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The use of GIS tools for analyzing eye-movement data

Tomasz Opach Jan Ketil Rød

some facts

In recent years an eye-tracking approach has become a common technique for collecting data in empirical user studies in cartography

Its popularity within this discipline has grown out of two basic convictions that it provides information about user's visual behavior and it does so in an unobtrusive manner

As a matter of fact these are advantages which distinguish eye-tracking from other empirical techniques known from usability studies

challenges and needs

Eye-tracking produces an enormous amount of data which is challenging for the analysis and which to some extent impedes the use of this technique

In order to analyze eye-movement data we might use dedicated software packages, however, they sometimes do not offer the functionality that one needs

Then, common GIS applications might be helpful for the analysis of the output from eye-trackers which usually can be exported as fixation points data

what do GIS tools offer?

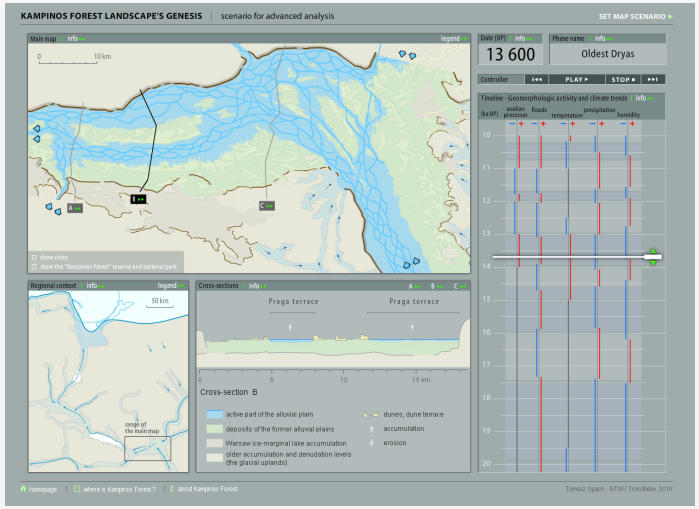
GIS tools may provide users with new insights which are difficult to derive while using default eye-tracking software

Fixation points* can be exported to any GIS application

**points to which a human has directed his/her visual attention and gathered as an output from eye-tracker*

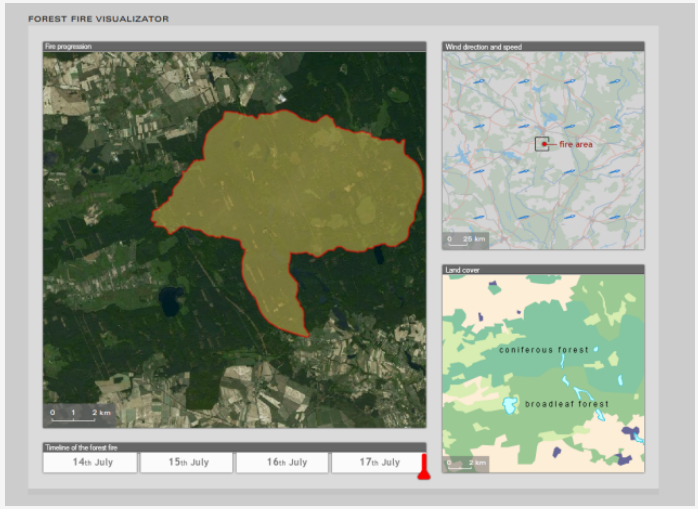
Since we may consider the screen as defining a Cartesian coordinate system, these fixation points are spatial data and of course we could use a tool-rich GIS to visualize and analyze eye-movement data

where were they used?



Project 1

Evaluation of the multi-component and multi-scenario animated map of the Kampinos Forest's landscape genesis



Project 2

How do people view multi-component animated maps?

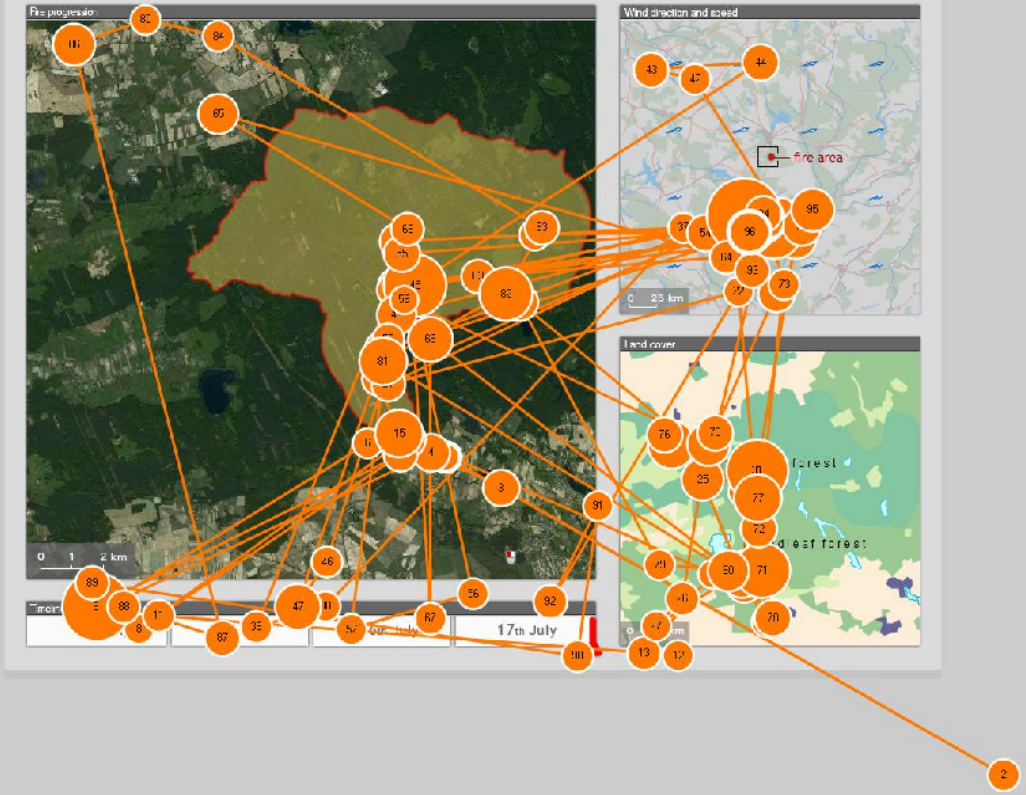
fixation filter threshold

GIS applications may facilitate optimization of the fixation filter threshold

Fixation points set after filtering (aggregating) can be easily compared with the raw data so users are able to evaluate whether raw fixation points have been “aggregated” in accordance with their observations or expectations

Media: Animation_2
Time: [illegible]
Participant filter: All

FORREST FIRE VISUALIZATOR



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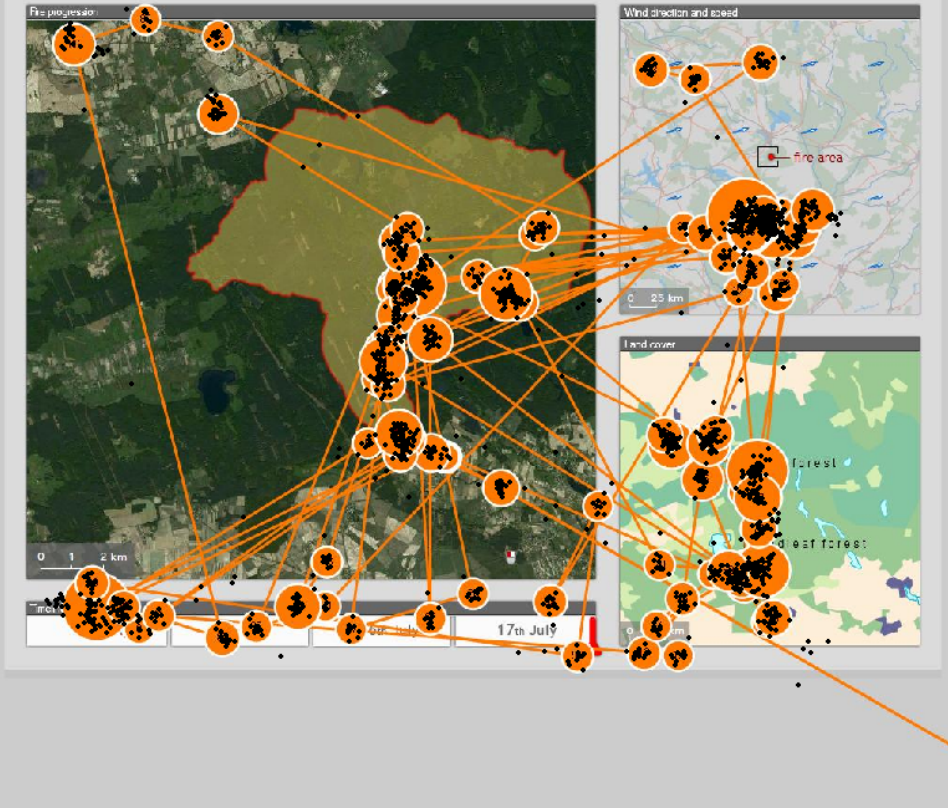
Media: Animation_2

FOREST FIRE VISUALIZATOR



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Media: Animation_2

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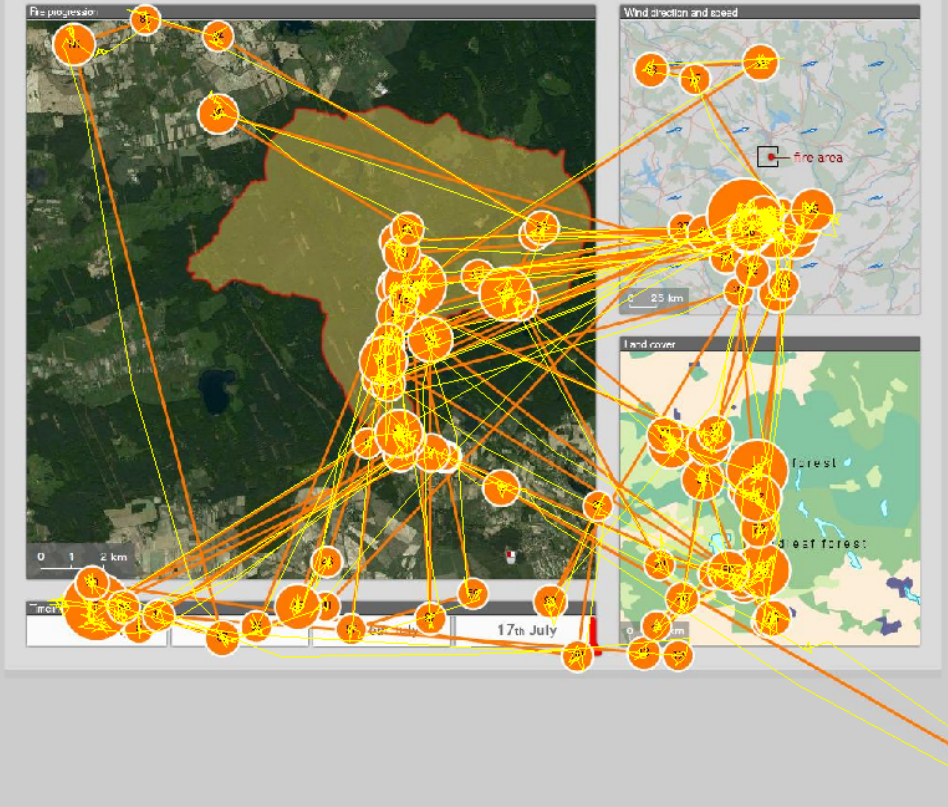

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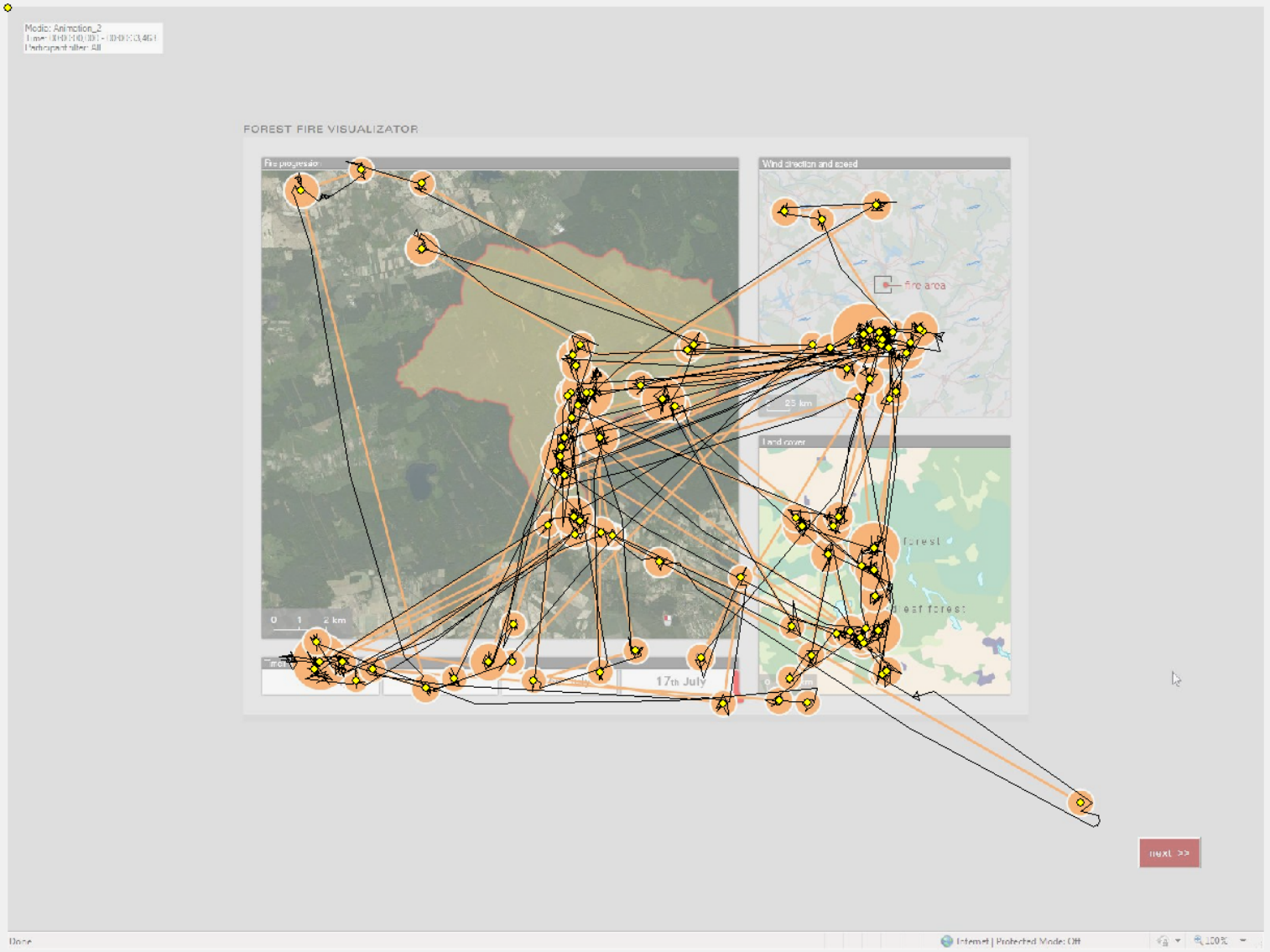

FOREST FIRE VISUALIZATOR
Fire progression
Wind direction and speed
Fire area
25 km
Land cover
forest
0 1 2 km
17th July
next >>

changes over time

Users may want to view fixations and saccades in a form of the space-time-cube for easier analysis of eye movement data

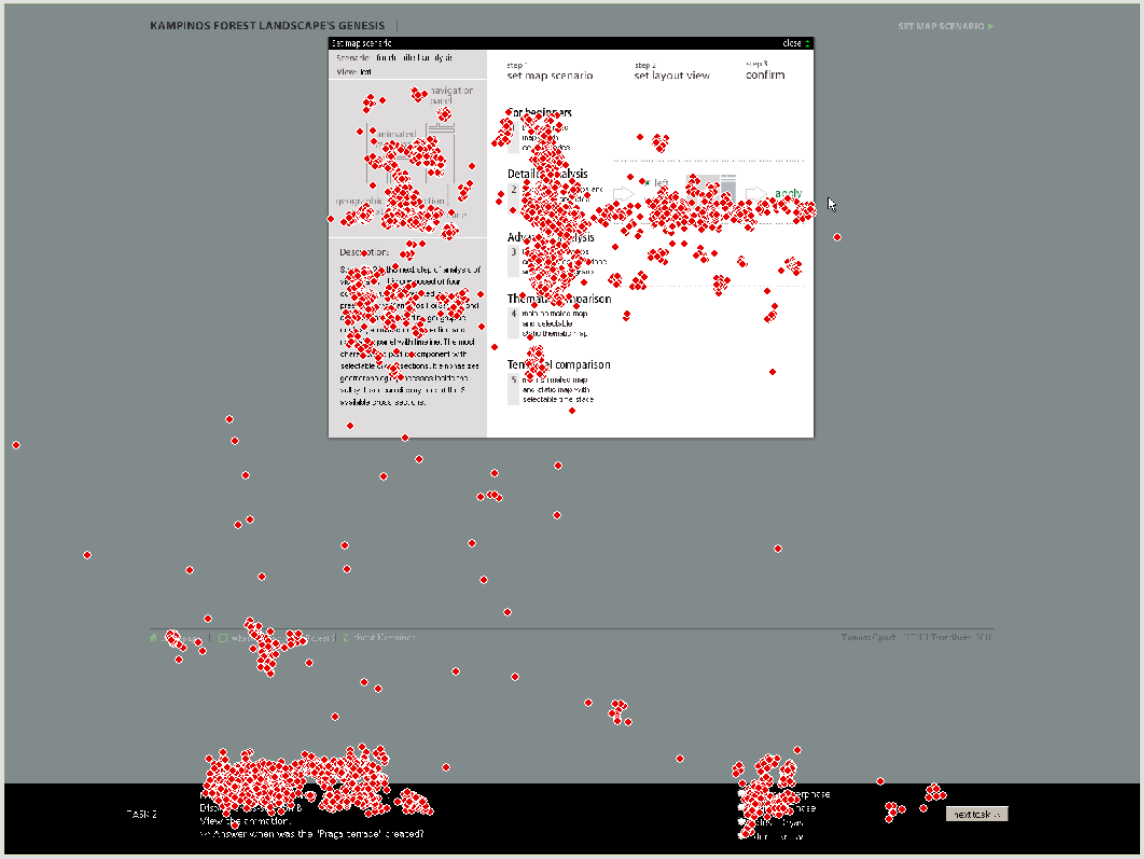
Traditional approaches conceal space-time variation due to aggregation. Space-time-cube visualization facilitates the user to discover patterns

Even if the 3D visualization of eye-movement data is not enough for revealing patterns across participants it can help to drive the research into the appropriate direction and to formulate further hypotheses

space-time cube in GIS

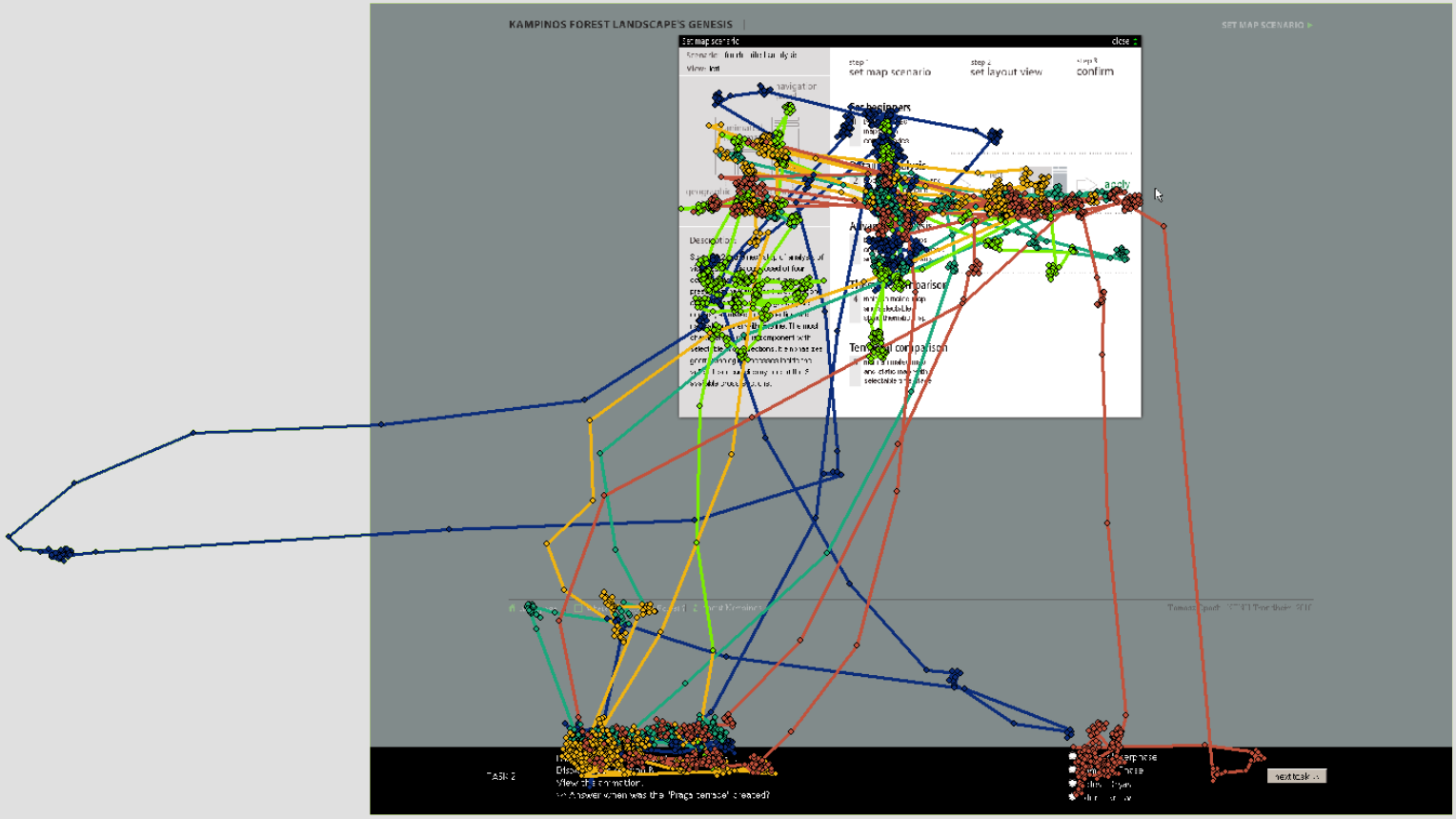
When using GIS applications users may easily customize space-time cube settings, for instance, both fixation points and saccades can be symbolized depending on their temporal attributes

Furthermore blocks built on the basis of the area-of-interest zones can be additionally visualized in the scene to support visual analysis


KAMPINOS FOREST LANDSCAPE'S GENESIS
SET MAP SCENARIO
close
step 1
set map scenario
step 2
set layout view
step 3
confirm
For beginners
Detail analysis
Thematic comparison
Temporal comparison
Description:
TASK 2
next task

KAMPINOS FOREST LANDSCAPE'S GENESIS
SET MAP SCENARIO
set map scenario
set layout view
confirm
navigator
Description
Temporal comparison
TASK 2
next task

KAMPINOS FOREST LANDSCAPE'S GENESIS
SET MAP SCENARIO
set map scenario
set layout view
confirm
navigator
For beginners
apply
Temporal comparison
TASK 2
View the animation.
Answer when was the 'Praga terrace' created?
next task


KAMPINOS FOREST LANDSCAPE'S GENESIS
SET MAP SCENARIO
set map scenario
set layout view
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Description
Temporal comparison
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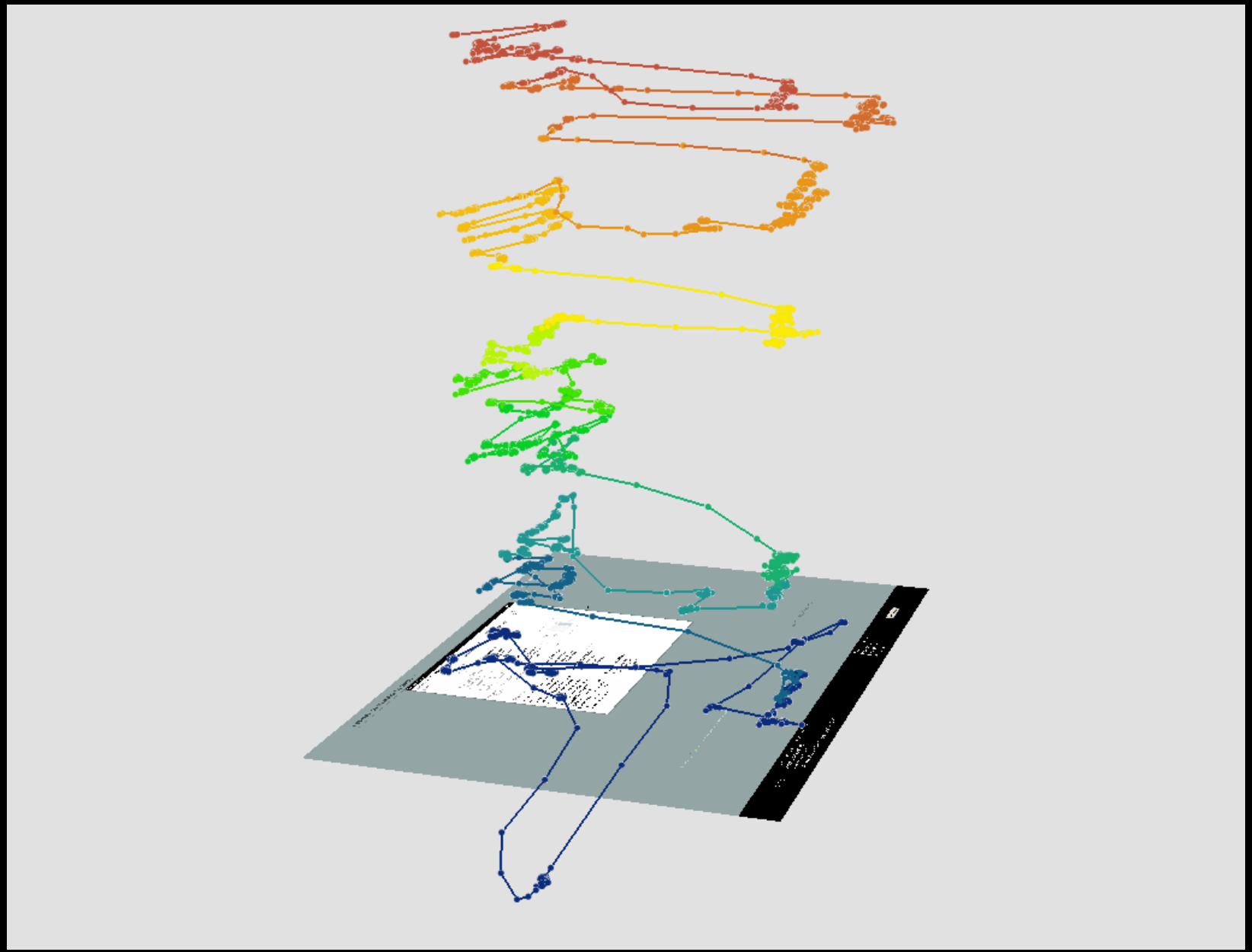
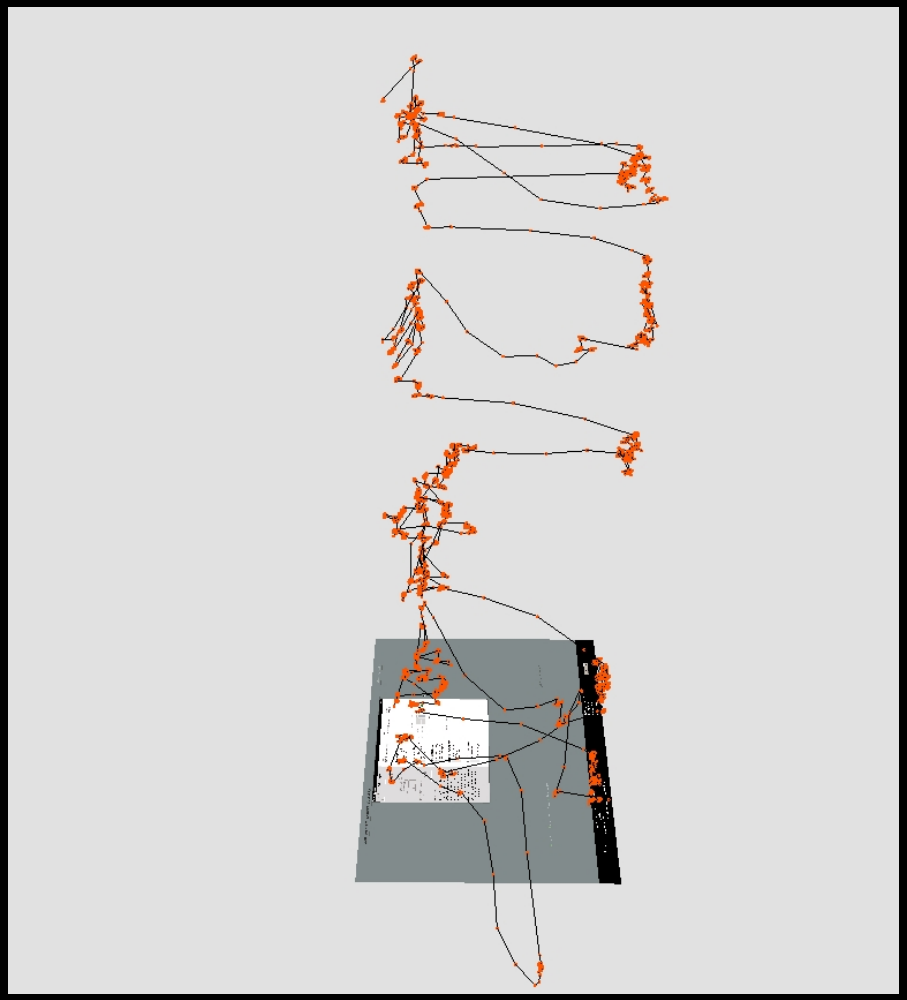
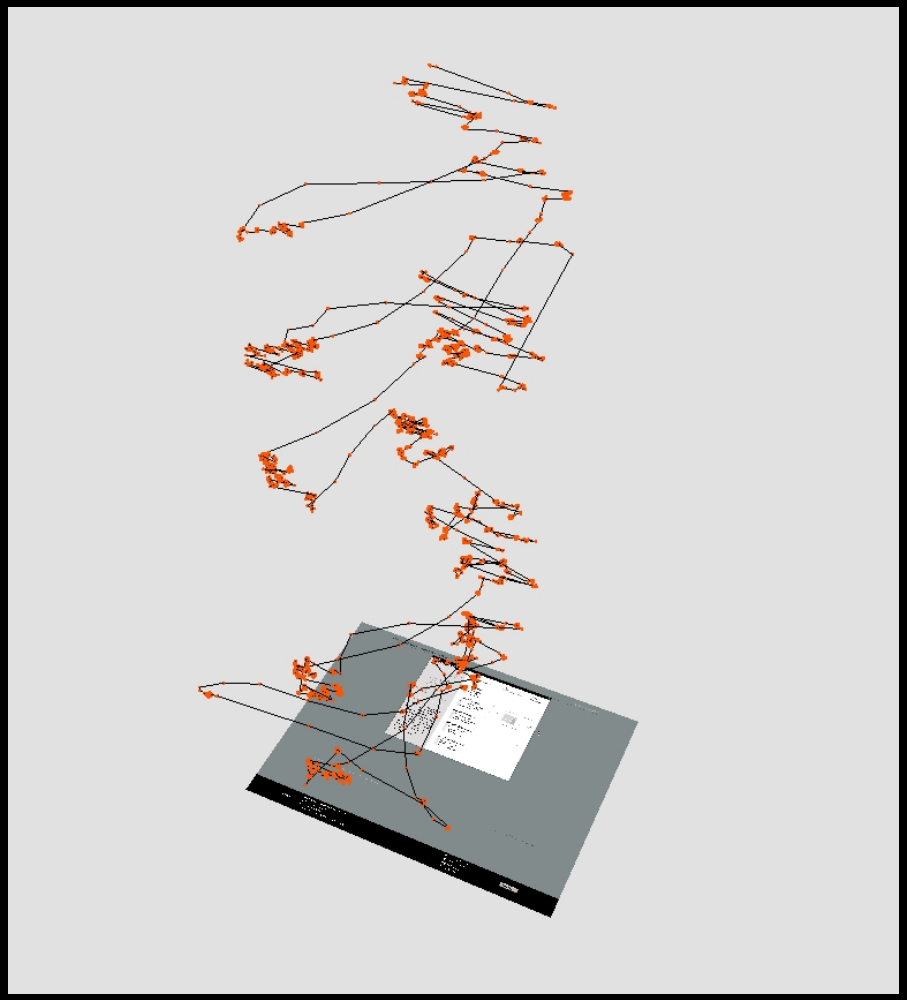
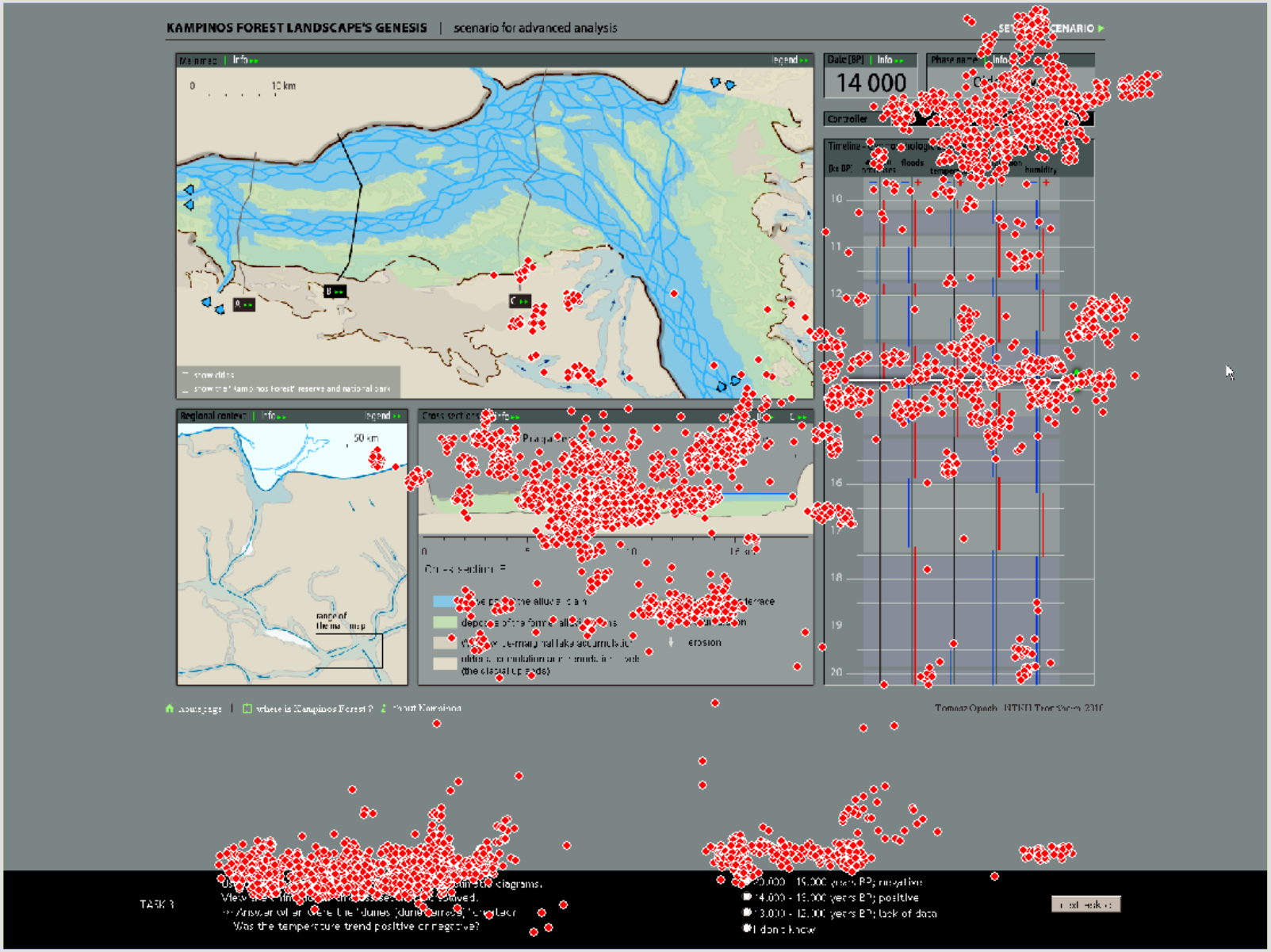
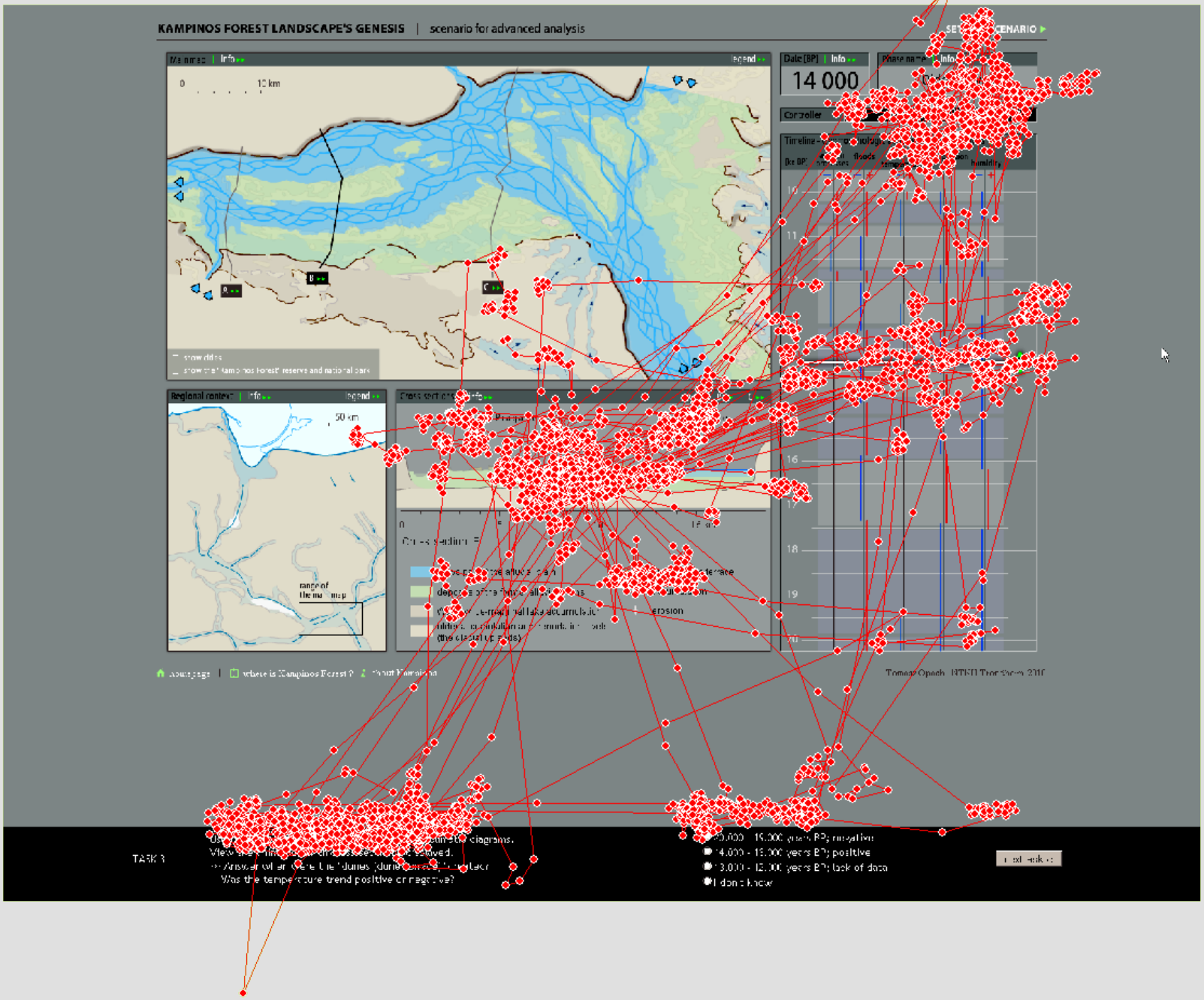
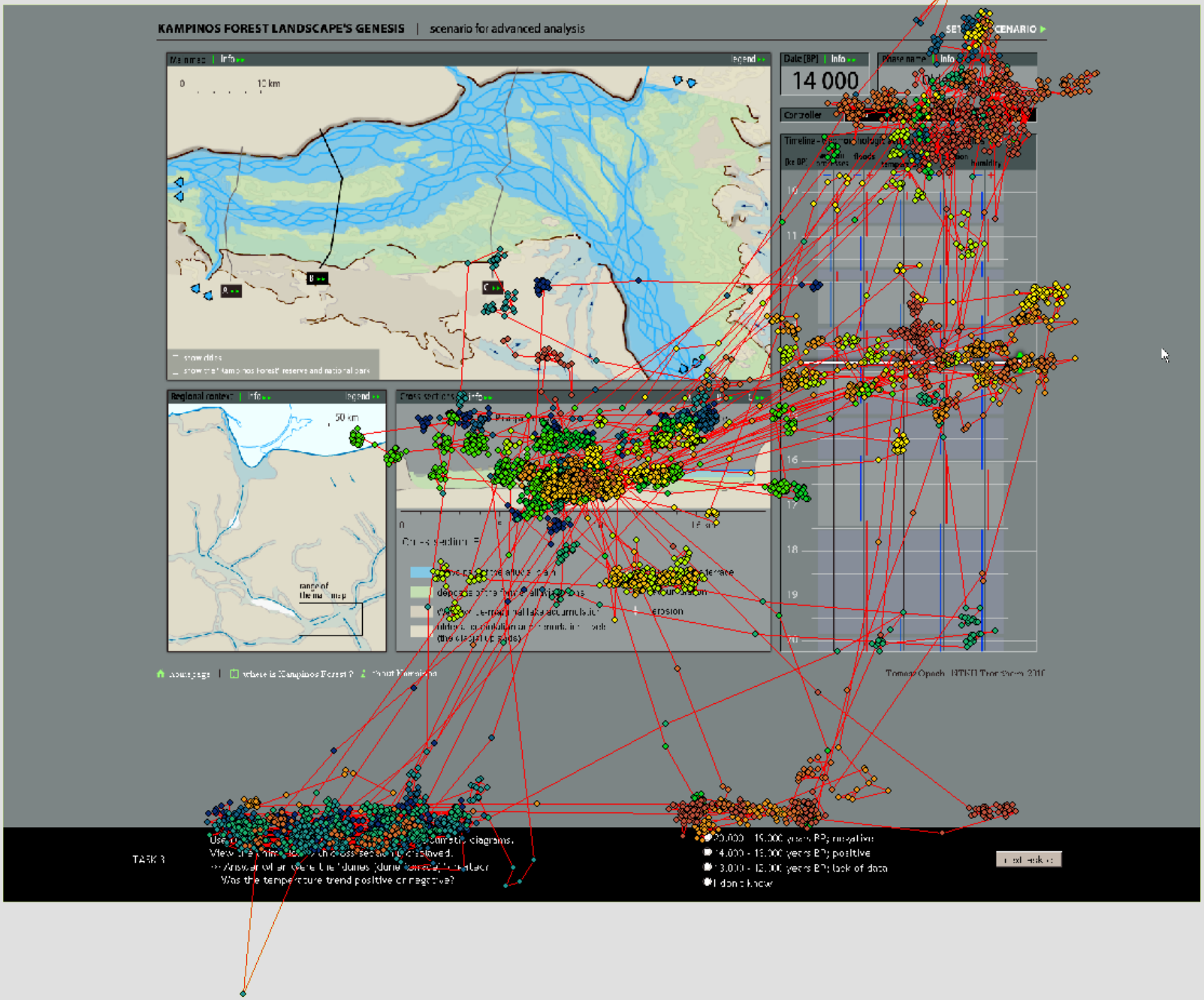


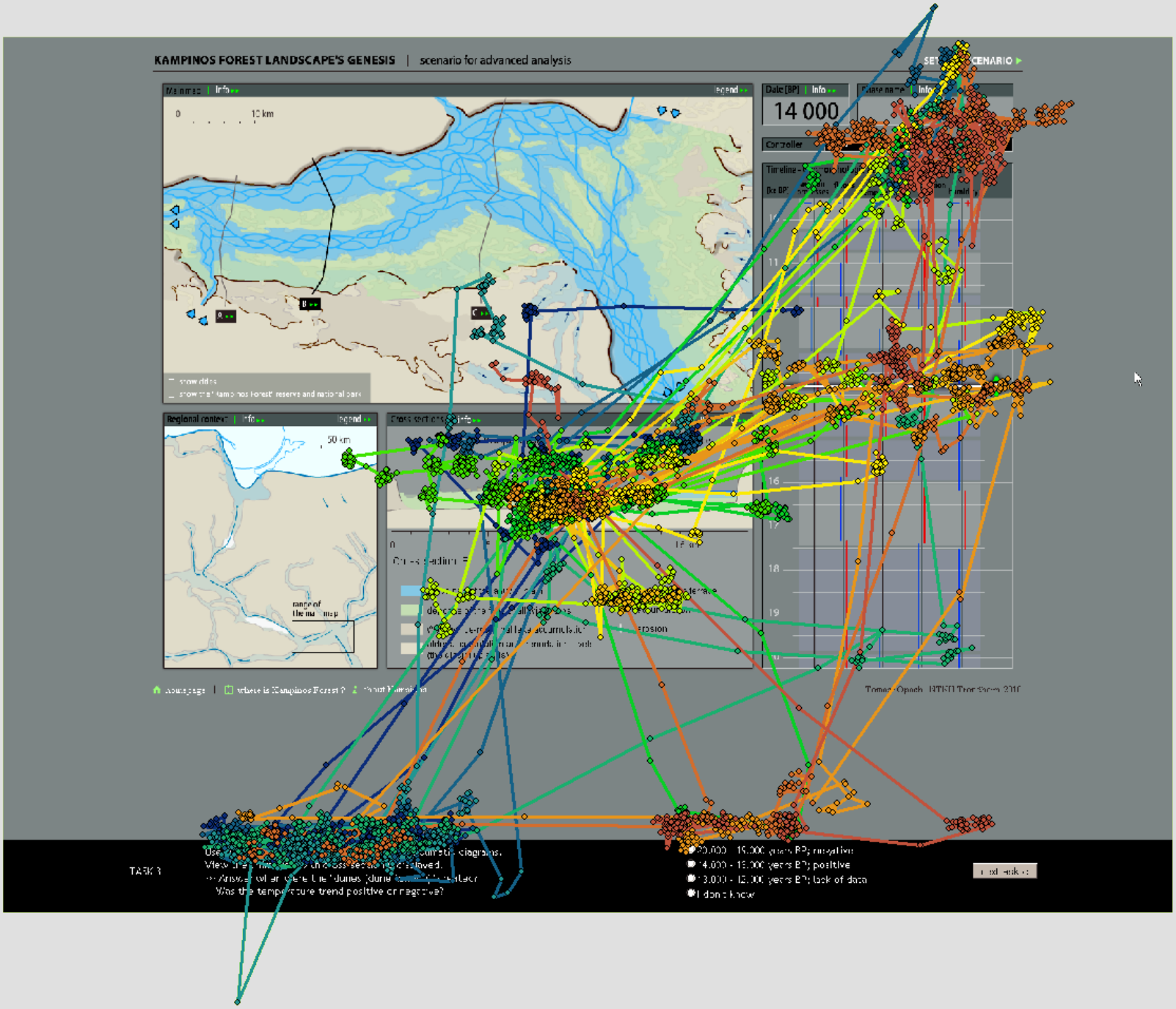





KAMPINOS FOREST LANDSCAPE'S GENESIS | scenario for advanced analysis
Date [BP] | Info
14 000
Controller
Regional context
Cross section
Tomasz Opach
TASK 3
Was the temperature trend positive or negative?
14.000 - 13.000 years BP; positive
13.000 - 12.000 years BP; lack of data
I don't know


KAMPINOS FOREST LANDSCAPE'S GENESIS | scenario for advanced analysis
Date [BP] | Info
14 000
Controller
Regional context
50 km
TASK 3
Was the temperature trend positive or negative?
14.000 - 13.000 years BP; positive
13.000 - 12.000 years BP; lack of data
I don't know


KAMPINOS FOREST LANDSCAPE'S GENESIS | scenario for advanced analysis
SCENARIO
Date [BP] | Info
14 000
Phase name | Info
Controller
Timeline
Regional context | Info
Cross sections | Info
10 km
50 km
range of the main map
Tomasz Opach, NTNU Trondheim 2016
TASK 3
Was the temperature trend positive or negative?
20.000 - 15.000 years BP; negative
14.000 - 13.000 years BP; positive
13.000 - 12.000 years BP; lack of data
I don't know


KAMPINOS FOREST LANDSCAPE'S GENESIS | scenario for advanced analysis
SCENARIO
Main map | Info
legend
0
10 km
Date [BP] | Info
14 000
Controller
Timeline
Regional context | Info
legend
50 km
range of
Cross sections | Info
Cross section
Erosion
Tomasz Opach, NTNU Trondheim 2016
TASK 3
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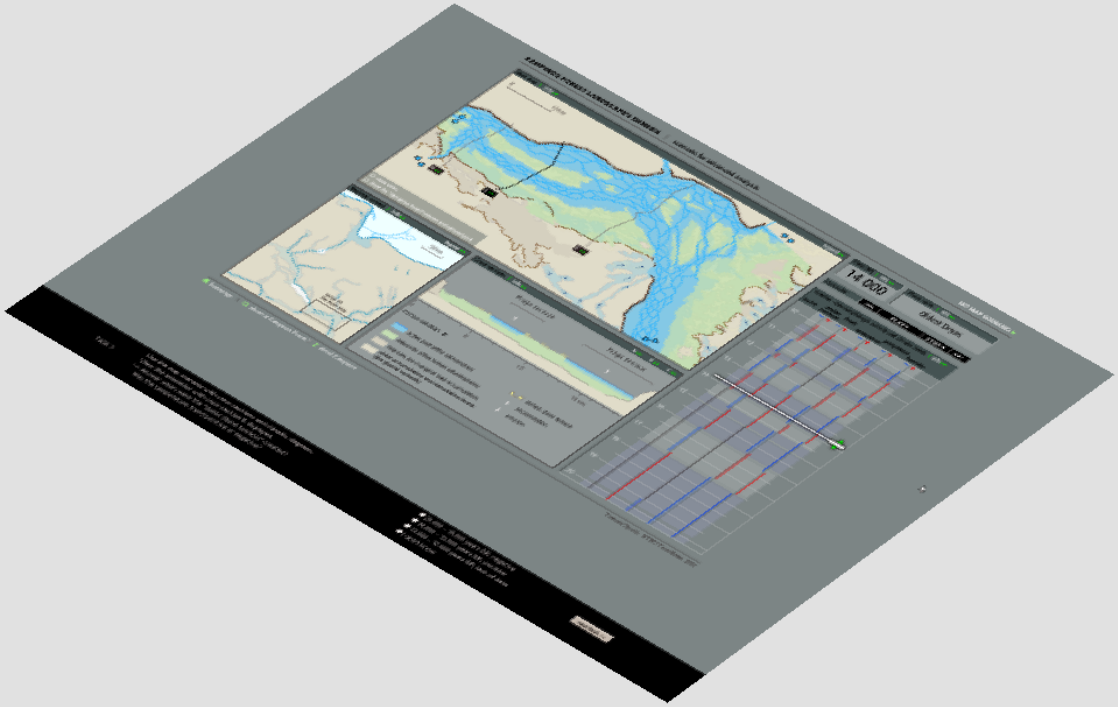
20.000 - 15.000 years BP; negative
14.000 - 13.000 years BP; positive
13.000 - 12.000 years BP; lack of data
I don't know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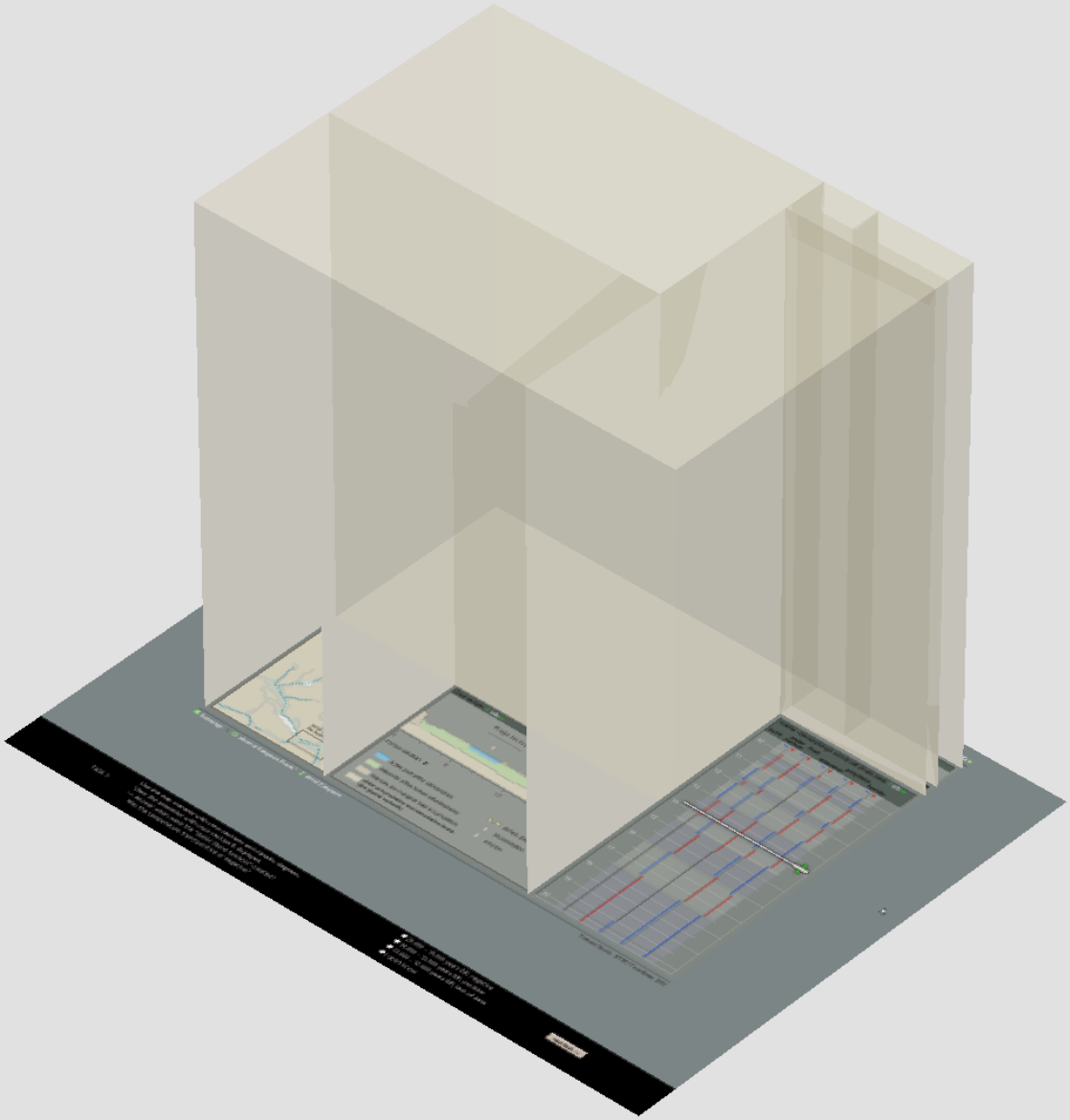

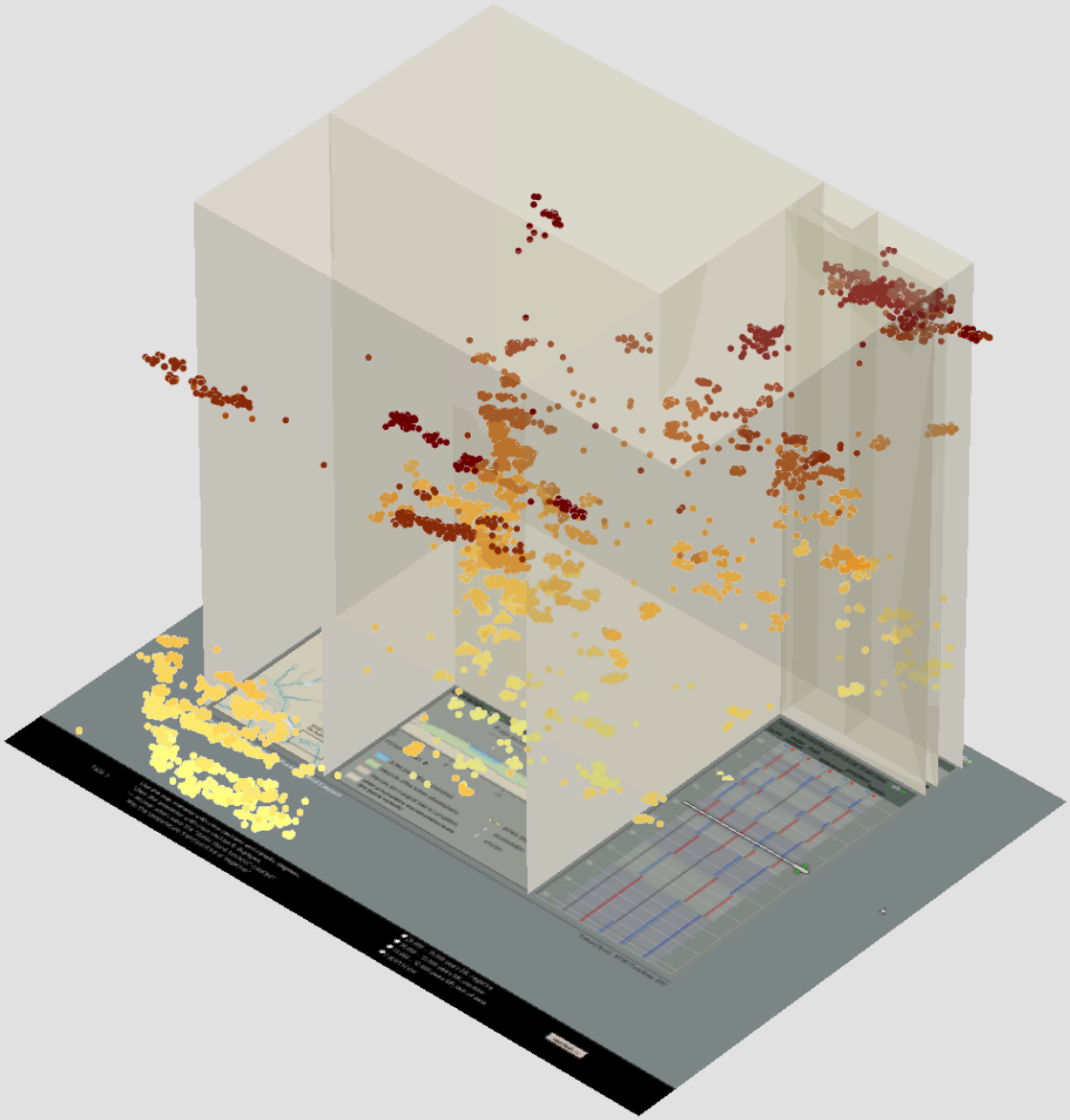

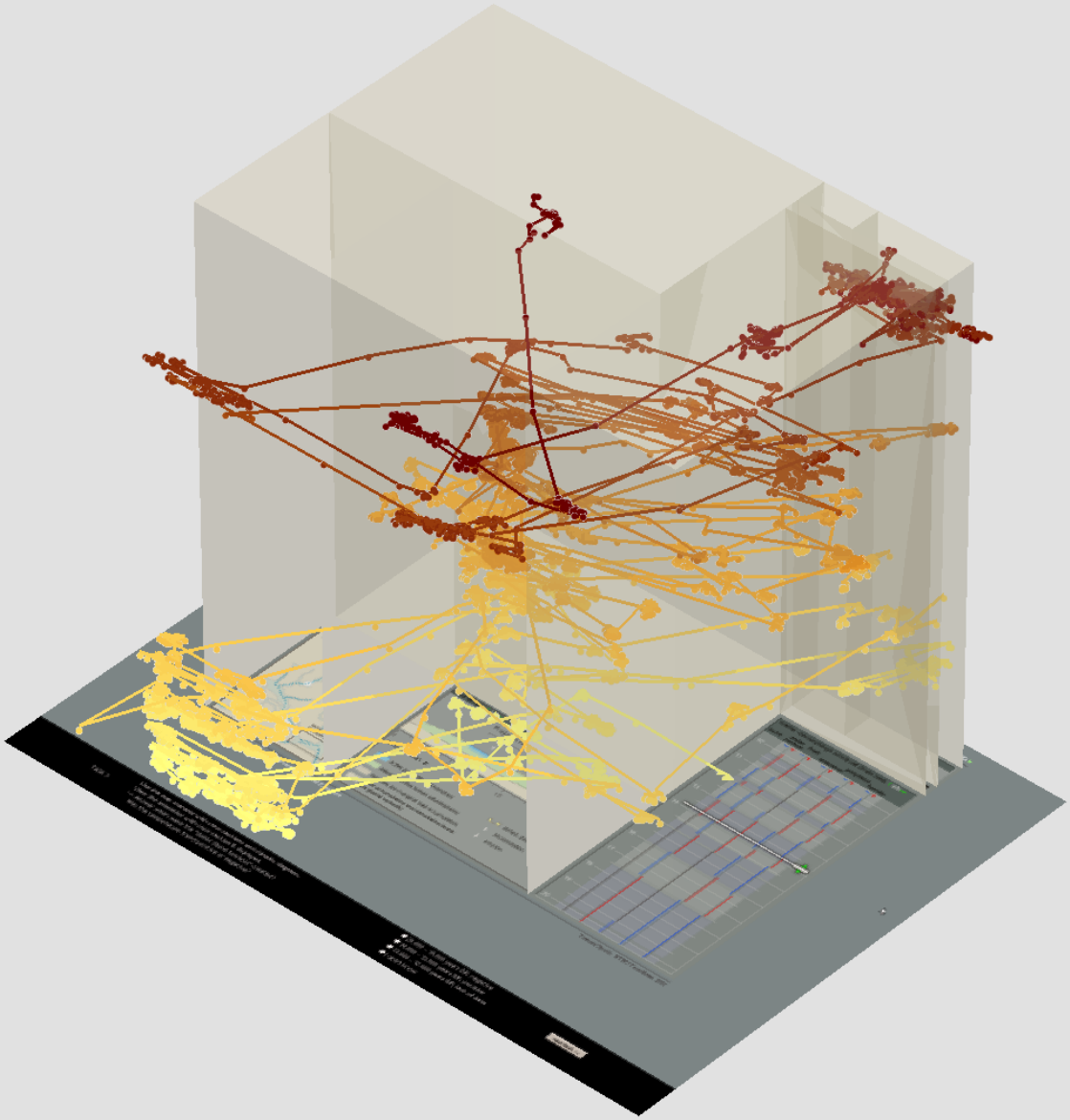

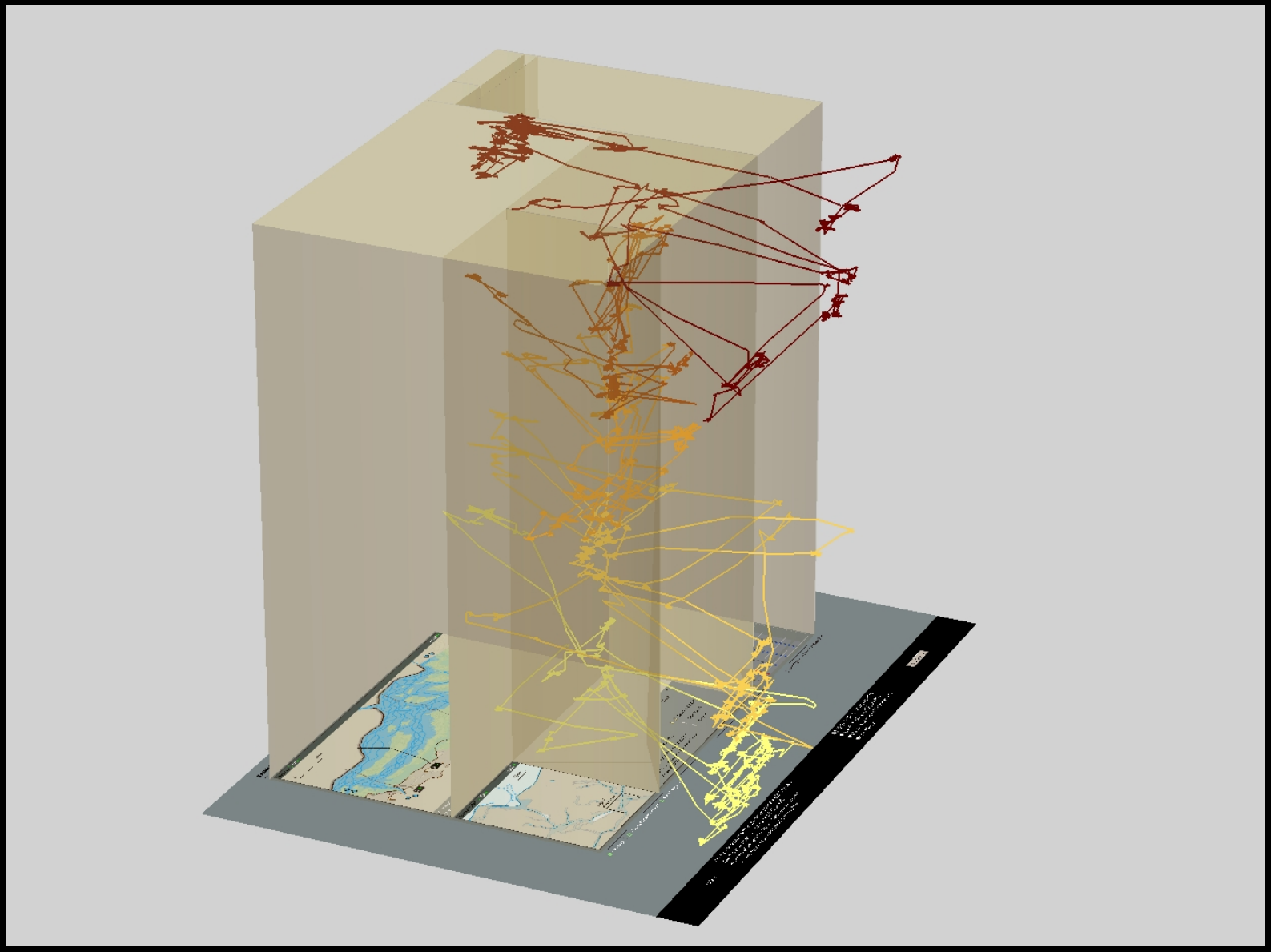

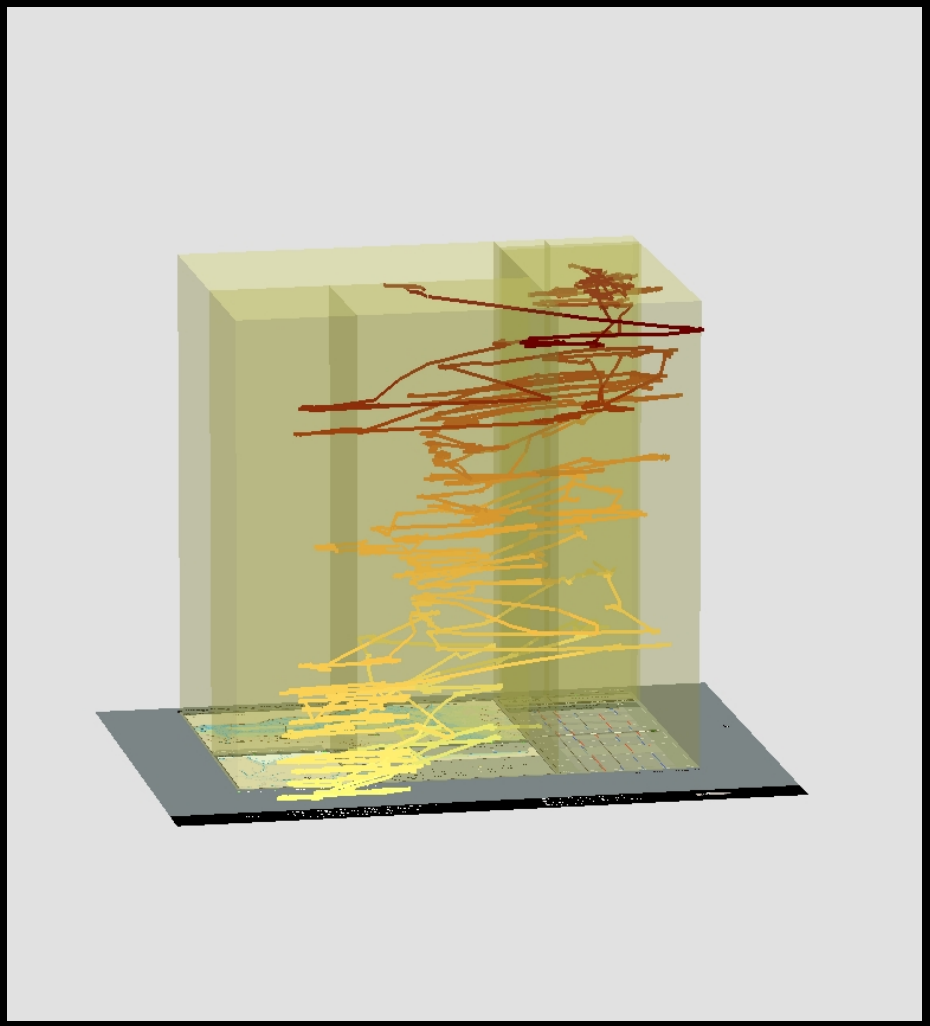

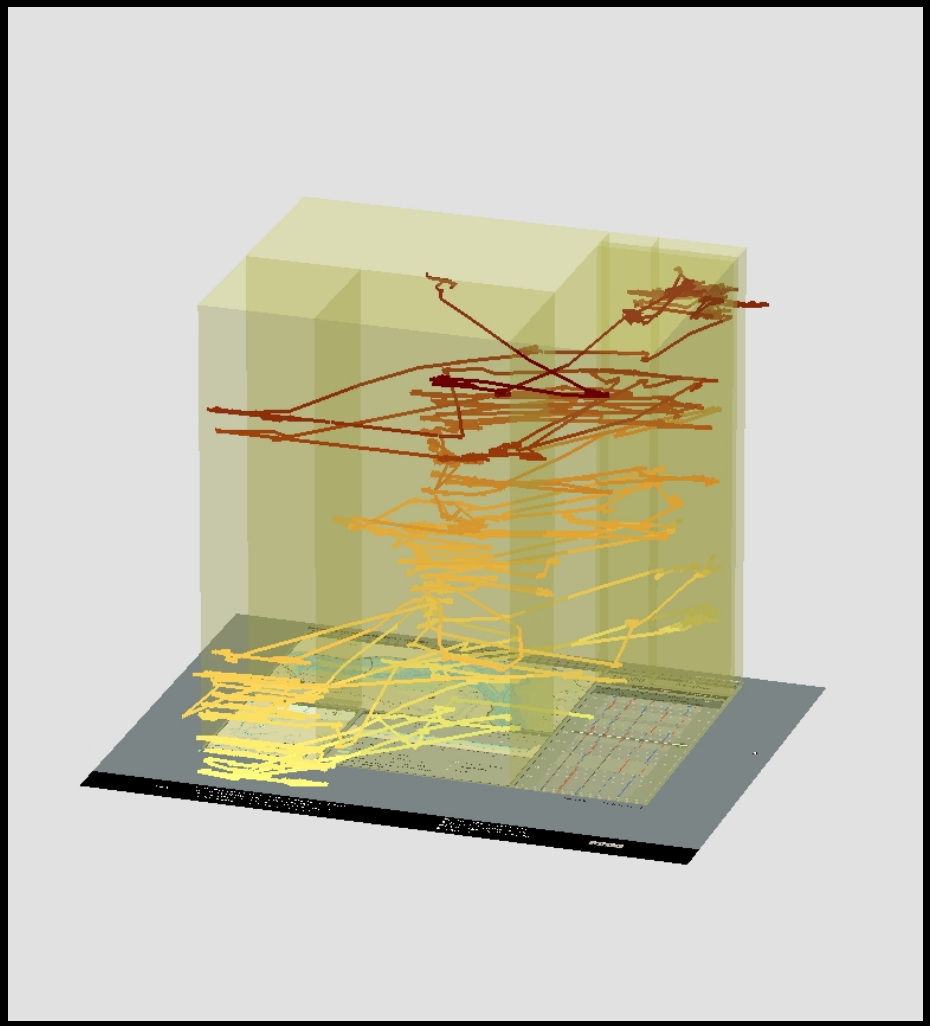

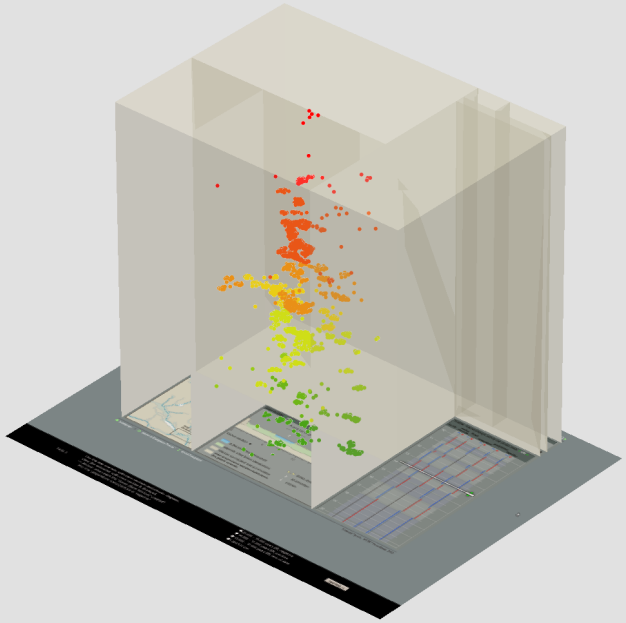

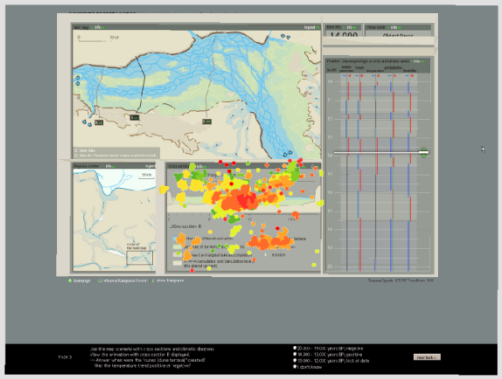

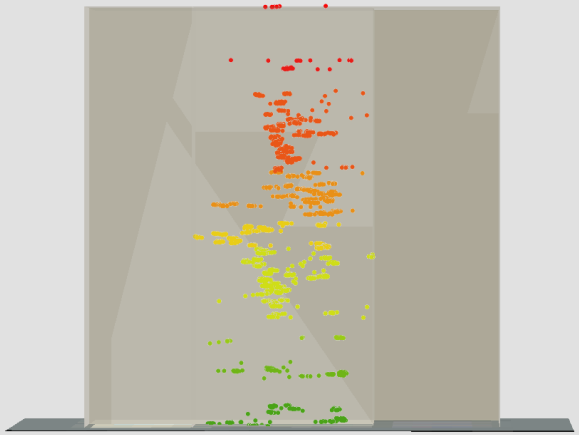

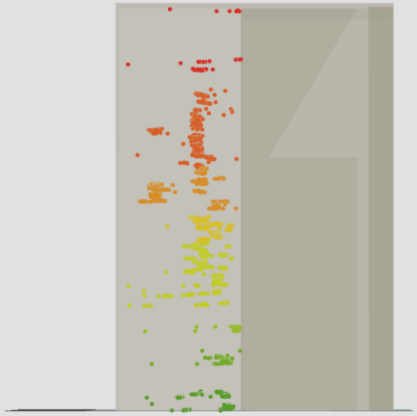

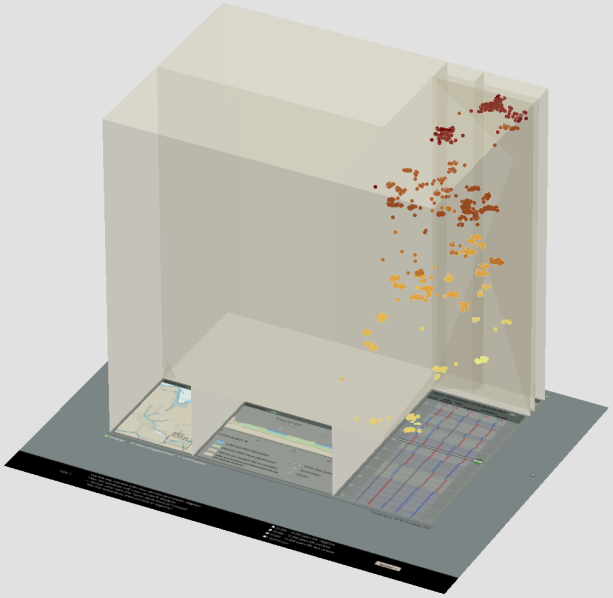

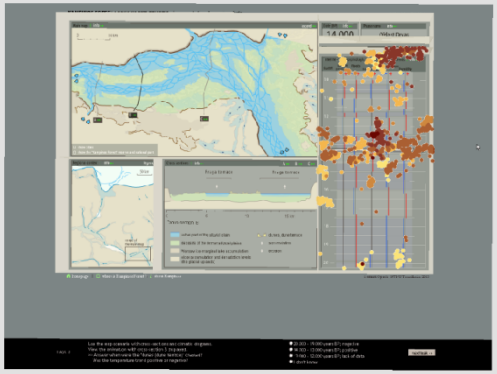

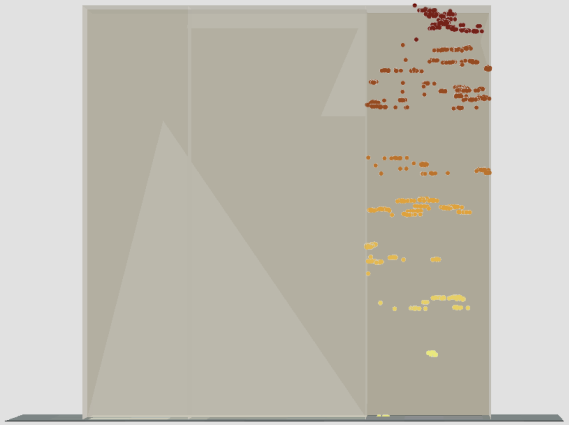

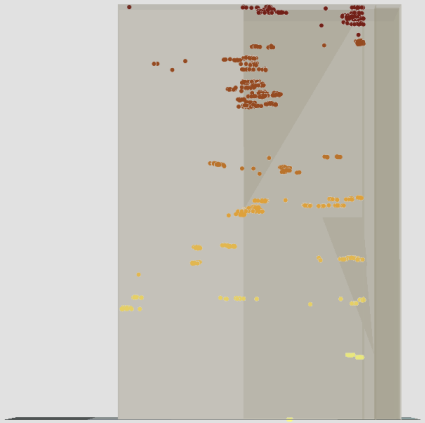

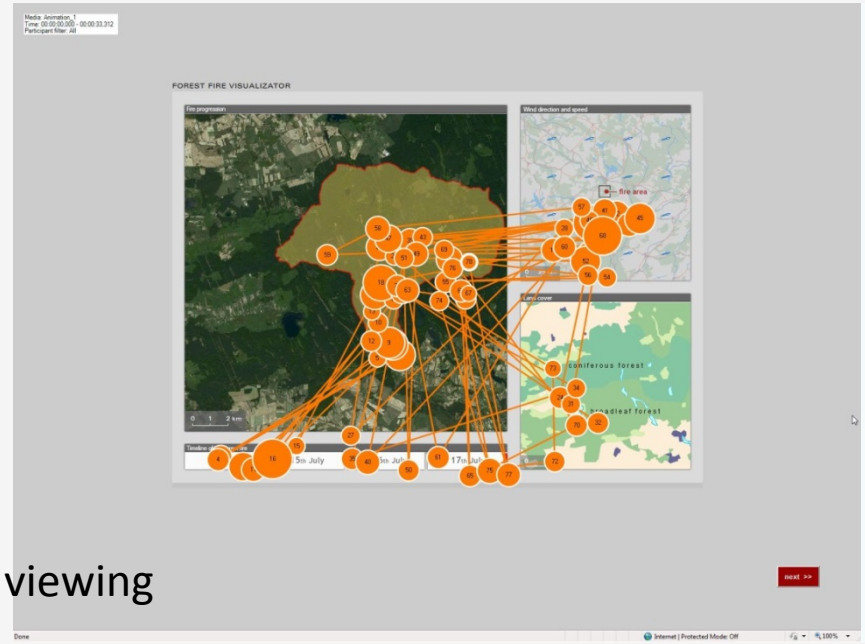

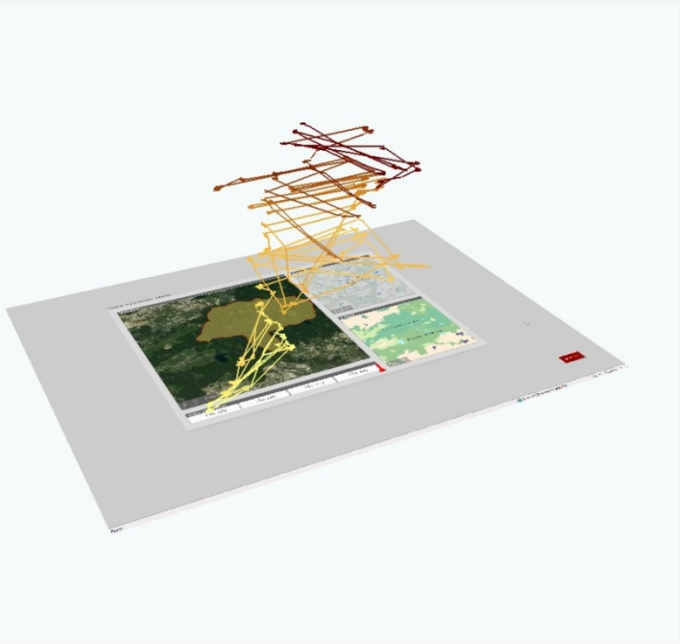

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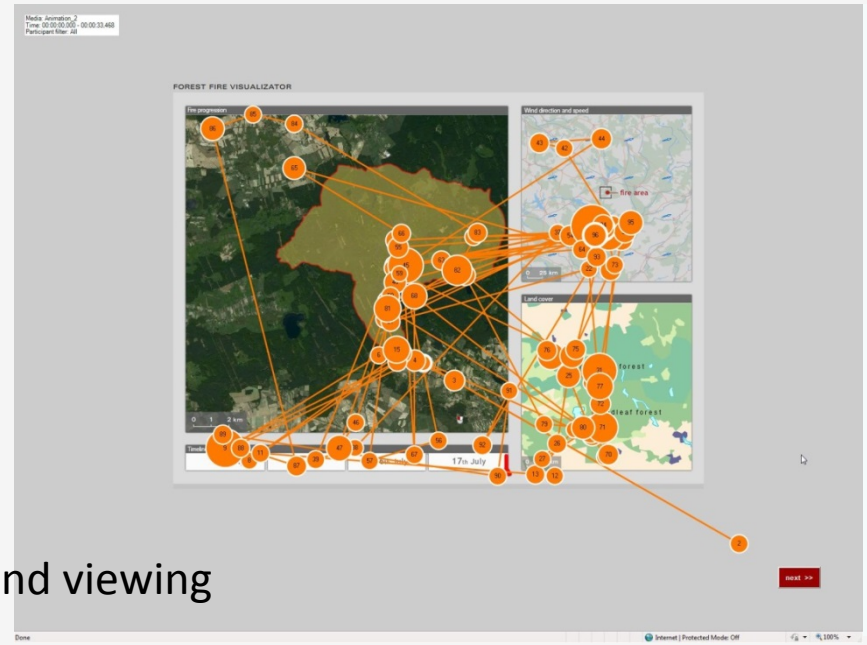

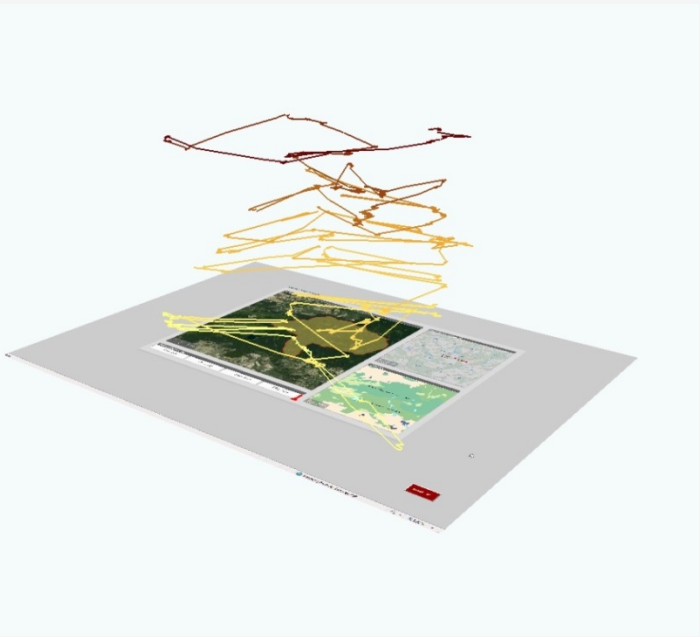

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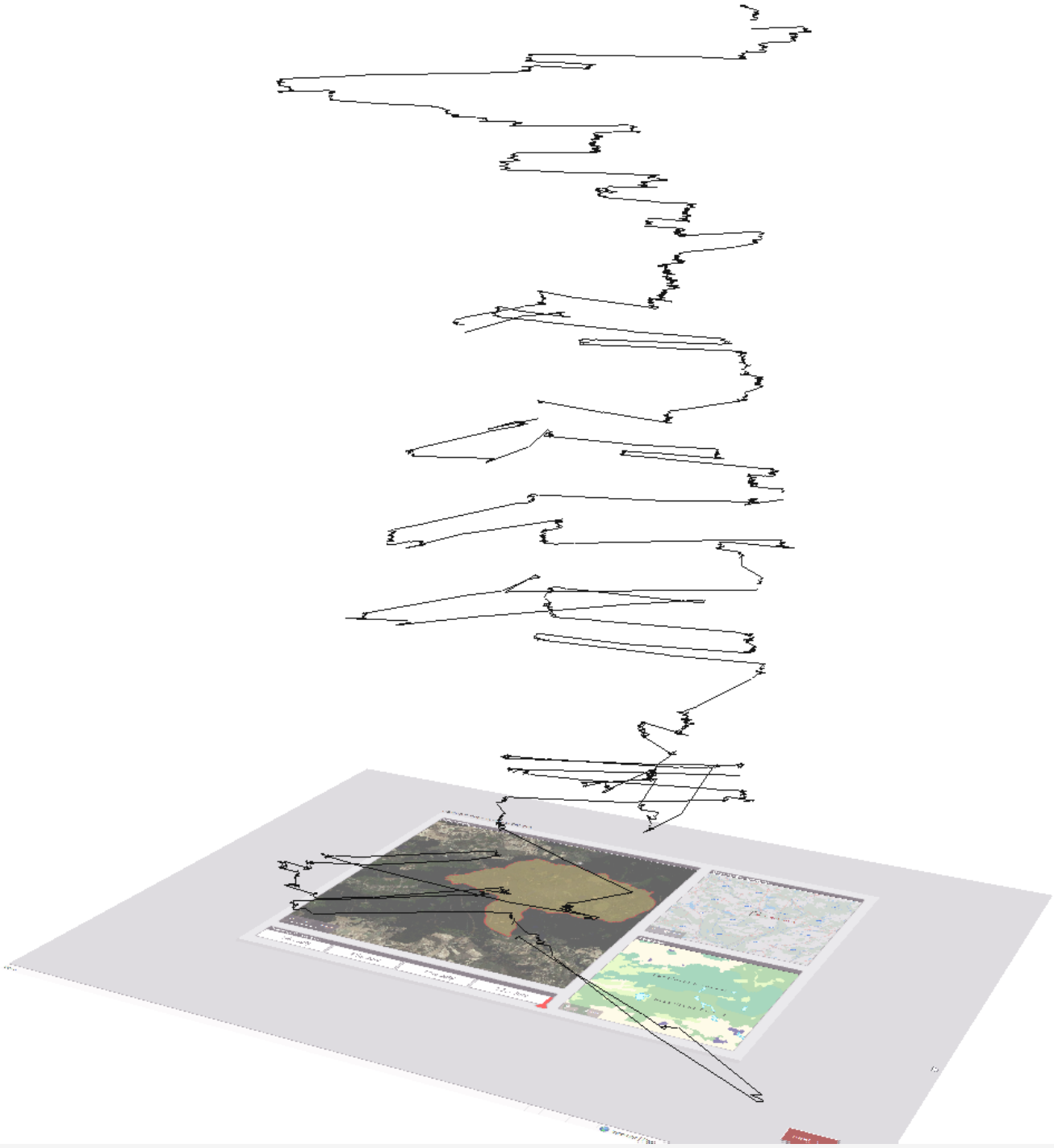

conclusion

The examples are quite straightforward.
Nevertheless, they demonstrate the potential for GIS applied to eye-movement data analysis

For cartographers already acquainted with GIS tools it is quite easy to use such applications to handle eye movements data

There are of course much more possibilities of use, but their applicability depends on the goals which are addressed

NTNU
Det skapende universitet

tomasz.opach@svt.ntnu.no

jan.rod@svt.ntnu.no