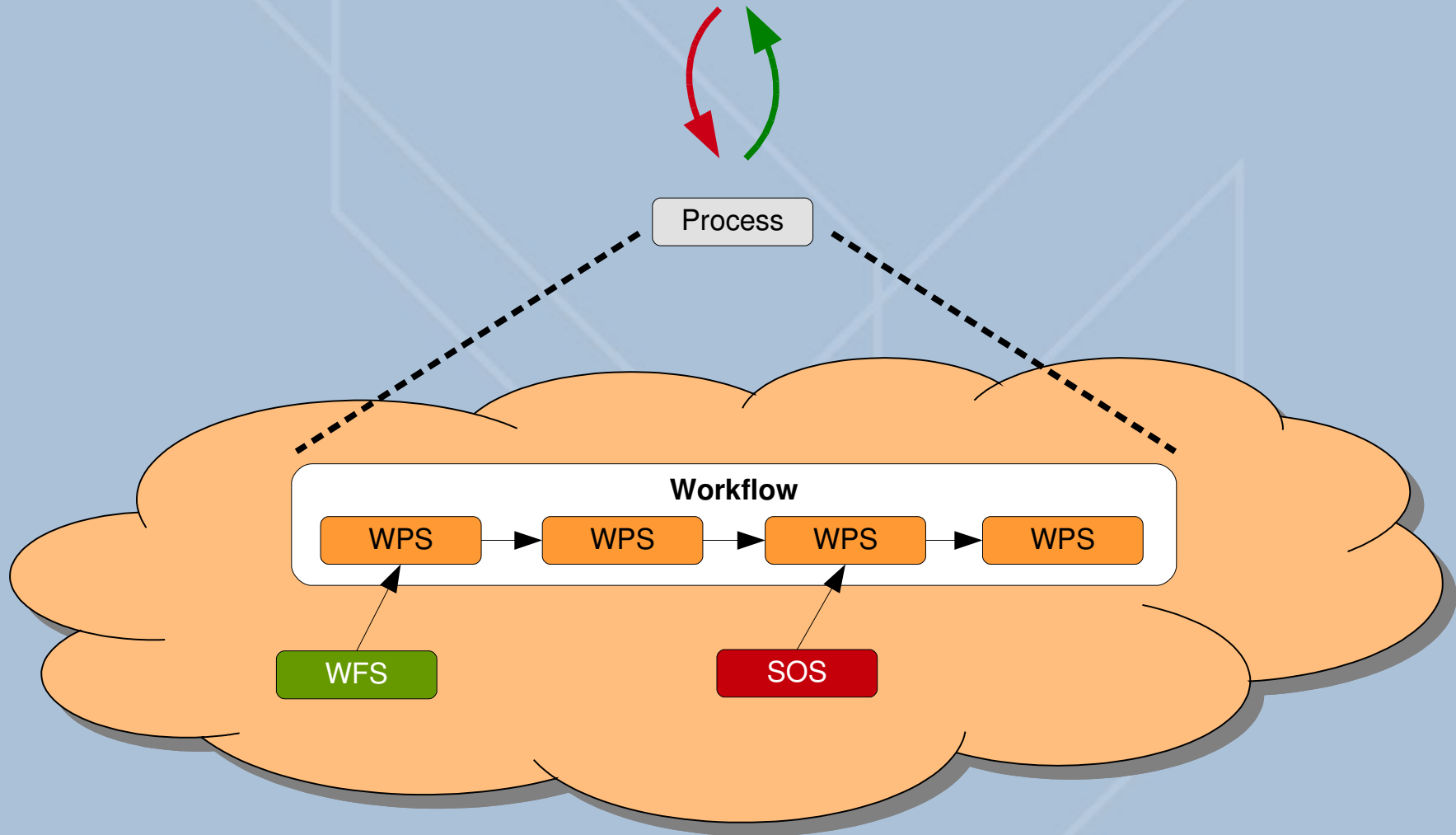
Summary and Outlook

Orchestration of Low-Level Gridified WPS



Summary and Outlook

Orchestration of High-Level Gridified WPS





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Institut für Geoinformatik
Universität Münster

Suggestions?

Questions?

Thank you for attention!

Bastian Baranski, University of Münster

Bastian.Baranski@uni-muenster.de

Discussion!