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cloud infrastructure

D3.4.3: Data Fusion Tools

Deliverable Lead: NETCAD

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Note

This deliverable is subject to final acceptance by the European Commission.

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Glossary

The glossary of terms used in this deliverable can be found in the public document “FOODIE_Glossary.pdf” available at: <http://www.foodie-project.eu>

Abbreviations and Acronyms

Abbreviation / Acronym	Description
API	Application Programming Interface
OGC	The Open Geospatial Consortium
WPS	Web Processing Service
GIS	Geographic Information System
REST	Representational State Transfer
SWG	The Standards Working Group
WCF	Windows Communication Foundation
WMS	Web Map Service
WFS	Web Feature Service
WFC	Web Feature Collection
WMTS	Web Map Tile Service
KML	Keyhole Markup Language
CAD	Computer-Aided Design
RS	Remote Sensing
NCC	Netcad Command
m-AHP	Modified Analytic Hierarchy Process

Table 1: Abbreviations and Acronyms

Executive Summary

This document introduces the third and final prototype of the data fusion tools, explaining the implementation architecture and capabilities in development.

Service overview

Data fusion tools combine data from different heterogeneous sources together to provide more efficient representation of data.

Data fusion tools aim to associate textual and/or spatial data in different structures from different sources in terms of geometry. Additionally process of data from multiple image sources is achieved by Data fusion services.

Implementation

OGC WPS

Data fusion capabilities are served by an OGC WPS standard [1] implementation. WPS implementation is updated for compliance with OGC WPS 2.0 standard [2]. Asynchronous processing ability is implemented based on OGC WPS 2.0 standards.

Data fusion WPS provides:

- Listing available data fusion processes.
- Getting detailed information about data fusion processes, including detailed description of inputs and outputs.
- Running data fusion processes
- Status information of running processes.

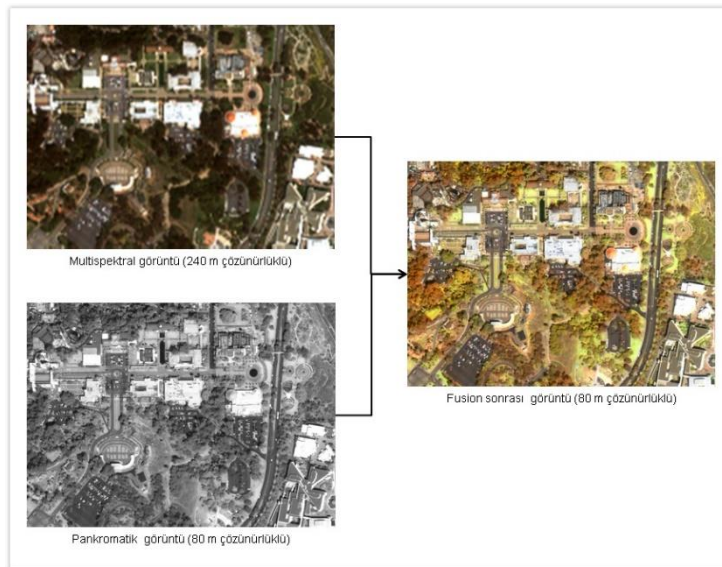
Data fusion WPS is enhanced to work with

Geoprocessing Service: Since FOODIE APIs are determined to be developed in RESTful Paradigm [4], related open standards has been studied. Although Restful API implementations are not yet standardized by OGC, implementation is based on documentation provided by GeoServices REST SWG. This service is designed as a wrapper service which is integrated to the WPS implemented before.

Architecture

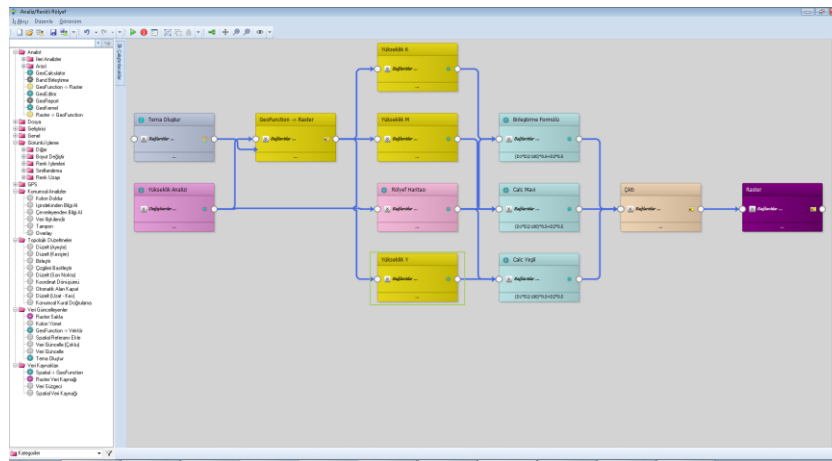
Netcad WPS implementation is built using several NETCAD [3] suite applications as building blocks:

- **Geoprocessing Service:** Geoprocessing Service is a web service implemented for FOODIE on WCF technology. Geoprocessing service is integrated with WPS implementation and runs on the same web server.
- **Netcad GIS:** Netcad GIS is an advanced desktop application designed to be used by Engineering and GIS users especially working with maps.
- **Netcad Analysis Module:** Netcad Analysis module is the Netcad application in which basic and advanced surface analyses, raster (image) analyses, basic and advanced spatial analyses can be performed. GIS, CAD, RS analyses are performed together interactively.



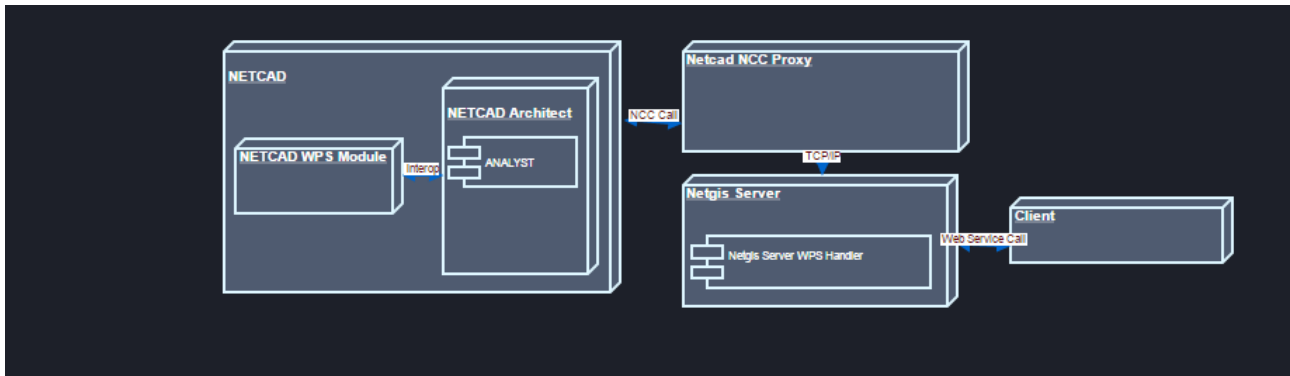
1-Analysis of multiple image sources

- **Netcad Architect:** Netcad Architect is an application used for creating, managing and editing workflow with the help of operators. You can design your own operations with workflows and you can get outputs in a single step.



2- Workflow development with Netcad Architect

- **Netcad WPS Module:** Netcad WPS Module is an application that accepts requests of WPS Handler and collects the results.
- **Netgis Server:** NETGIS Server is the common name of Netcad Enterprise Solutions. NETGIS Server Family includes many components/modules. These components provide data in OGC WPS, WMS, WFS, WFC, WMTS, KML standards. The solutions are database independent.
- **Netgis WPS Handler:** WPS handler module, as a part of Netgis server is providing online data fusion capabilities.
- **Netcad NCC Proxy:** NCC proxy application is an integration tool for desktop and server features of Netcad Suite.



3- Data Fusion Services on Netcad Architecture

Entry point of Data Fusion Restful API is available at: <http://foodie-vm5.man.poznan.pl/geoprocessing/wps>

- **Netcad Online Map API & Openlayers Component:** GUI developed for two different online mapping tools. Netcad Online Map API & Open source Openlayers. These tools are working similarly on the base of providing end users interfaces for creating the data fusion analysis request and see the results in an intuitive manner. Openlayers component will be easily adapted to the applications and frameworks developed by FOODIE partners and other parties.



4- GUI for Netcad Online Map API

Development process

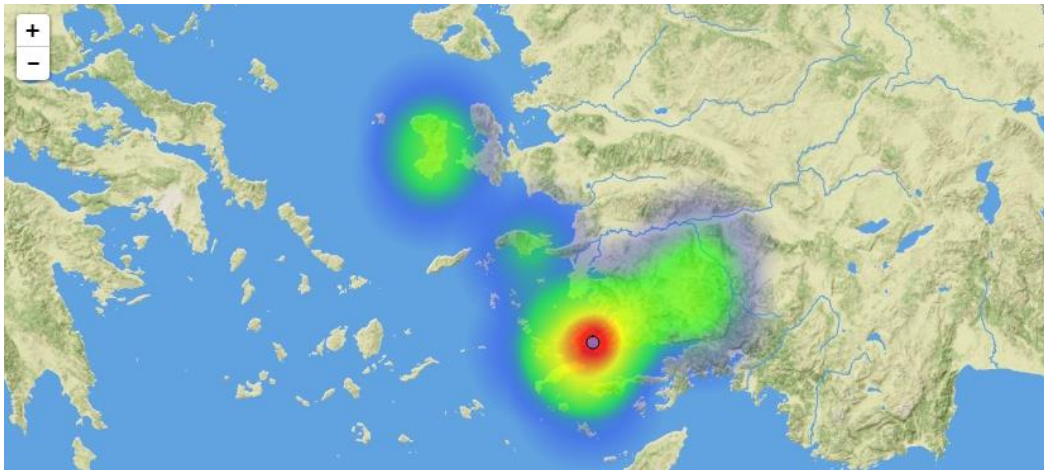
Fusion processes is being developed based on web enabled Workflows and Netgis WPS Handler processes. Netcad Architect workflows and operators are developed to provide capabilities below:

Index Calculations: Vegetation, Water and Moisture Indexes are measurements that calculated from combinations of satellite imagery bands. These indices are calculated by using arithmetic operations between pixel intensity values of an image in a specific band and corresponding pixel intensity values in a second band.

Advanced Precision Farming Analyzes: Advanced Precision Farming Analyzes are classification and decision support processes that based on logistic regression analysis and modified analytic hierarchy process (m-AHP). These techniques enable us to assign relative weights to the different criteria involved in making a decision on suitability of land mapping unit for a land-use. Crop-land suitability analysis and soil water balance analysis models has been implemented according to similar models developed. [5]

Feature Level Fusion: Feature level fusion approach includes combining data from different sources to provide more efficient representation of data. Different features from the source data will be extracted first in order to integrate them with information provided from the semantic layer produced in FOODIE project [6]. The integration will use some specific rules to create a geographic object for each data entry which are based on the annotation vocabulary in the semantic layer, features extracted and the original spatial information of data itself if any.

Implementation of data fusion is based on dynamic generation of heat maps. Feature extraction is achieved by SPARQL queries. Resulting data sets have a visual representation on map which creates a relational visual guidance.



5- SPARQL query based heat map

- **Vegetation indexes:** Indicators describing density and health of the vegetation.
 - Normalized Difference Vegetation Index (NDVI): <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/ndvi>
 - Enhanced Vegetation Index (EVI): <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/evi>
- **Water indexes:** Indicators describing vegetation liquid water
 - Normalized Difference Water Index (NDWI): <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/ndwi>
 - ND17: <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/ndi7>

- Shortwave Infrared Water Stress Index: <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/siwsj>

- **Moisture indexes:** Determination of surface moisture level.
 - Moisture Stress Index: <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/msi>
 - Global Vegetation Moisture Index: <http://foodie-vm5.man.poznan.pl/geoprocessing/wps/gvmi>

- **Computation of Time Differences of NVDI:** Difference calculation of remote sensor input.

- **Contour Line Generator:** Image Processing of remote sensor input.

- **Crop-Land Suitability Analysis:** Classification process of land to support a certain use

- **Feature Level Fusion (Annotation Vocabulary Integration):** Integration of spatial data and semantic data on service level

References

References

- | | |
|----|---|
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