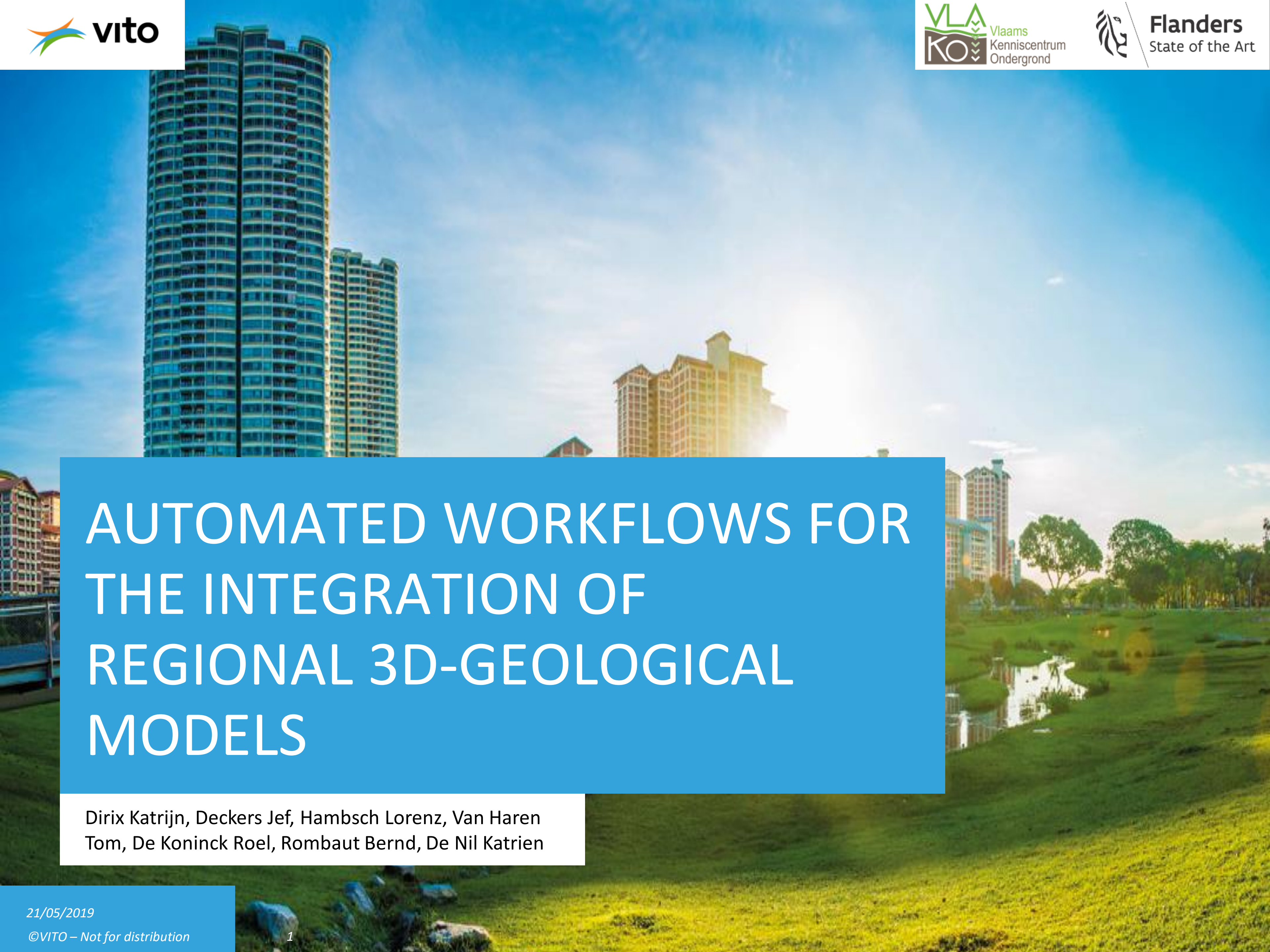

AUTOMATED WORKFLOWS FOR THE INTEGRATION OF REGIONAL 3D-GEOLOGICAL MODELS

Dirix Katrijn, Deckers Jef, Hambsch Lorenz, Van Haren Tom, De Koninck Roel, Rombaut Bernd, De Nil Katrien

CONTEXT

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Context

- By order of 'Flemish Planning Bureau for the Environment and Spatial Development'
- G3Dv2-model (2013): first 3D geological model of Flanders (

Goals 2013 – 2018:

- **Detailed models** for subsurface applications
- **Faults in 3D** (SKUA-GOCAD)
- **Linking** geological and hydrogeological units/models
- Large existing **seismic dataset**
- **Parametrization** of near-surface resources (voxel models)
- **Cross-boundary** harmonization of models (H3O-projects)
- **Integration** existing and new models into **comprehensive models**
- **Intergration in DOV**

- **G3Dv3-model(2019):** Updated & refined 3D geological model of Flanders
- **H3D-model (2019)**: G3Dv3-model translated into hydrogeological model for Flanders and adjacent areas

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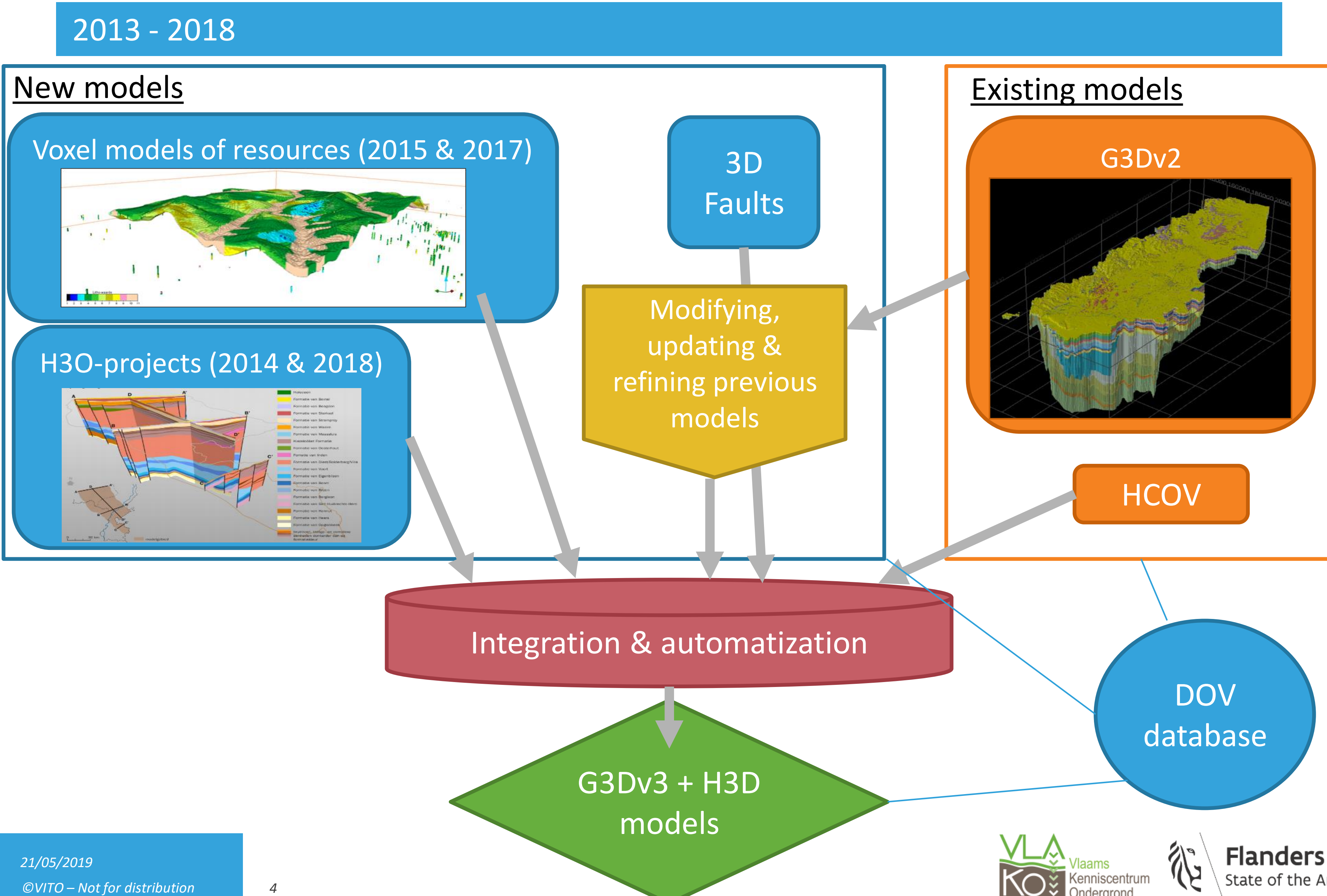
Flanders State of the Art


2013 - 2018
New models
Voxel models of resources (2015 & 2017)
H3O-projects (2014 & 2018)
3D Faults
Modifying, updating & refining previous models
Existing models
G3Dv2
HCOV
Integration & automatization
DOV database
G3Dv3 + H3D models

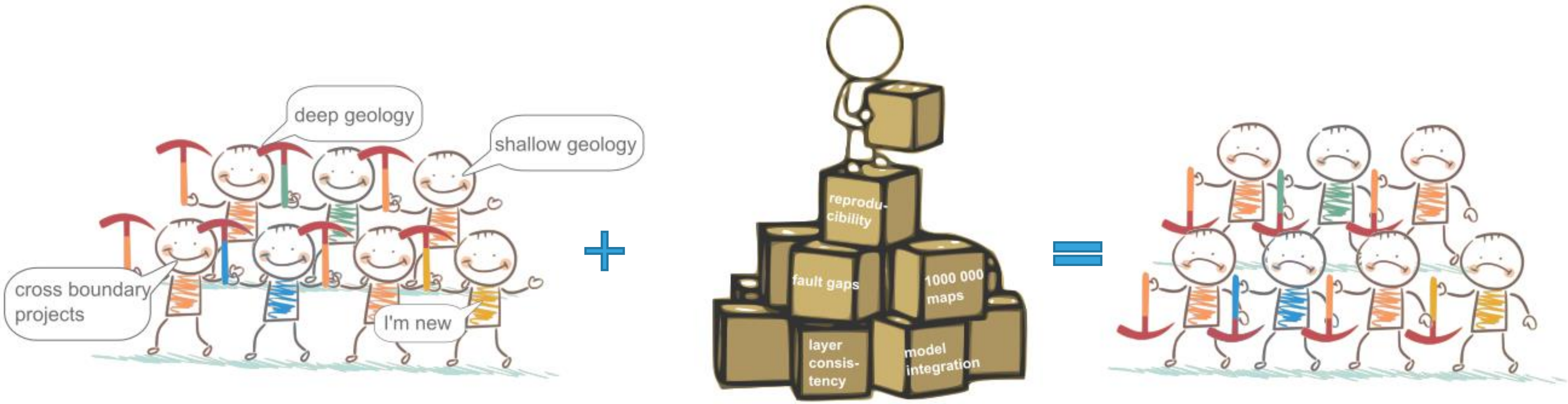
CONTEXT

- New 3D (hydro)geological models of Flanders (Palaeozoic to Quaternary):
  - 117 geological layers
  - 139 hydrological layers

- Output for each layer:
  - 100 x 100 m raster files of top, base, thickness
  - Shapefiles of geological occurrences, fault intersections, isolines

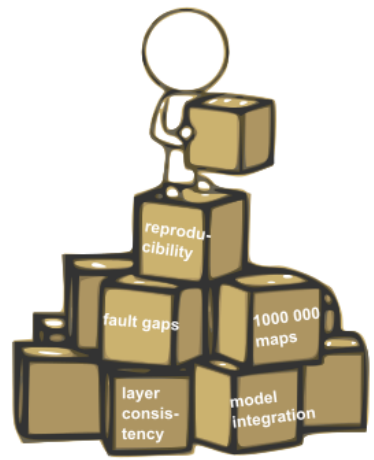
→ > 1500 maps needed to be produced

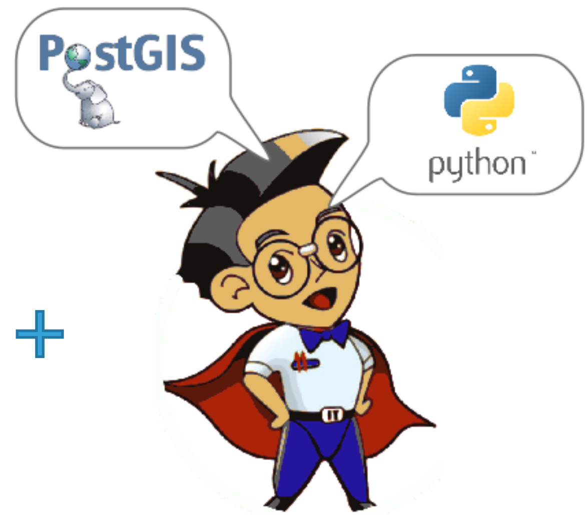
CONTEXT

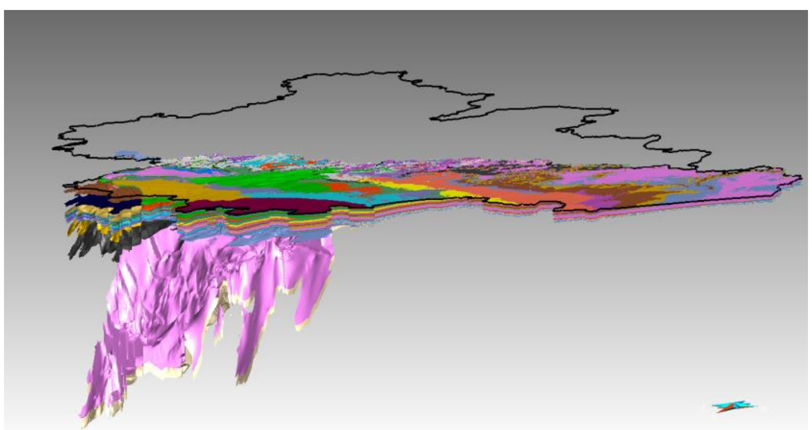


deep geology
shallow geology
cross boundary projects
I'm new
+
reprodu-cibility
fault gaps
1000 000 maps
layer consis-tency
model integration
=

CONTEXT







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AUTOMATED WORKFLOW

MODELLING TASKS

- **Combine** input data into standardized formats
- **Convert stratigraphy** (cross-boundary projects, (hydro)geological units)
- **Re-model** input data (if necessary)
- **'Knit' raster files** from layers of different projects together across buffer
- **Model detail** (**new layers**) into existing models
- **Model 3D fault planes** (and extend outside their limits in existing projects)
- **Ensure fault-fault contacts** from different model areas
- Ensure **layer-fault contacts**
- Ensure overall **model consistency** (detect modeling errors)
- **Store the model**
- **Calculate derived products**

borehole sets

metadata

figures

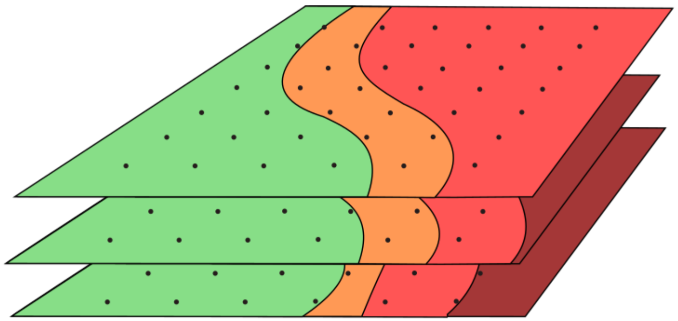
fault traces

top, base, thickness

isolines

geographic extent

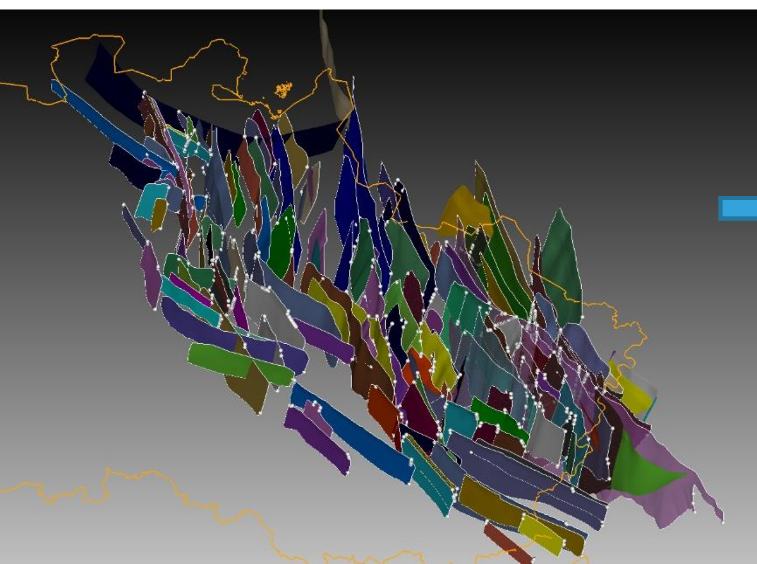
DATA STORAGE



Layer A
x
y
z

Layer A
polygon

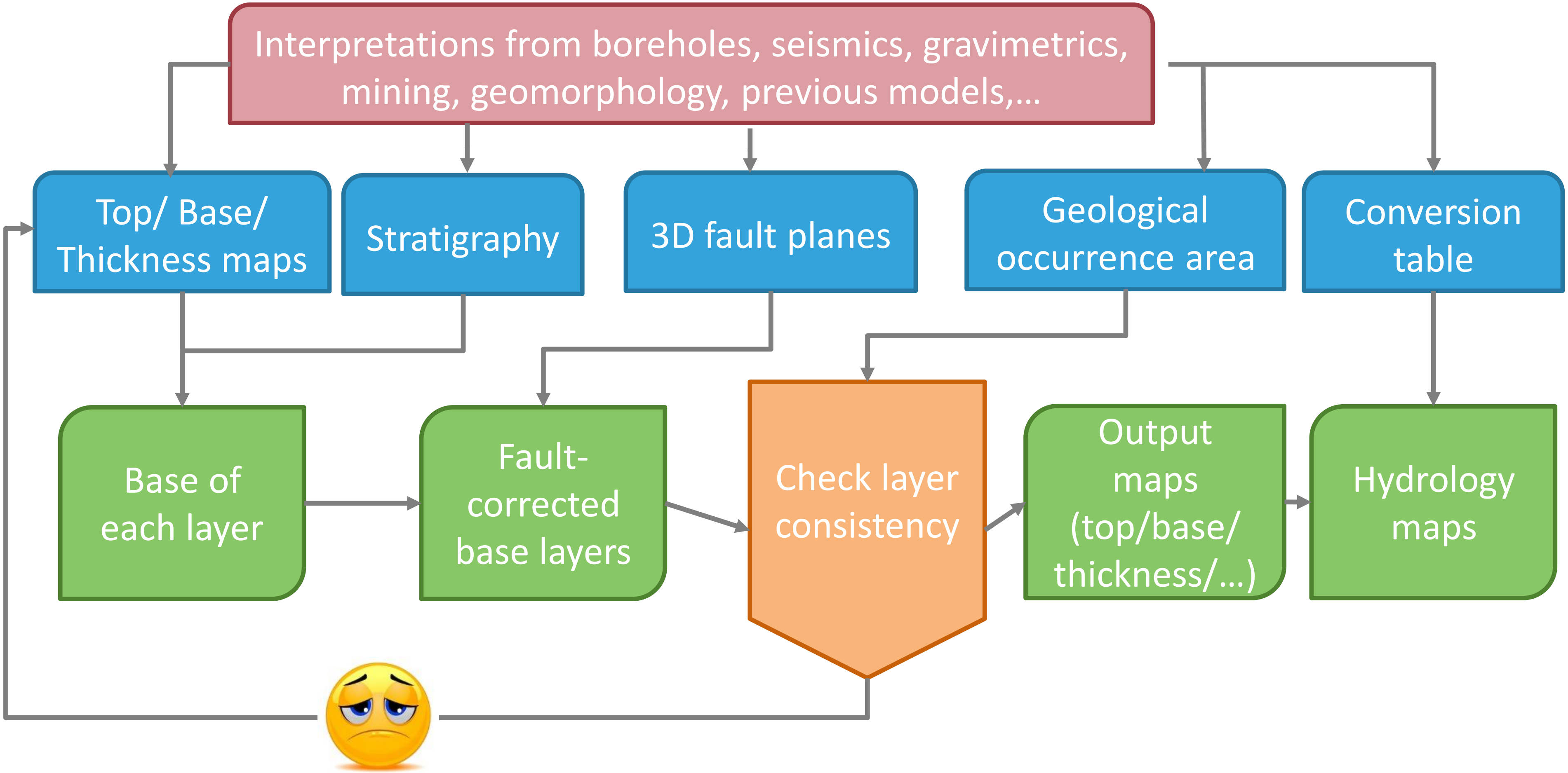
POSTGIS



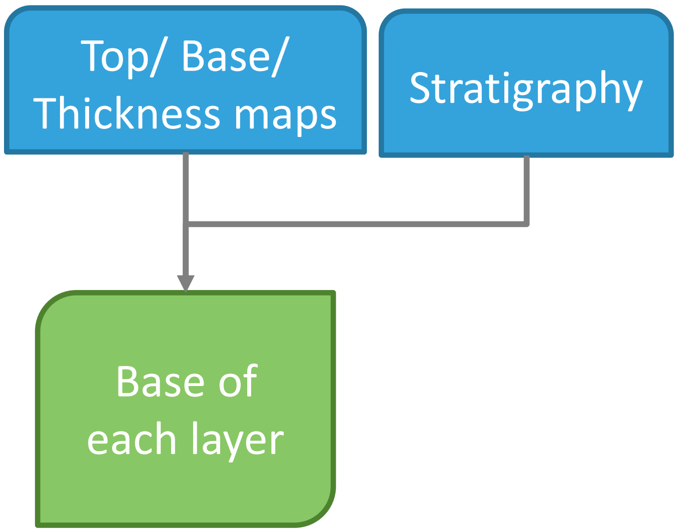
Fault 1.dxf

Fault 1
polygon

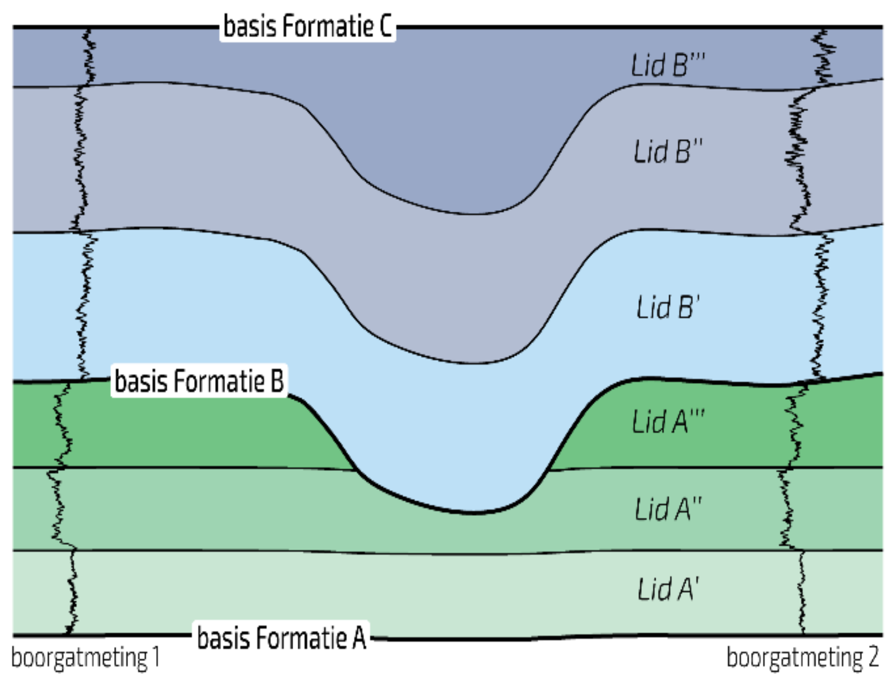
SCRIPT TOOLCHAIN



SCRIPT TOOLCHAIN

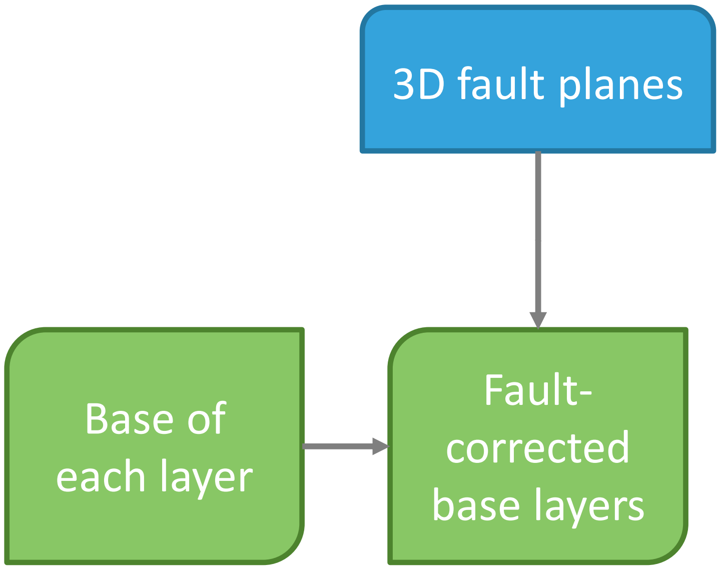


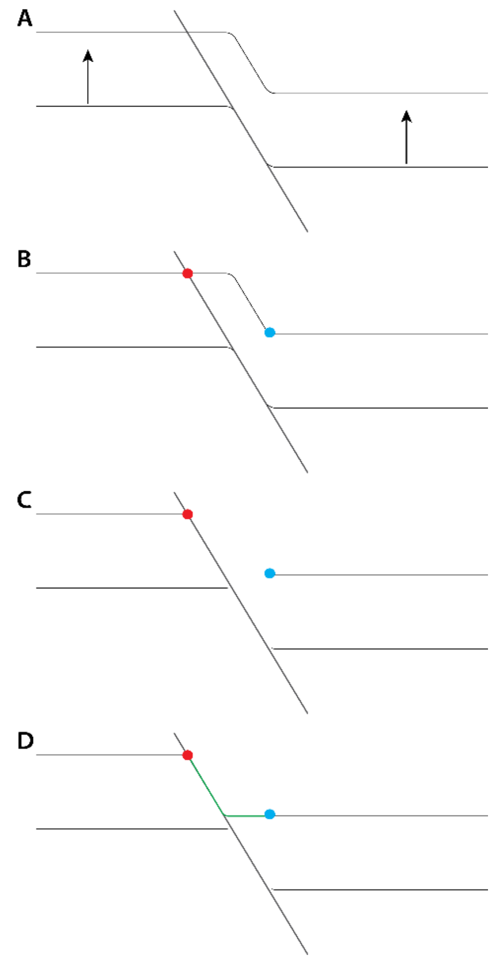
- Modeled layers = base or top or thickness
- Stratigraphy = list of stratigraphic position of modeled layers
- Set of logical rules uses stratigraphy to transform input into base layers for each unit
- Each base is stored in db for further use



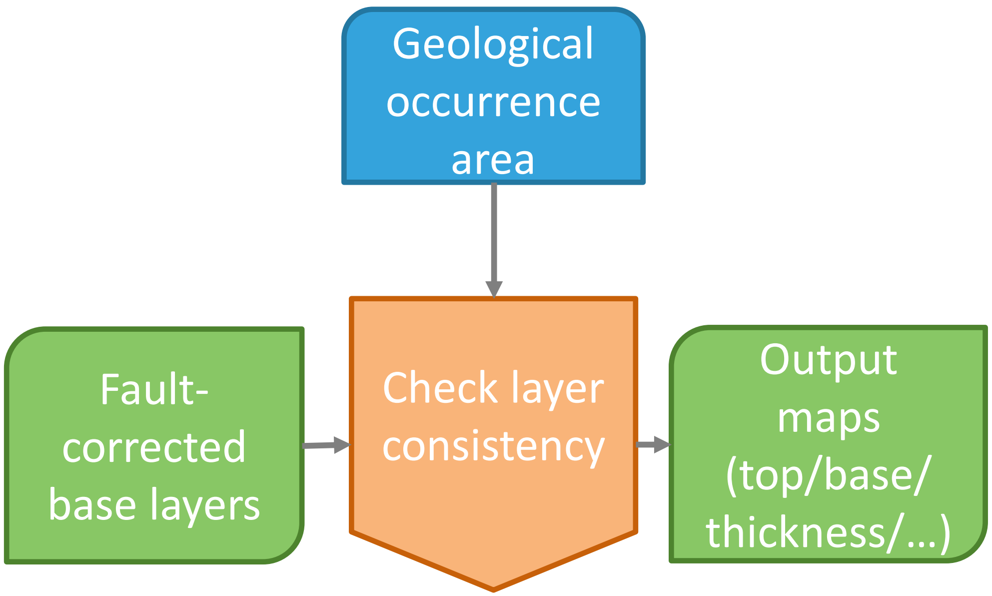
SCRIPT TOOLCHAIN

- In many base layers, faults were vertical ⇨ Needed tilting based on 3D fault planes

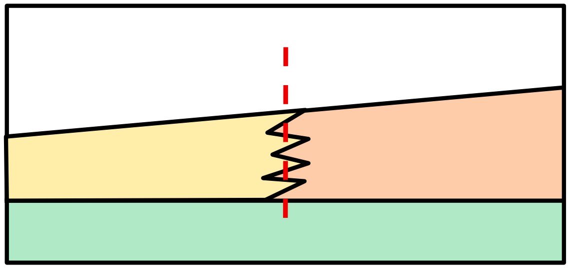




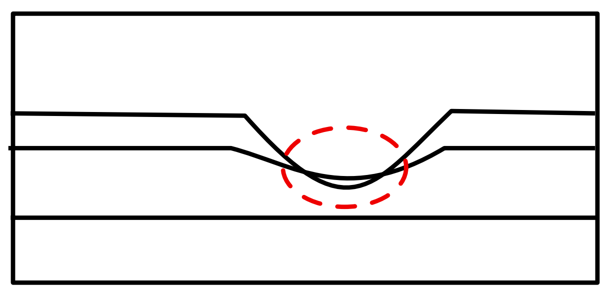
SCRIPT TOOLCHAIN



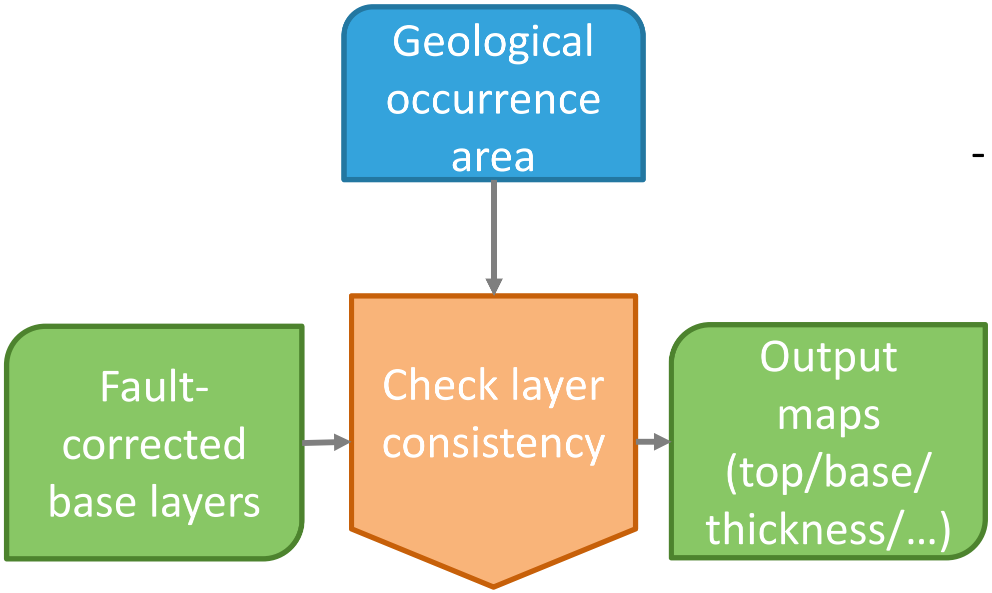
- Geological occurrence area to spatially clip base layers



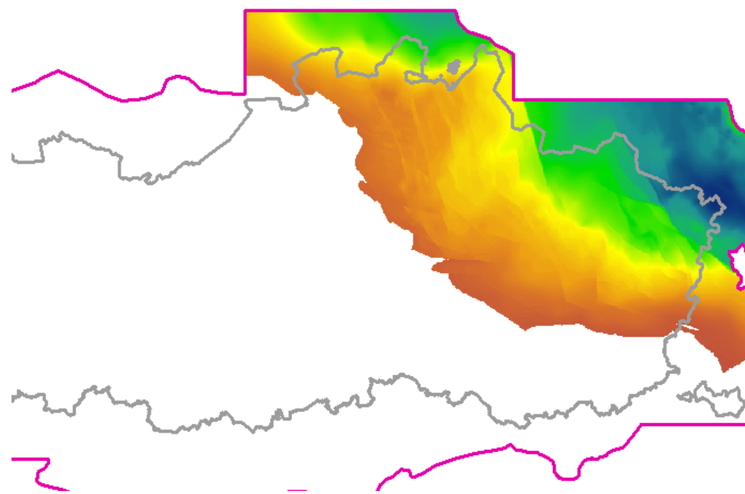
- Layer consistency check used stratigraphic column and thickness calculations to detect errors



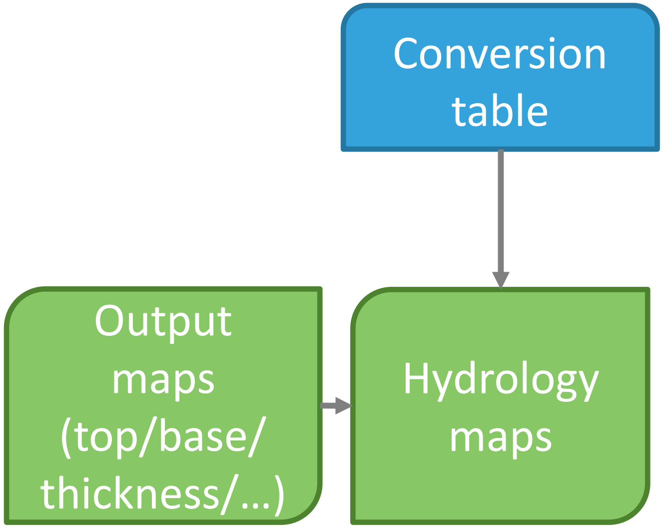
SCRIPT TOOLCHAIN



- Stratigraphy table + clipped base layers are used to calculate top- and thickness layers for each unit
- Calculated layers are converted to required outputs, e.g.: 100 x 100 m raster maps in generic ASCII format



SCRIPT TOOLCHAIN



- Hydrology units can (generally) be derived from geology units
- Use conversion table + simple script to convert names

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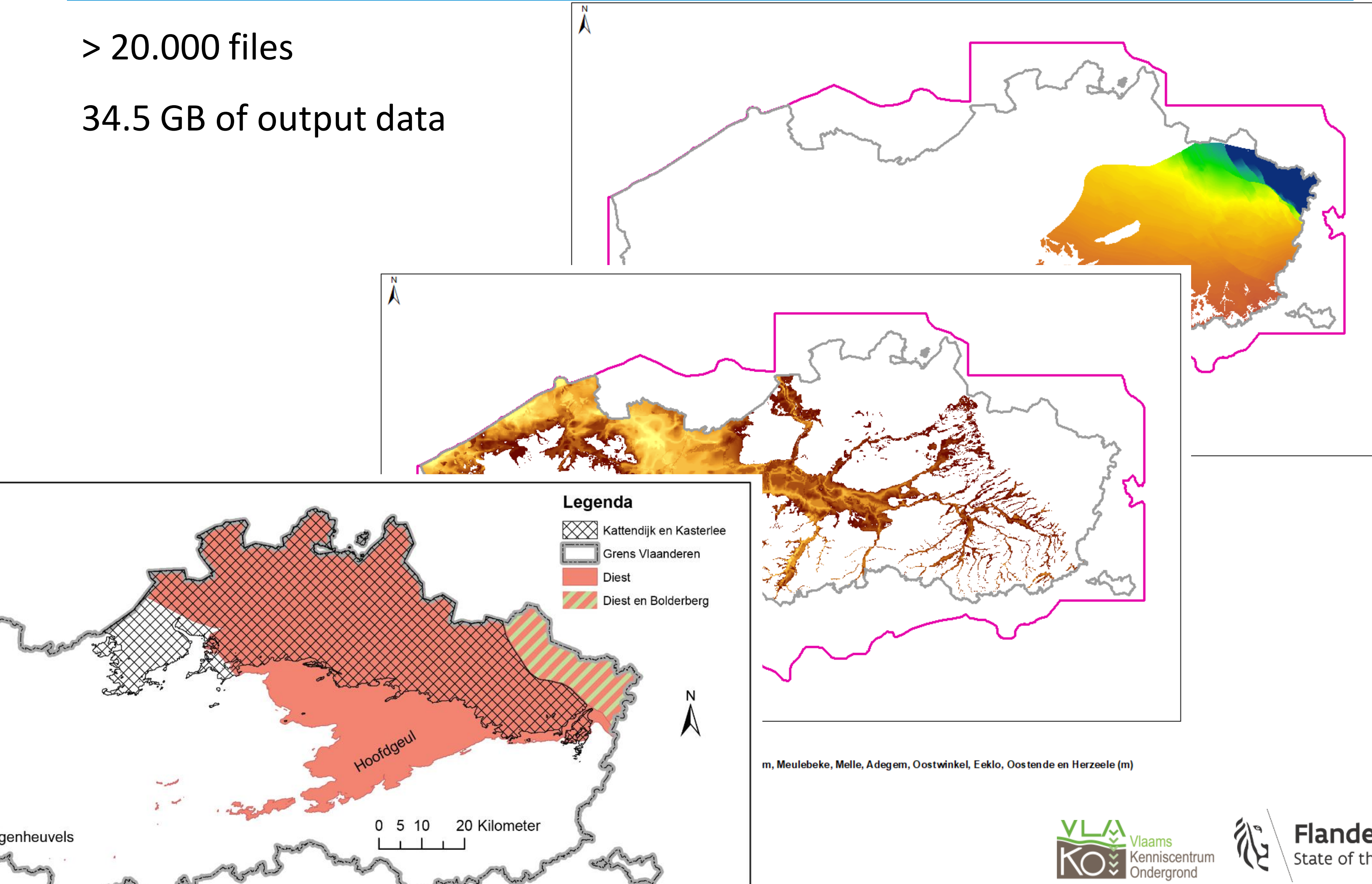
RESULT

> 20.000 files

34.5 GB of output data



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TOOLS USED

SQLAlchemy

Databank Ondergrond Vlaanderen

Psycopg2

ArcGIS

GDAL

PostGIS

Spatial PostgreSQL

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Flanders
State of the Art

CONCLUSIONS

Lessons learned:

- Include IT from beginning of the project
- Make sure the geo-IT part does not become ‘black box’ for the geologists
- Foresee enough time for QC of the automated results

Advantages:

- Efficiency gain => time saved by automated steps gives more space for geology
- Error reduction (iterative process of model generation)
- Reproducible results
- Structured methodology
- Data consolidation (no more data lost in subfolders or version problems)