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Using ILWIS Software for teaching Core Operations in Earth Observation

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***Abstract*—Computational methods in GIS and Earth Observation are an important part of the curricula in Geo-informatics. Apart from the theoretical foundations students need to get acquainted with the practical application of these methods in software. However, many GI software packages are not designed for the purpose of educating principles of GIS and Earth Observation and therefor do not provide the right tools and interfaces for students and novice users to comprehend the core concepts. In this paper we describe our effort to build a GI software that does support students in learning through visual workflows and linked views of different representations of raster images such as maps, tables and graphs.**

***Keywords*— technology, education, earth observation, GIS, wiki, ontology, concept browser**

I. Introduction

The University of Twente develops the Integrated Land and Water Information System (ILWIS http://52north.org/communities/ilwis/). ILWIS is an open source, C++ based, Earth Observation and GIS software. ILWIS delivers a wide range of features including import/export, digitizing, editing, analysis and visualization of geodata. ILWIS software is renowned for its functionality and user-friendliness and has established a wide user community over the years of its development. ILWIS is currently being renewed and transformed into a more modular platform called ILWIS-Objects along with a redesigned plug-in platform and APIs. The modularity allows for the creation of tailored applications and the use of components in other software platforms. On top of ILWIS-objects we provide our own desktop interface (see Fig. 1) which is especially designed to help users understand better the data and operations which they are using. Researchers, trainers and students can now easily implement, store and share their methods via software, in addition to their written reports.

II. Working with workflows

In the education, projects and research at our faculty we see frequent use of methods consisting of chains of software operations. A workflow represents a combination of process steps to be handled by computers or humans. Geoprocessing

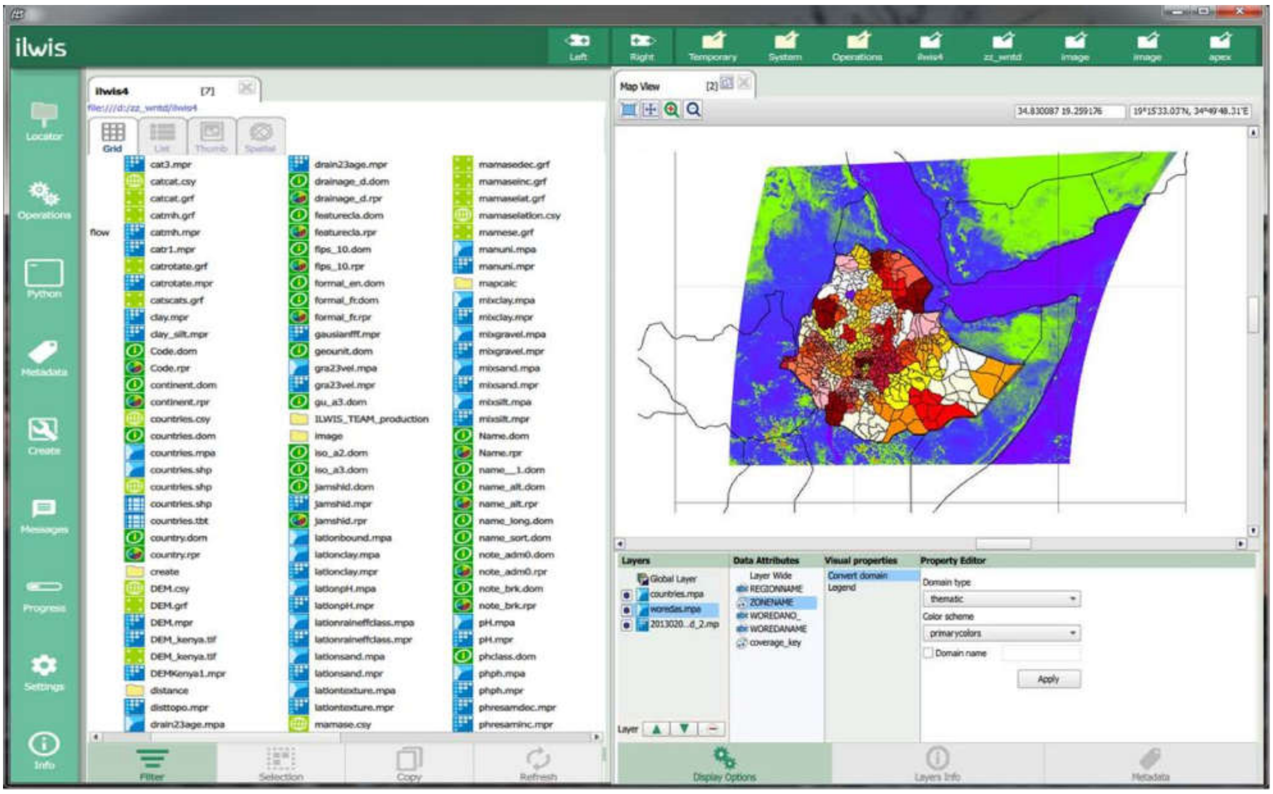

Fig. 1. User Interface of the ILWIS desktop.

workflows consist of geodata (satellite images, in-situ sensor data, human sensor data) and the operations needed for their storage, analysis and presentation.

In one of our projects (afrialliance.org) we develop methods for creating and sharing geo-workflows between humans and computers to support knowledge sharing and system interoperability. We distinguish between abstract workflows (software- and data-independent) and concrete workflows (software- and data-dependent).

A. *Abstract workflows*

An abstract workflow provides a general overview of process types and their input/output, without necessarily stating data sources and operation parameters. Fig. 2 shows an abstract workflow for calculating rainfall for administrative areas in one of our case studies in the MaMaSe project (mamase.org) in Kenya. This allows users to create and grasp the general essence of the process steps. An abstract workflow can turn into a concrete workflow and vice versa.

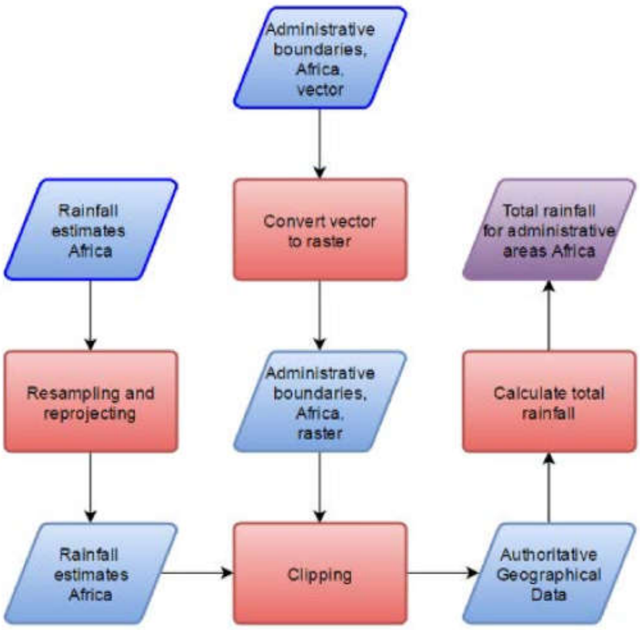

Fig.2 Abstract workflow.

B. *Concrete workflows*

A concrete workflow contains process steps which are executable by a specific software. Fig.3 shows the visualization of the system logic of the abstract workflow of Fig. 2. This workflow can be executed in ILWIS.

C. *Sharing workflows*

Several process languages such as BPMN allow standardized sharing of workflows. We have developed a collaborative web environment using a semantic web-based exchange format in JSON-LD which allows both sharing between machines and humans [2], see also Fig. 4.

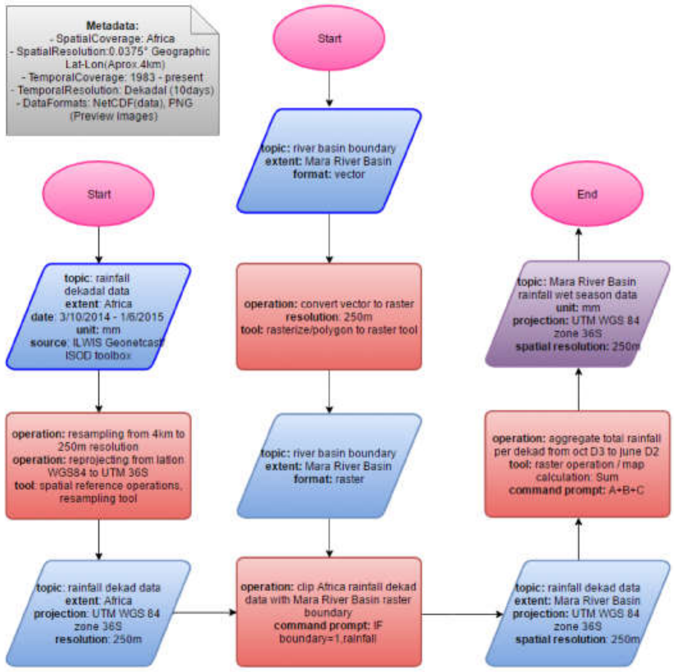

Fig.3 Concrete workflow.

Semantically enriched workflows can be visualized in a spatio-temporal explorer based on Linked Data [3].


```
"subworkflows": [
    {
        "id": 0,
        "metadata": {
            "longName": "PRODUCTION",
            "description": "The workflow for the MaMaSe project",
            "syntax": "MaMaSeWorkflow(raster,raster,raster,raster)",
            "resource": "Ilwis",
            "keywords": "workflow, MaMaSe, drainage",
            "inputParameterCount": 4,
            "outputParameterCount": 2
        },
        "operations": [
            {
                "id": 0,
                "metadata": {
                    "longName": "Anoperation",
                    "description": "AnOperationDescription ",
                    "syntax": "thefirstoperation(inputrastermap)",
                    "resource": "Ilwis",
                    "keywords": "operation, keyword,operation",
                    "inputParameterCount": 1,
                    "outputParameterCount": 1,
                    "final": false
                },
                "inputs": [
                    {
                        "id": 0,
                        "url": "veg.com",
                        "term": "",
                        "type": "map",
                        "value": "",
                        "units": "",
                        "min": "",
                        "max": "",
                        "name": "Vegetation structure",
                        "show": true,
                        "change": true,
                        "description": "",
                        "picture": ""
    }
```


Fig 4. Sharable workflow represented in JSON.

In ILWIS, workflows can be visually constructed, debugged and reused, see Fig. 5.

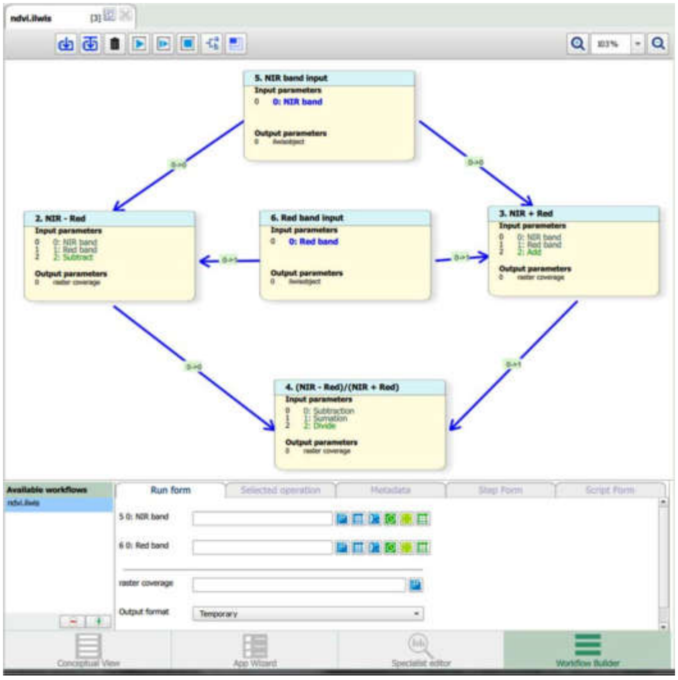

Fig. 5. Workflow builder in ILWIS. Depicted is the workflow for the calculation of a Normalized Difference Vegetation Index (NDVI).

III. EDUCATIONAL CONTEXT

We are currently developing ILWIS to support our core education in Earth Observation. The theory is covered in our core text book [4]. The accompanying practicals entail the following topics:

- Introduction to Remote Sensing
- EM Radiation
- Visual Image Interpretation
- Sensors and Image Data Characteristics
- Visualisation and Radiometric Operations Digital Image Classification
- Geometric operations – Geocoding images
- SatSatellite-based Positioning – Planning a GNSS Survey

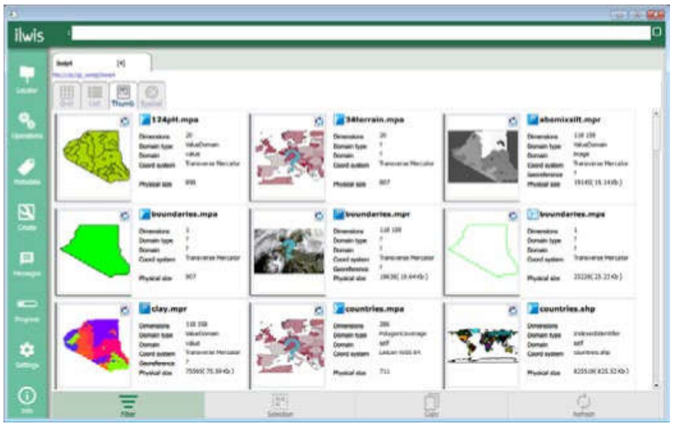

Fig. 6. Catalog view with thumbnails representing spatial data.

We believe that it is important for students to fully comprehend the data and functions they are using. For that sake we try to make such components as clearly visible as possible. Another example is the ILWIS catalog interface which depicts all data with their metadata and thumbnail preview (see Fig. 6).

IV. CONCLUSIONS

Our educational effort in GIS and Earth Observation is targeted towards the insightful creation and reuse of software. Typical education-focused software solutions include linked-views (e.g., a change in a histogram is instantly visible in a change in the corresponding raster image) and a comprehensible workflow environment for chaining software operations to support a good understanding of the combination of individual software functions. After implementing the functionality of our core module content, ILWIS will be further developed to be able to support further education, projects and research.

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