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Landslide susceptibility mapping in Denmark – Machine Learning approach

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Landslides in Denmark

Type of movement:

- Fall

- Slide

- Flow

- Slope deformation

Type of geological material:

- Stone

- Loose sediments

Photo: Kystdirektoratet and GEUS

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Motivation

- Little awareness of landslide hazards in Denmark

- In 2020-21 The Geological Survey of Denmark and Greenland (GEUS) mapped 3200 distinct landslide occurrences

- Climate change will likely have an accelerating impact on landslide activity

- A screening tool to predict where landslide can occur is needed to communicate potential risks

Svennevig K. (2020)

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Main assumptions

- Landslide events leave recognisable traces that can be classified and mapped through field work or remote sensing products

- The past can explain the future

- Future landslides are more likely to happen in areas with similar conditions as areas that have been affected by landslides in the past

An example of a landslide from the Danish landslide inventory, east of Røjle Klint, Fyn (Svennevig K. et al., 2020)

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Area of Interest

- Area around Vejle Fjord

- 189 inland landslides

- 264 coastal landslides

- Various sizes between 96 m^2 and 73000 m^2

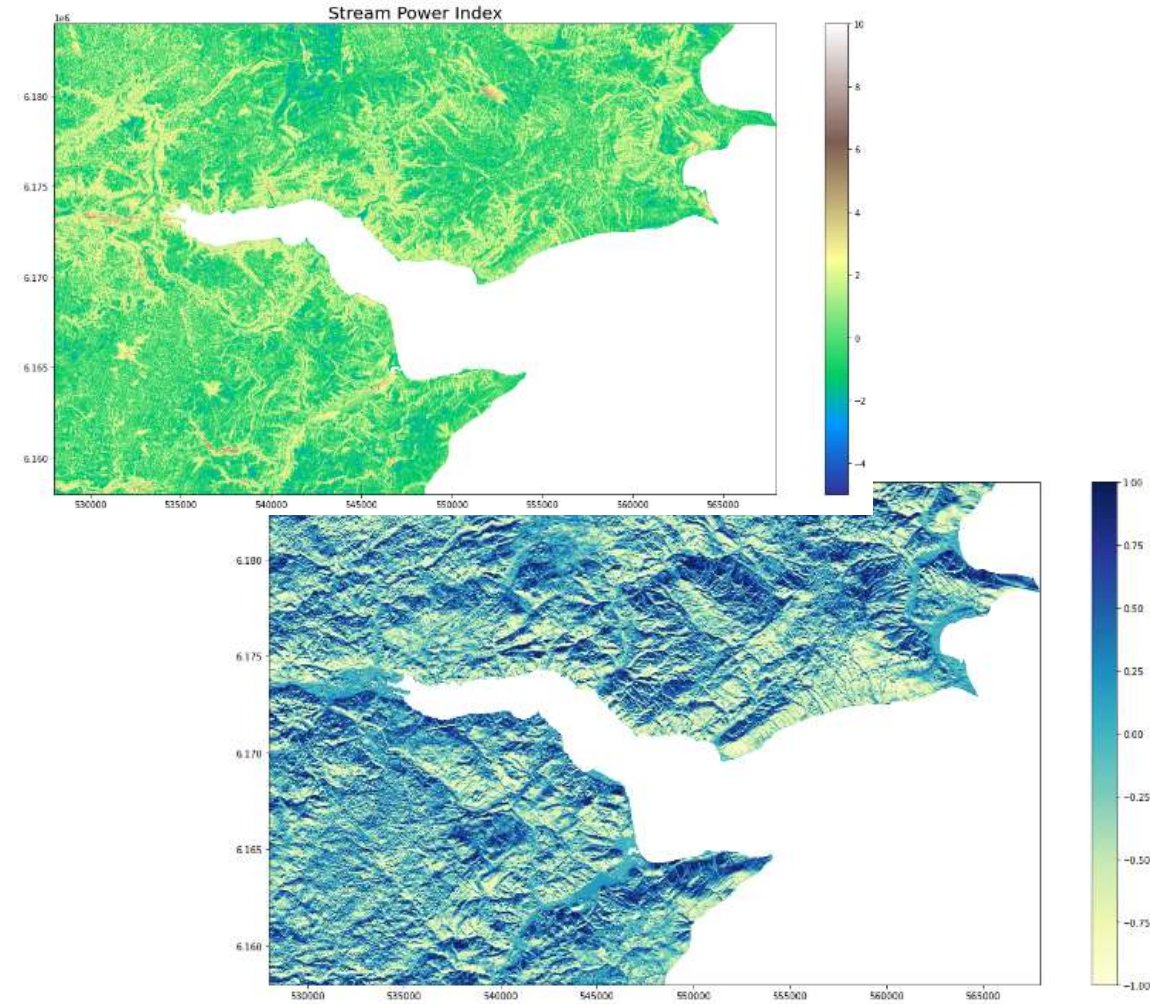# XXVII FIG CONGRESS
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Data

Landslide occurrence data:
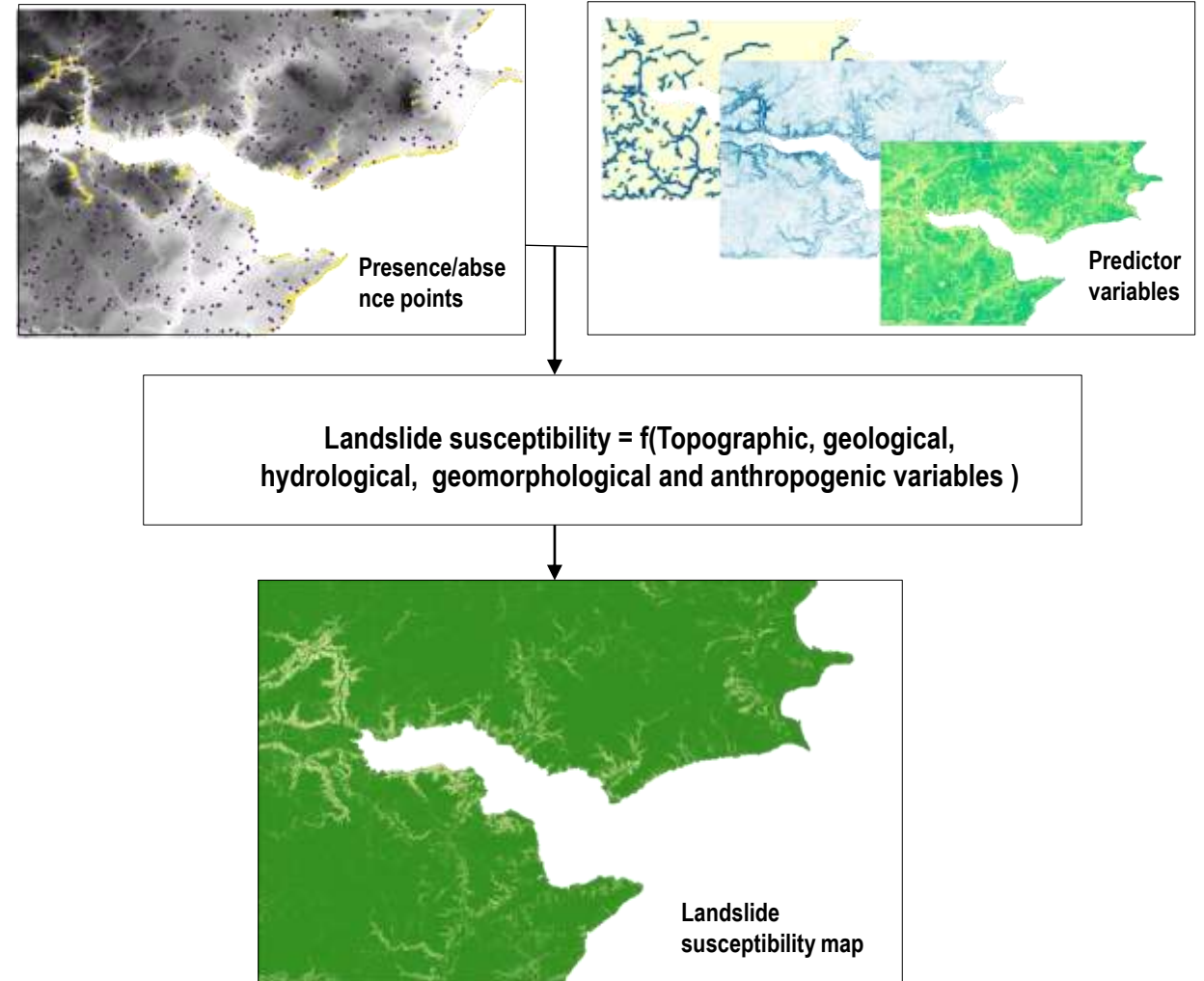- GEUS' landslide database
- Absence/presence points

Variables that can explain landslide occurrences - open data:
- DTM derivatives: elevation, slope, curvature, aspect (easterness, northerness), roughness, TRI, TPI, SPI, TWI
- Soil type, geology and geomorphology
- Distance to coast, streams, roads, railroad

Stream Power Index

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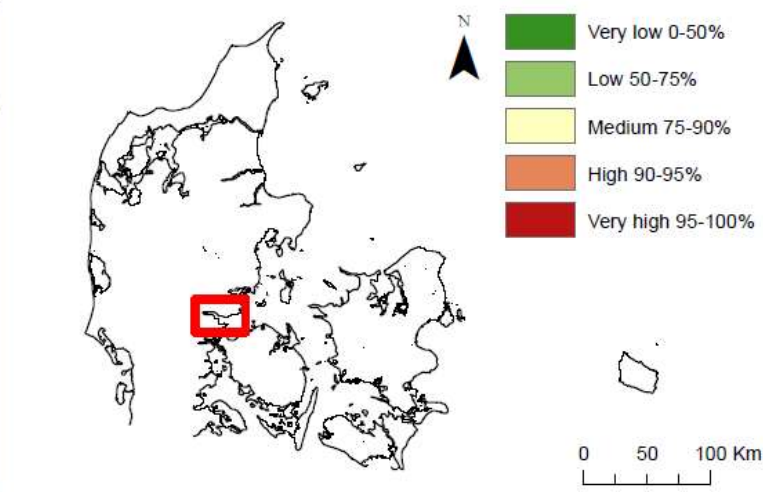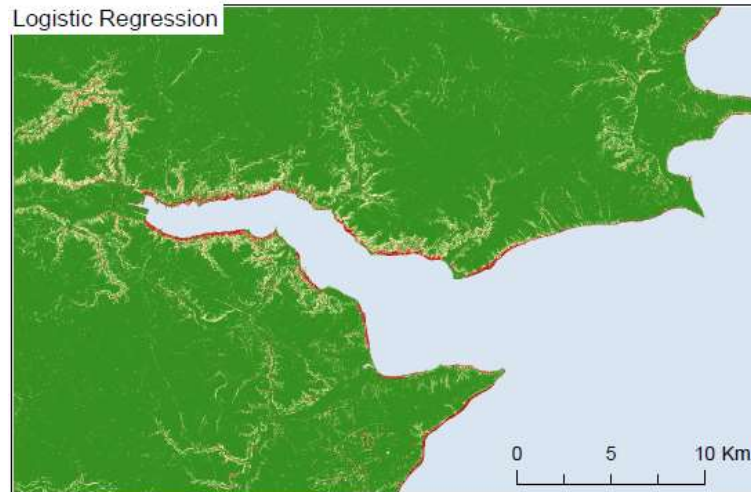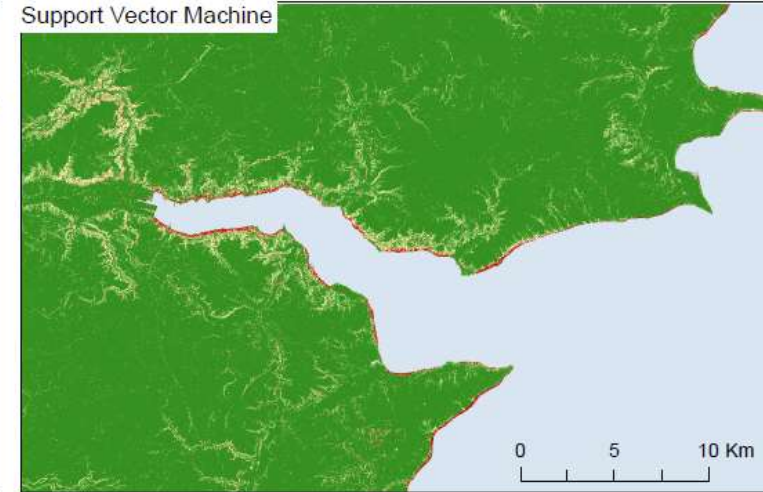for a better living

Simplified workflow

- Tools: Python libraries

- The models use raster-based layers as predictors

- The predictor data is combined with absence/presence landslide points

- Feature engineering applied

Presence/absence points

Predictor variables

Landslide susceptibility = f(Topographic, geological, hydrological, geomorphological and anthropogenic variables)

Landslide susceptibility map

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Results

Overall accuracy

- Random Forest   94%
- Support Vector Machine 94%
- Logistic Regression   92%

Results

Landslide Susceptibility (RF)
- Very low 0-50%
- Low 50-75%
- Medium 75-90%
- High 90-95%
- Very high 95-100%
- GEUS Landslides

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Conclusion and further suggestions

- The method has shown promising results and potential for the landslide susceptibility mapping in Denmark

- The method can be transferred to other types of susceptibility and risk mapping – land subsidence, inundation etc.

- The mapping can be useful for decision-makers and can potentially pave the way to a legislative framework and land management practices for areas vulnerable to landslides and for preventive and mitigating measures

- Incorporation of climate variables into the models to project the future scenarios and to be used in climate adaptation plans

- Usage of InSAR data for monitoring landslide activity

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Thank you for your attention!