Institute of Geology and Geography

Evaluation of the sea level rise aspects on the Lithuanian coast and modeling of its impacts

J. Šečkus, L. Ž. Gelumbauskaitė

jonas.seckus@geo.lt; leonora@geo.lt

Riga 11 05 2007

Trzesacz church (West Poland)

German friars founded the Trzesacz town in 12th century. The church of the town was built in the 15th century about 1,8 km from the coast!!!

In the 17th century (because of sea level rise) were destroyed the cemeteries of the town. In the beginning of the 21st century is left only the southern wall of the church. 1800 m in 600 years!!!!

Photos by dr. Ricardo Olea (USA)

Content of presentation

1. Review of the data;
2. Seismogeological profiles;
3. Curves of sea level changes;
4. Digital elevation model;
5. Model of paleorelief (for 10500 years);
6. Influence of the sea level rise for Lithuanian coast;
7. Lack of legal framework and scientific research in Lithuanian seashore.

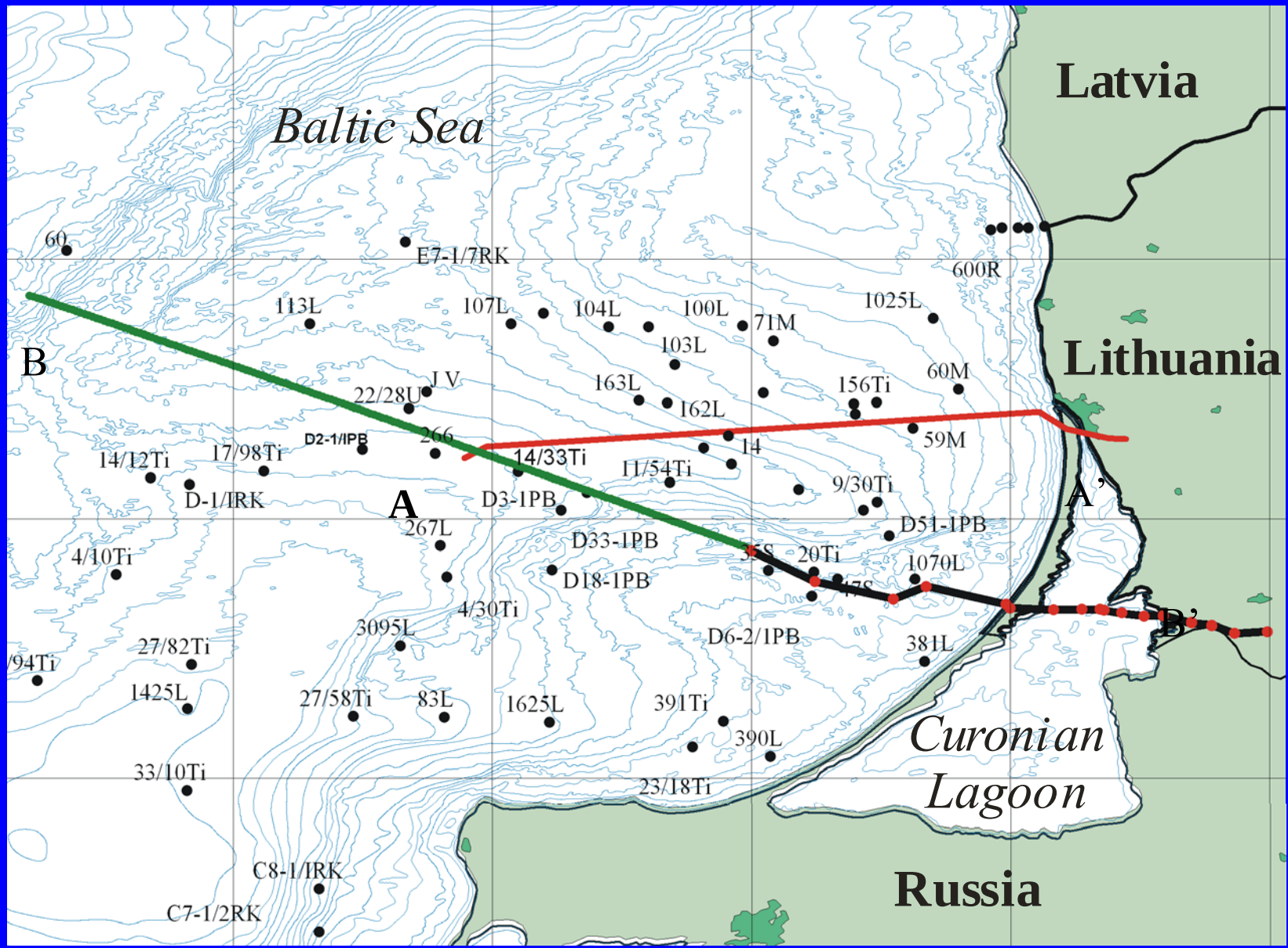
Data

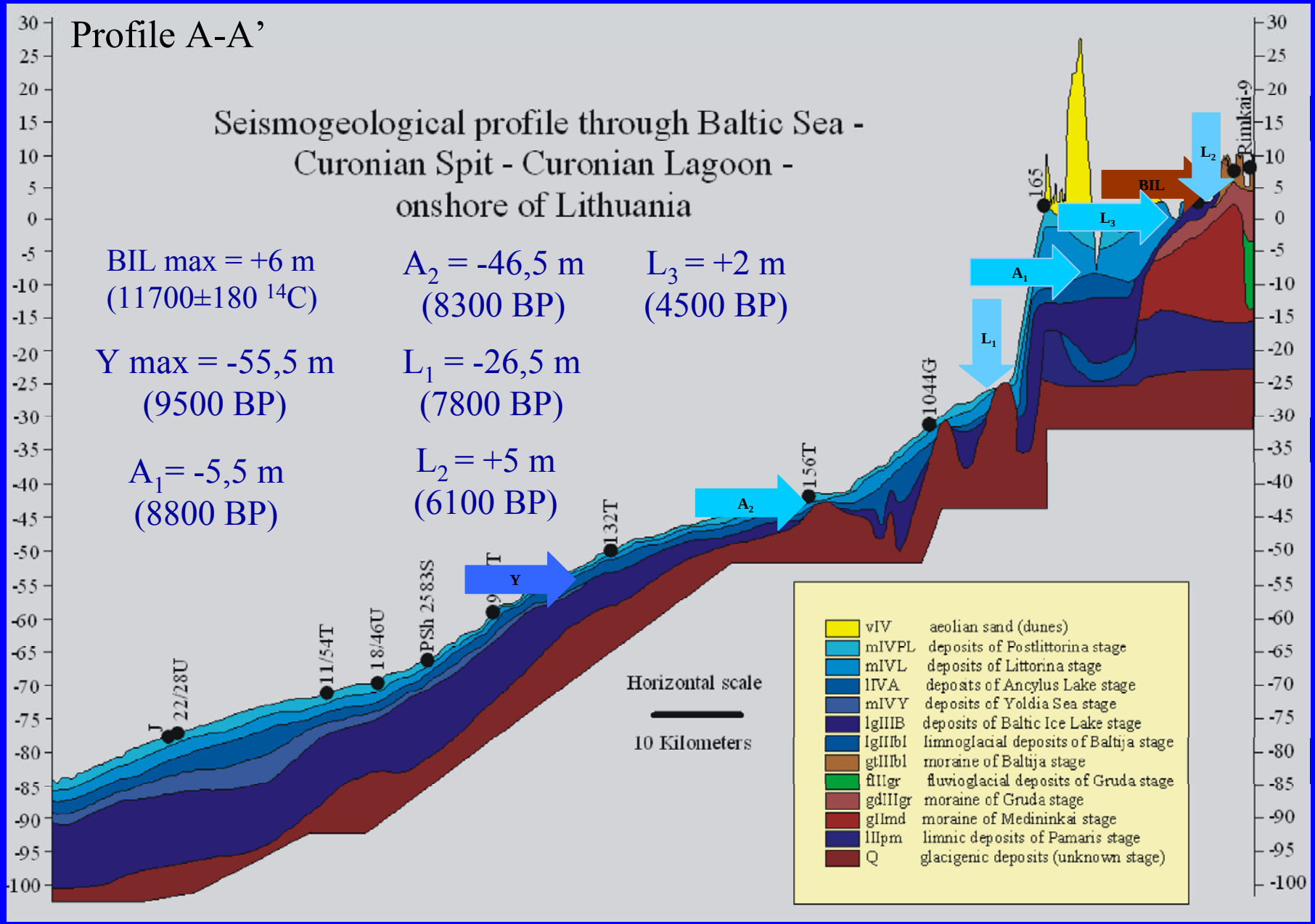
The interpretation of two seismogeological profiles was performed in detail

633 points for modelling were used

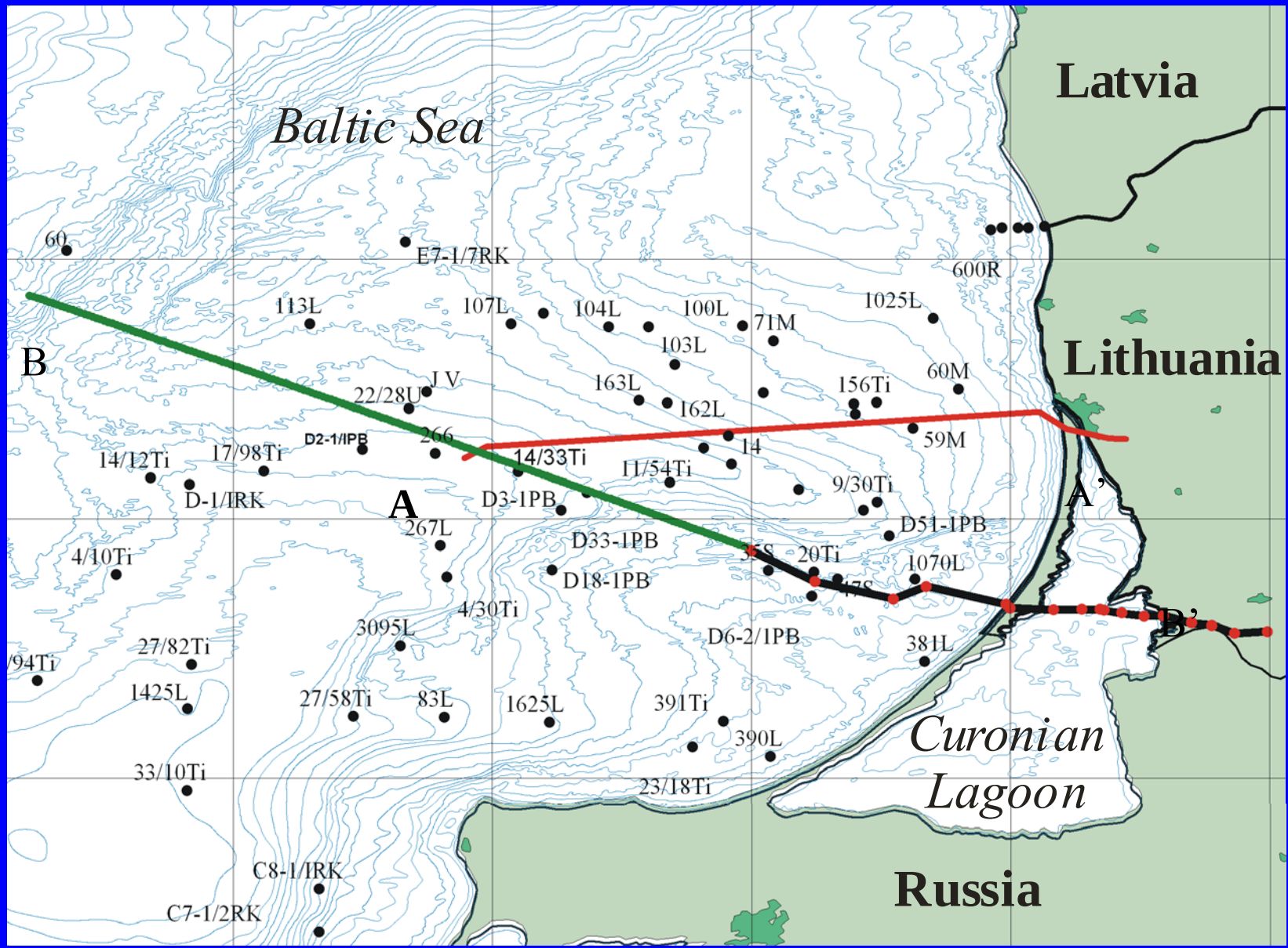
1. 209 points were taken after the interpretation of seismoacoustic data;
2. 421 cores (offshore) and boreholes (onshore);
3. 3 nonfactual points (based on expert recommendations).

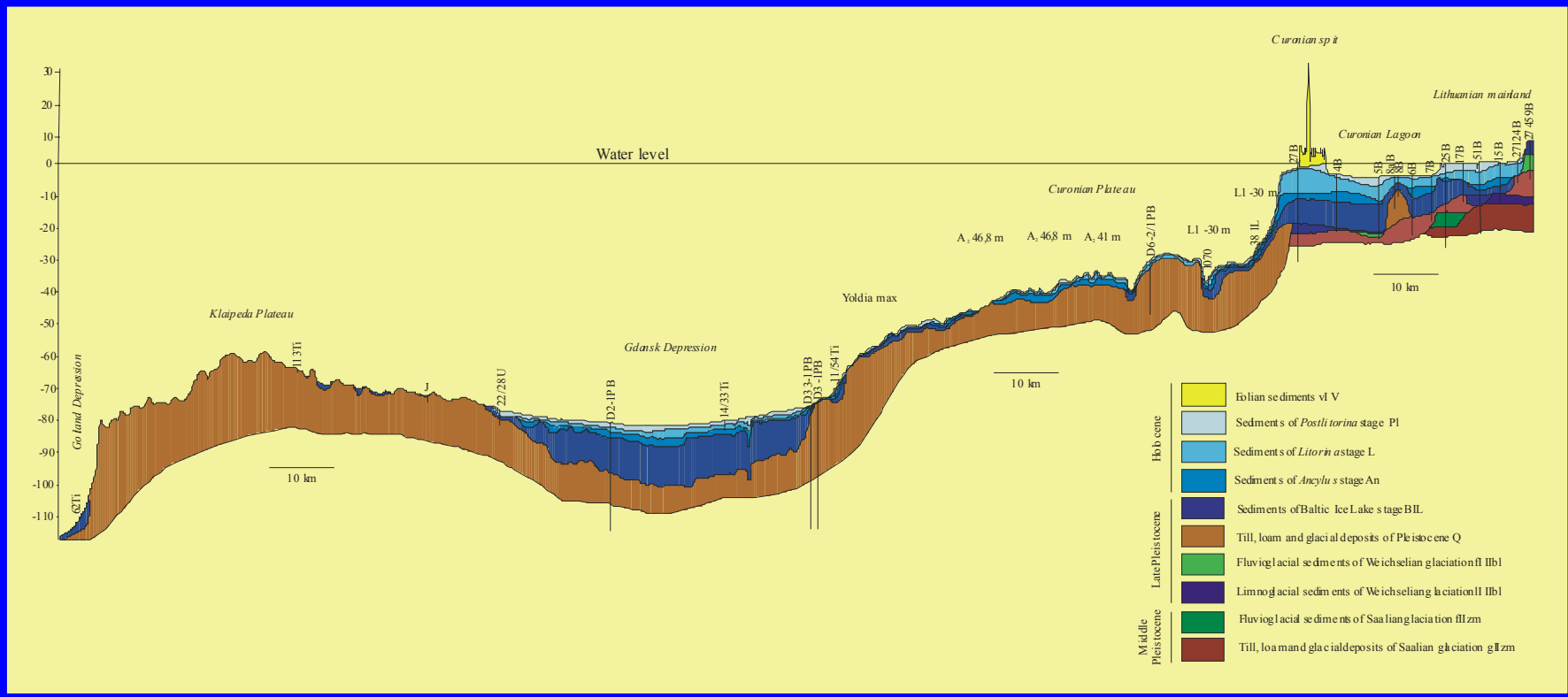
Working area

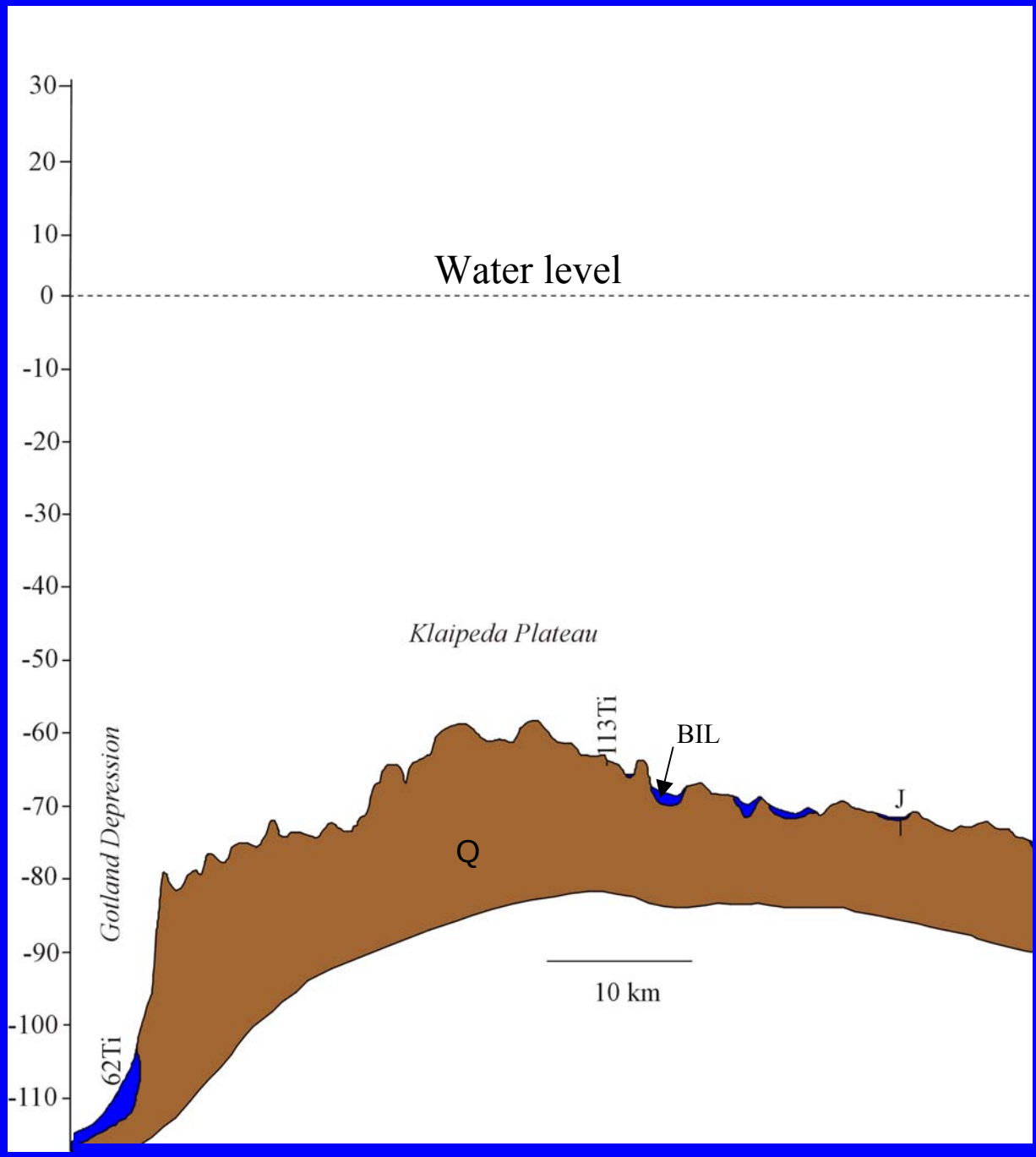



Profile A-A'
Seismogeological profile through Baltic Sea -
Curonian Spit - Curonian Lagoon -
onshore of Lithuania
BIL max = +6 m
(11700±180 14C)
A2 = -46,5 m
(8300 BP)
L3 = +2 m
(4500 BP)
Y max = -55,5 m
(9500 BP)
L1 = -26,5 m
(7800 BP)
A1= -5,5 m
(8800 BP)
L2 = +5 m
(6100 BP)
Rimkai-9
165
1044G
156T
132T
PSh 2583S
18/46U
11/54T
22/28U
BIL
L2
L3
A1
L1
A2
Y
Horizontal scale
10 Kilometers
vIV aeolian sand (dunes)
mIVPL deposits of Postlittorina stage
mIVL deposits of Littorina stage
lIVA deposits of Ancylus Lake stage
mIVY deposits of Yoldia Sea stage
lgIIIB deposits of Baltic Ice Lake stage
lgIIIbl limnoglacial deposits of Baltija stage
gtIIIbl moraine of Baltija stage
flIIgr fluvioglacial deposits of Gruda stage
gdIIIgr moraine of Gruda stage
glImd moraine of Medininkai stage
lIIpm limnic deposits of Pamaris stage
Q glacigenic deposits (unknown stage)

Tyrimų plotas

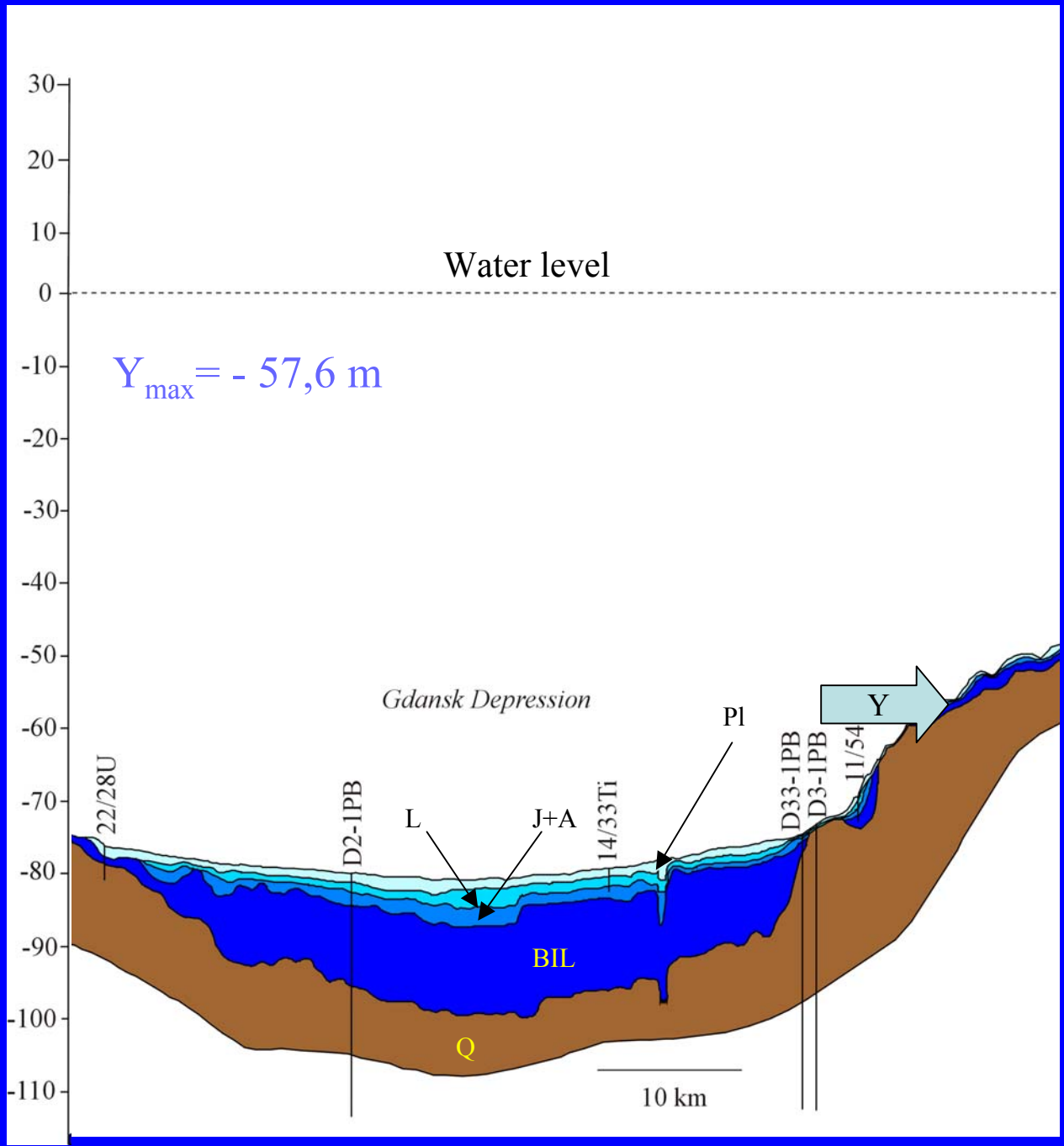



Curonian spit
Lithuanian mainland
Curonian Lagoon
Water level
Curonian Plateau
Klaipeda Plateau
Gdansk Depression
Yoldia max
Gotland Depression
L1 -30 m
L1 -30 m
10 km
10 km
10 km
Holocene
Eolian sediments vl V
Sediments of Postlitorina stage Pl
Sediments of Litorina stage L
Sediments of Ancylus stage An
Late Pleistocene
Sediments of Baltic Ice Lake stage BIL
Till, loam and glacial deposits of Pleistocene Q
Fluvioglacial sediments of Weichselian glaciation fl IIb1
Limnoglacial sediments of Weichselian glaciation l IIb1
Middle Pleistocene
Fluvioglacial sediments of Saalian glaciation fl Izm
Till, loam and glacial deposits of Saalian glaciation gl Izm



Klaipeda plateau

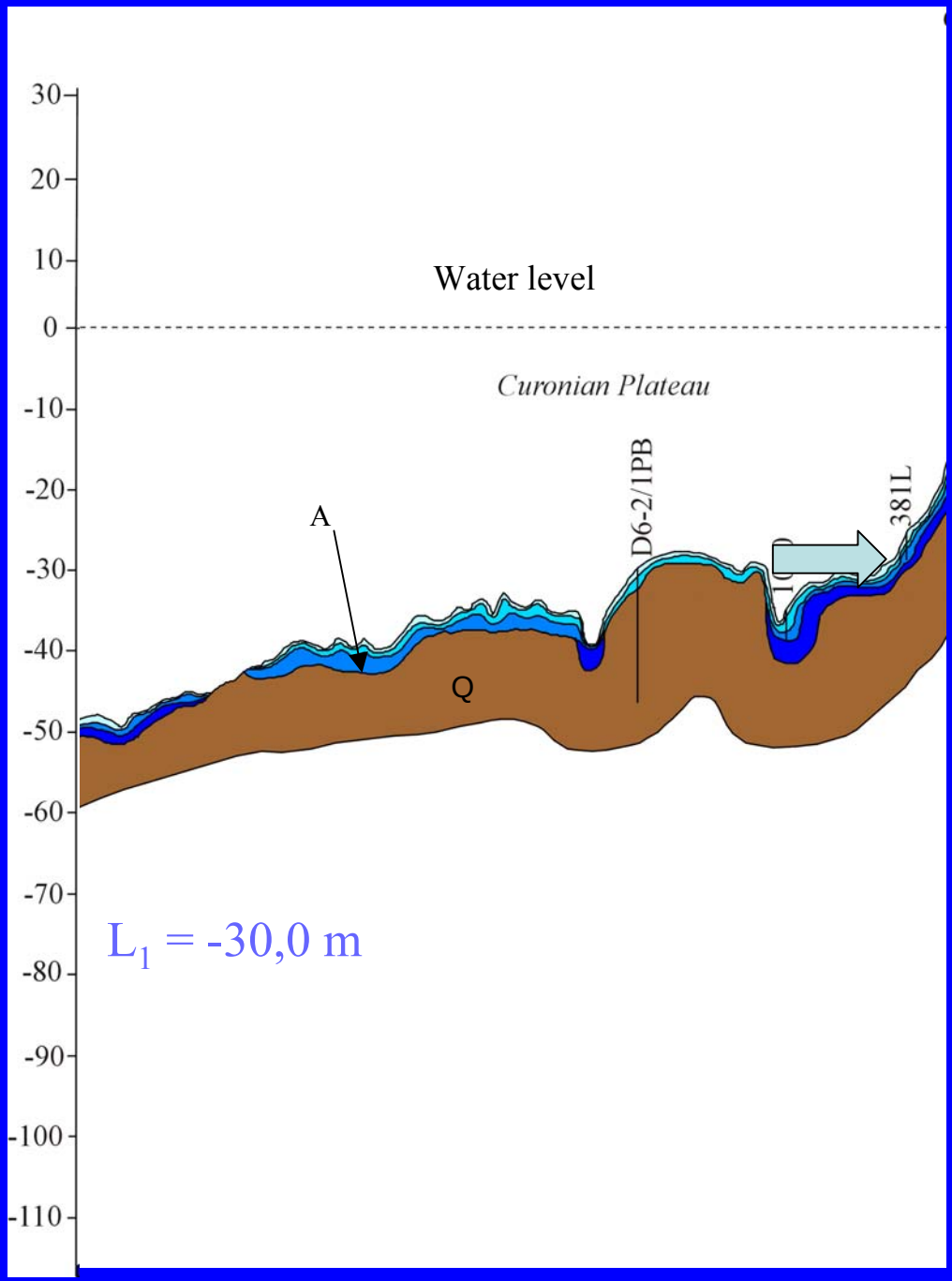
Almost all area has no postglacial deposits. Only in some lows BIL sediments with thickness not more than 2-3 m are foundable.



Gdansk Depression

Contains of thick BIL sediments layer (from 1-2 m at the slopes to 15 m in central part of the depression). Holocene contains of the layer with thickness to 10 m in central part.

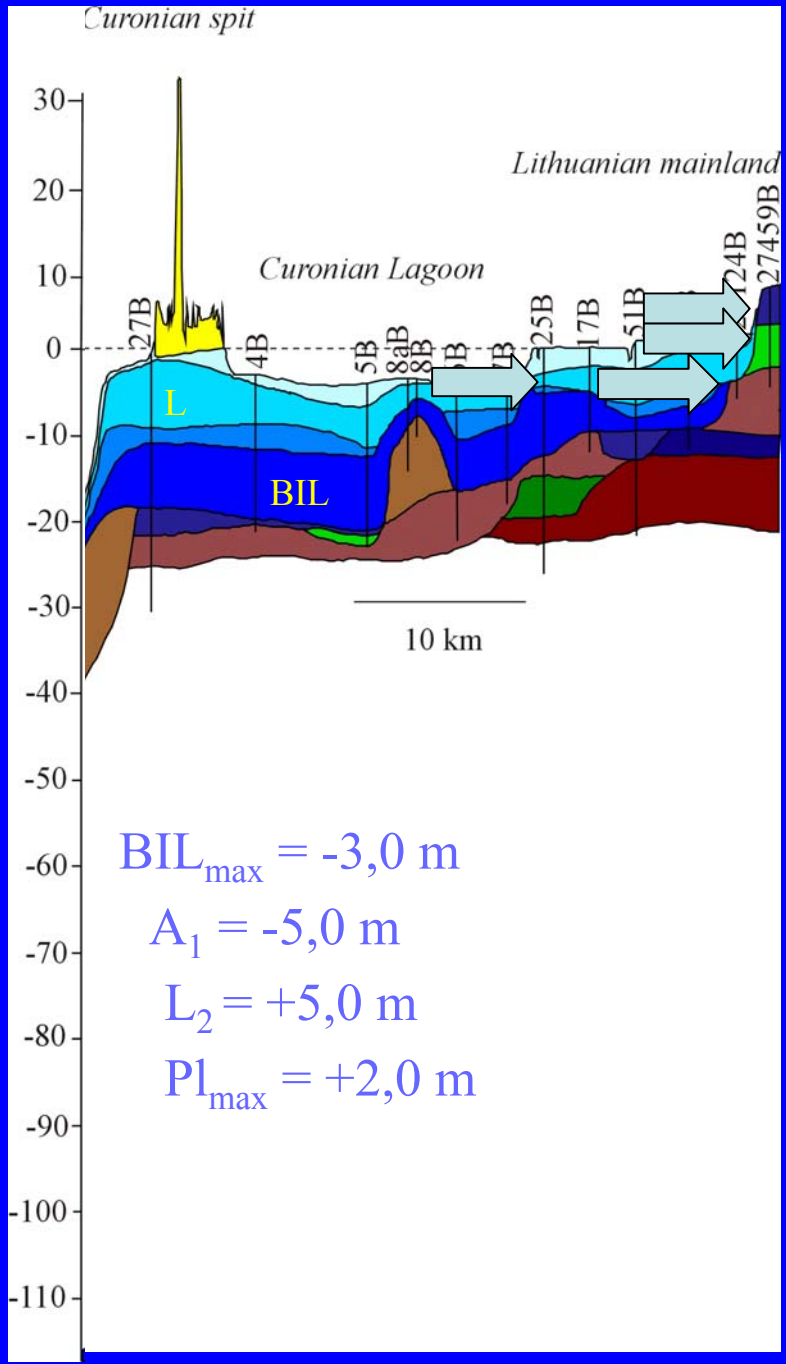
In seismoacoustic record are seeable structures similar to paleoincisions. Detail study of the geomorphology shows that Y coast terrace occurs in the depth -57,6 m.



Curonian Plateau

Curonian plateau is the structure formed by paleo Nemunas delta. Holocene overlays till and contains of the layer not thicker than 5 m. In central part of Curonian Plateu layer of Ancylus Lake sediments is about 3 m of thickness. In the deeps occur thin layer (1-3 m) of the Baltic Ice Lake sediments.

At the depth of -30 m was found L_1 transgression coast terrace.



BIL_{max} = -3,0 m

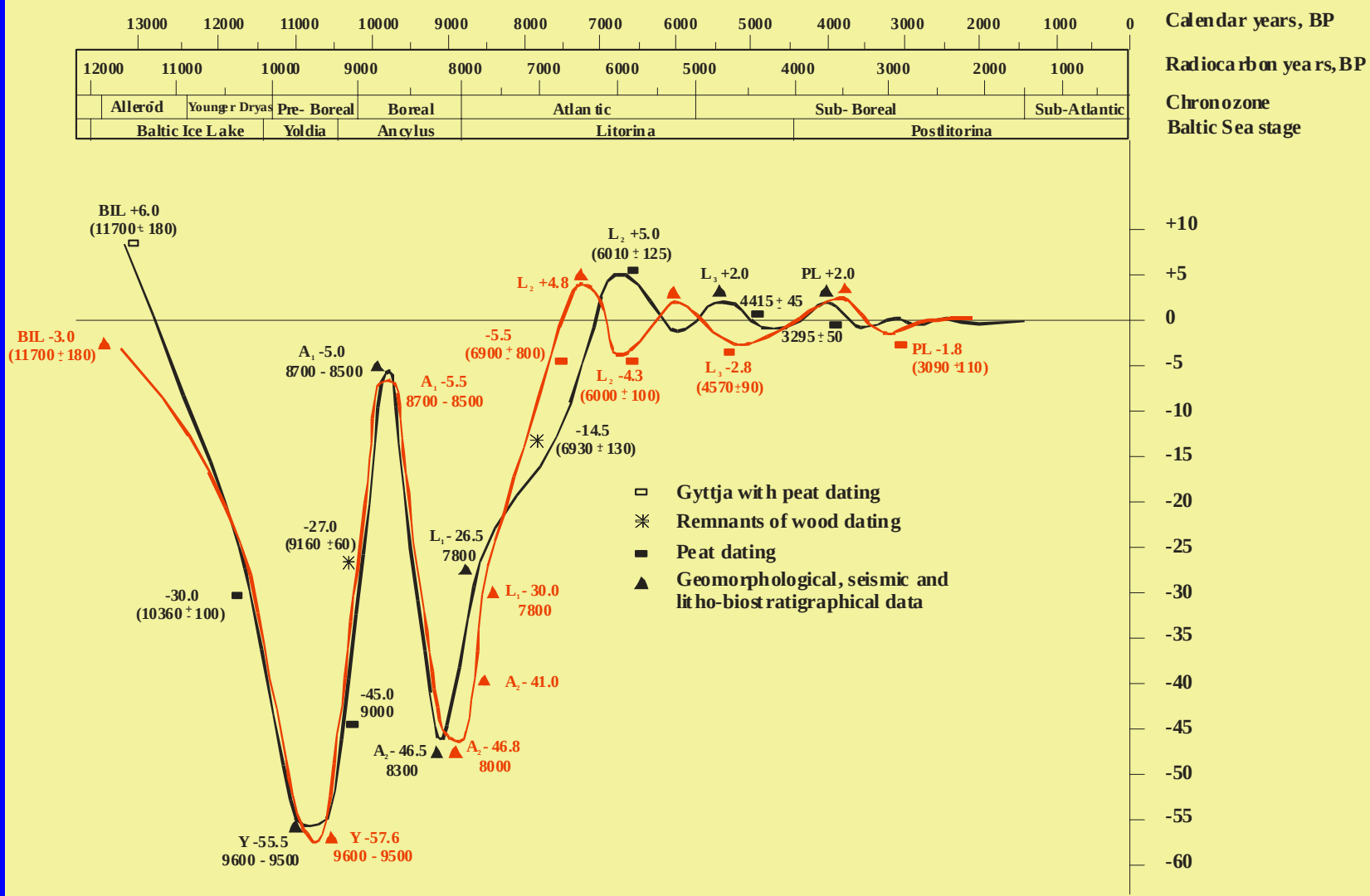
A_1 = -5,0 m

L_2 = +5,0 m

Pl_{max} = +2,0 m

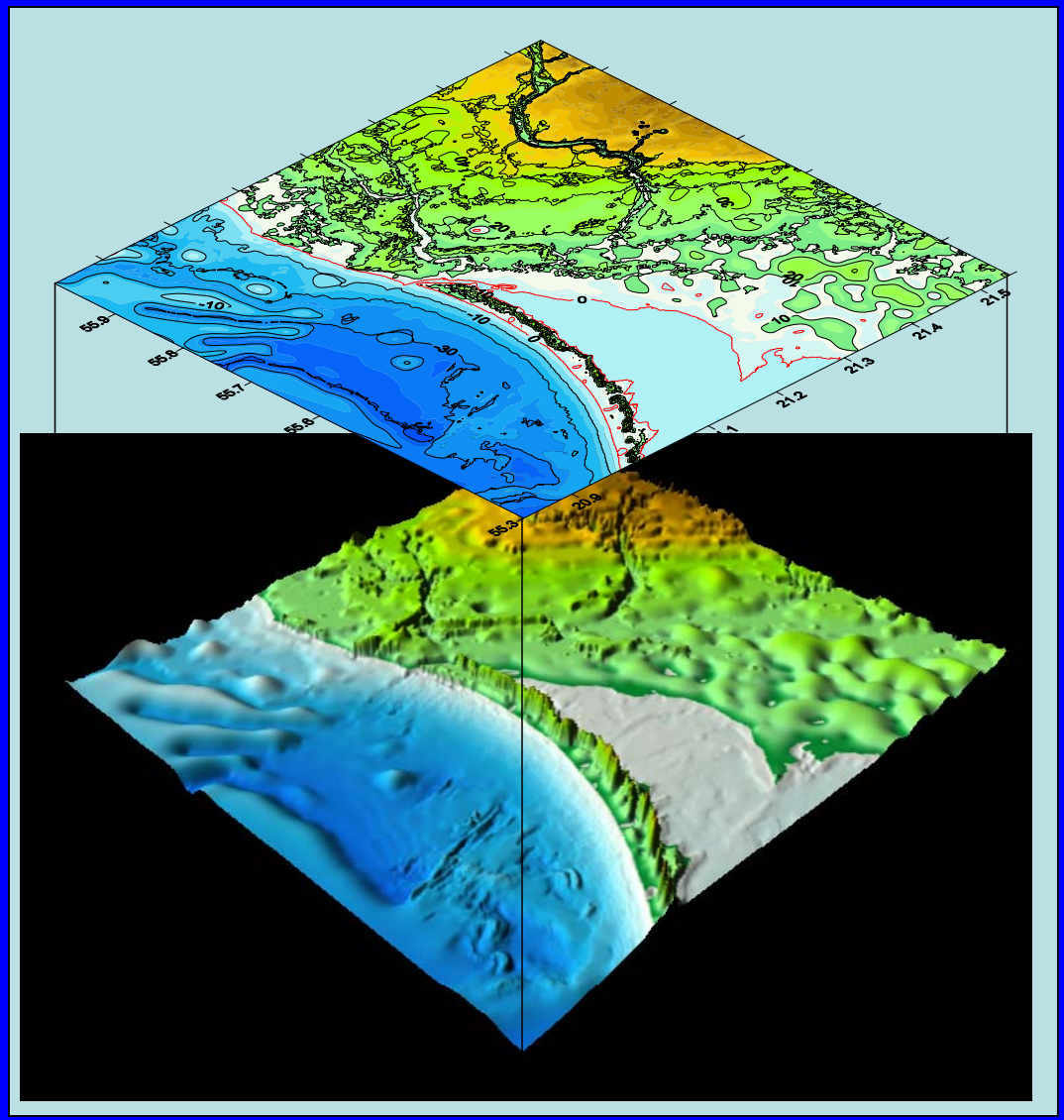
Curonian spit, Curonian Lagoon and Lithuanian mainland

Formed by the most thick BIL and Holocene layers (BIL 2-15 m; H 4-12 m). In Lithuanian mainland were fixed maximum transgressions of Baltic Ice Lake, Ancylus, Litorina and Postlitorina stages.



Relative sea level changes in the south-eastern Baltic Sea (— Klaipėda traverse), (— Nemunas delta - Nida - Klaipėda bank traverse), 2006; age is given in calendar years BP and conventional radiocarbon years BP after E. Andren, 1999; Kabailienė, and Rimantienė 1966; Kabailienė 1999; Blazhchishin et al.1985, 1989, Bitinas et al. 2001-2004; isostatic factor is not separated.

Digital elevation model (DEM_0)



Digital elevation model can be described by the formula (t<0):

$$DEM_t = DEM_0 + SED_{E/D} + RSL_t$$

DEM_t – Digital elevation model in time;
DEM_0 – recent digital elevation model;
$SED_{E/D}$ – sediments affected by erosional or sedimentational processes;
RSL_t – sea level changes.

Sea level changes can be described ($t<0$):

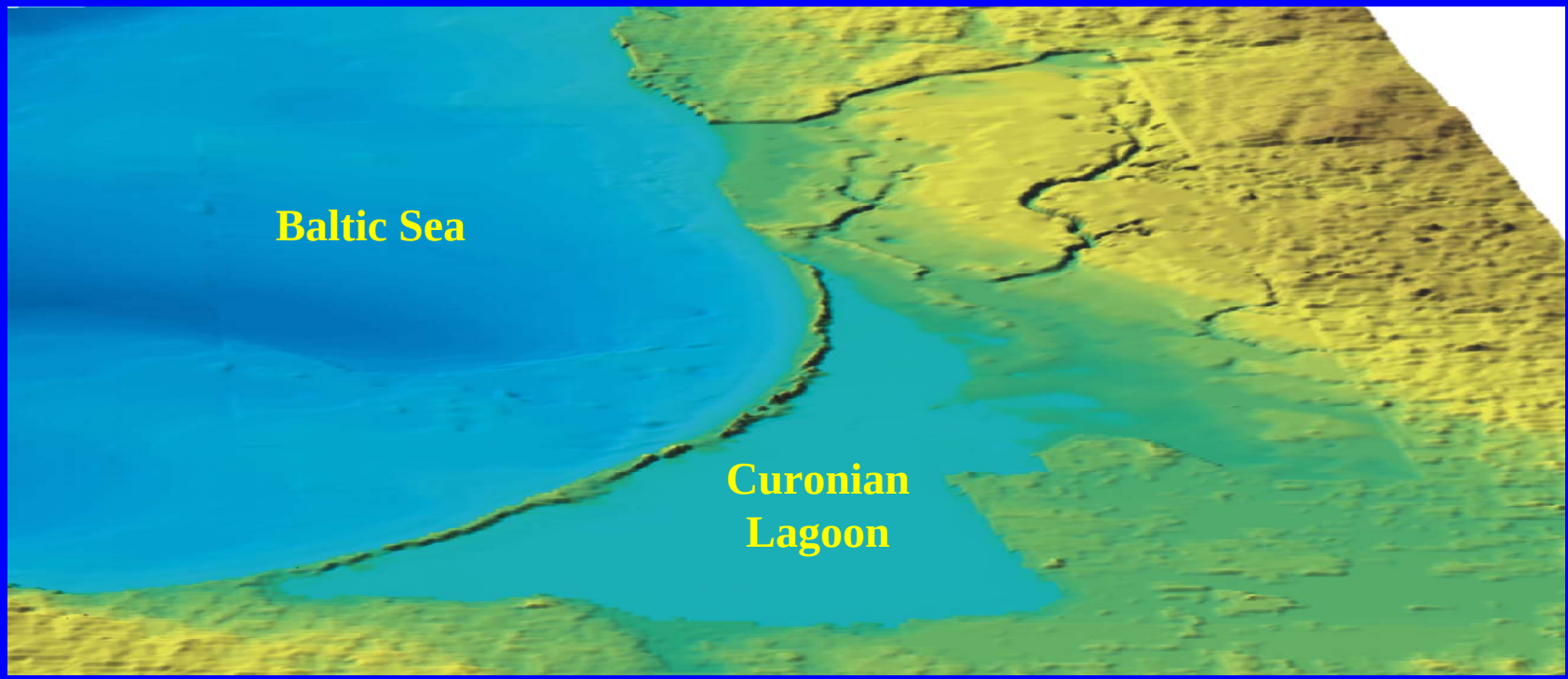
$$\mathbf{RSL_t = EC_t + IC_t}$$

EC_t – eustatic component;
IC_t – isostatic component.

Eustatic and isostatic components for the modelling of the future development scenarios should be used seperatly ($t>0$):

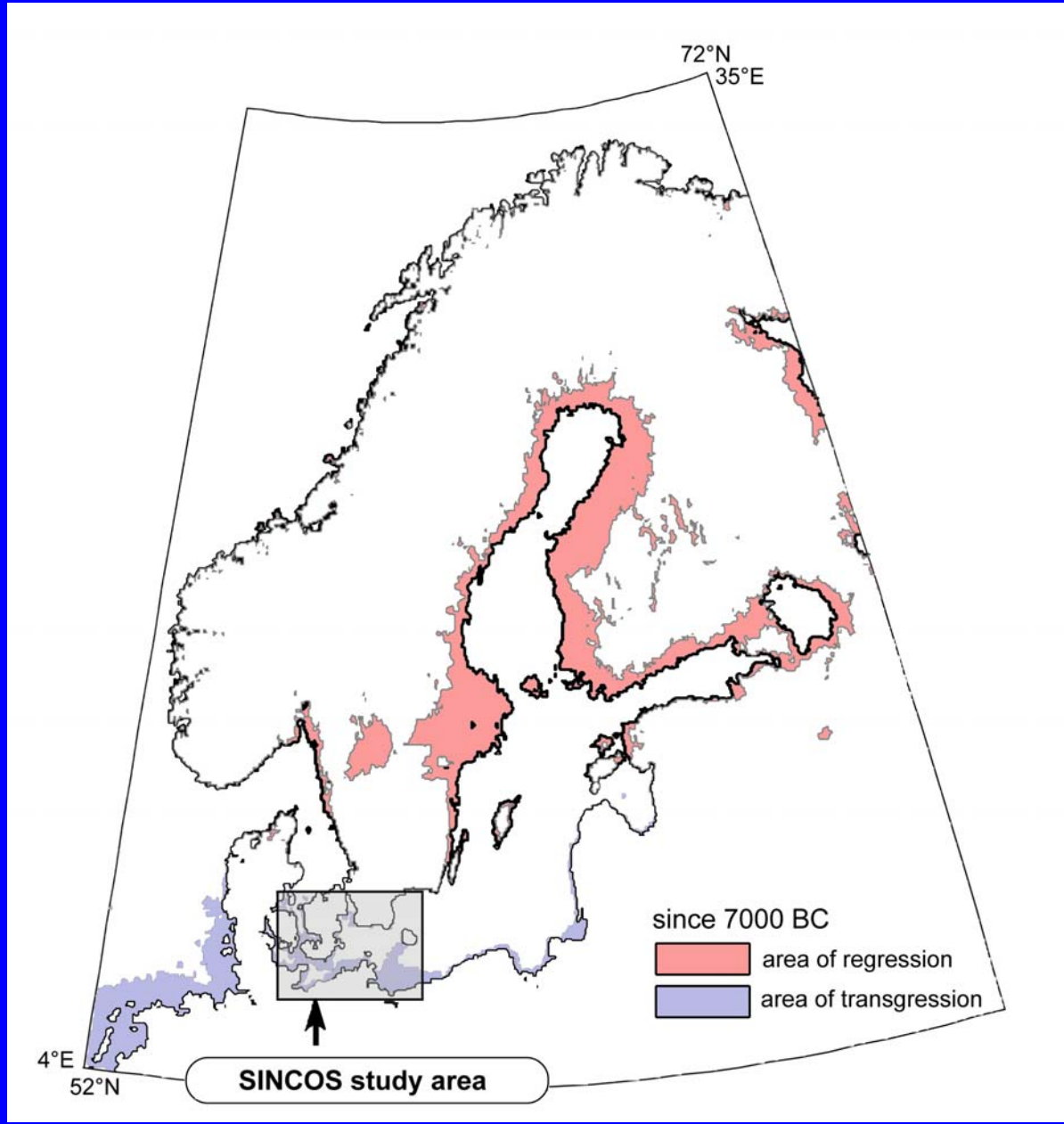
$$\mathbf{DEM_t = DEM_0 + SED_{E/D} + EC_t + IC_t}$$

Digital elevation model (DEM_0)



The model was created using *minimum curvature* interpolation method in Surfer program:
Horizontal resolution – 200 m.
Vertical resolution – 0,5 m

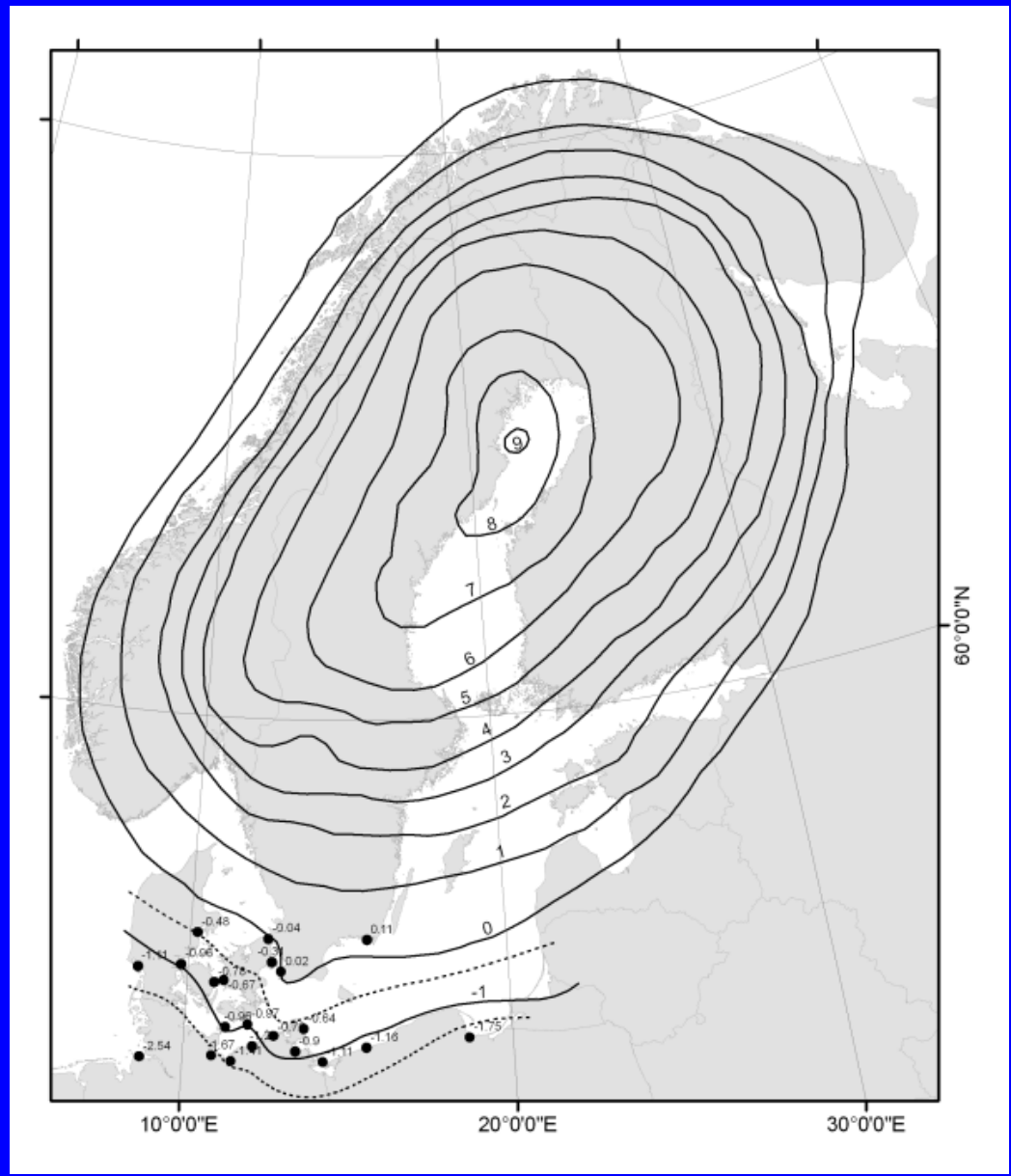
Isostatic factor



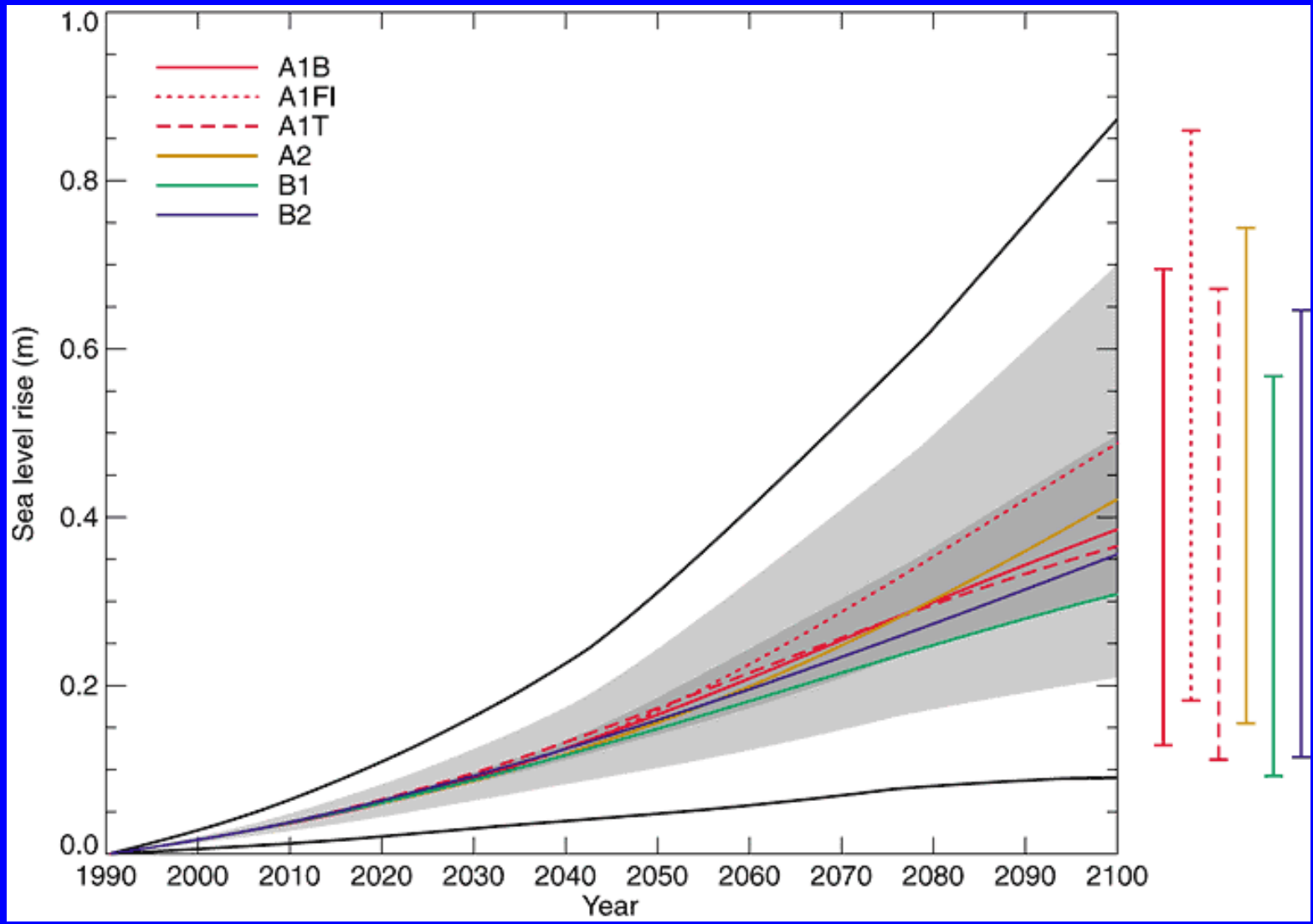
The map showing transgression/regression areas (Harff et al. 2007)

Isostatic factor

Map of vertical crustal movement relative to the sea level (A. Rosentau et al. 2007) .

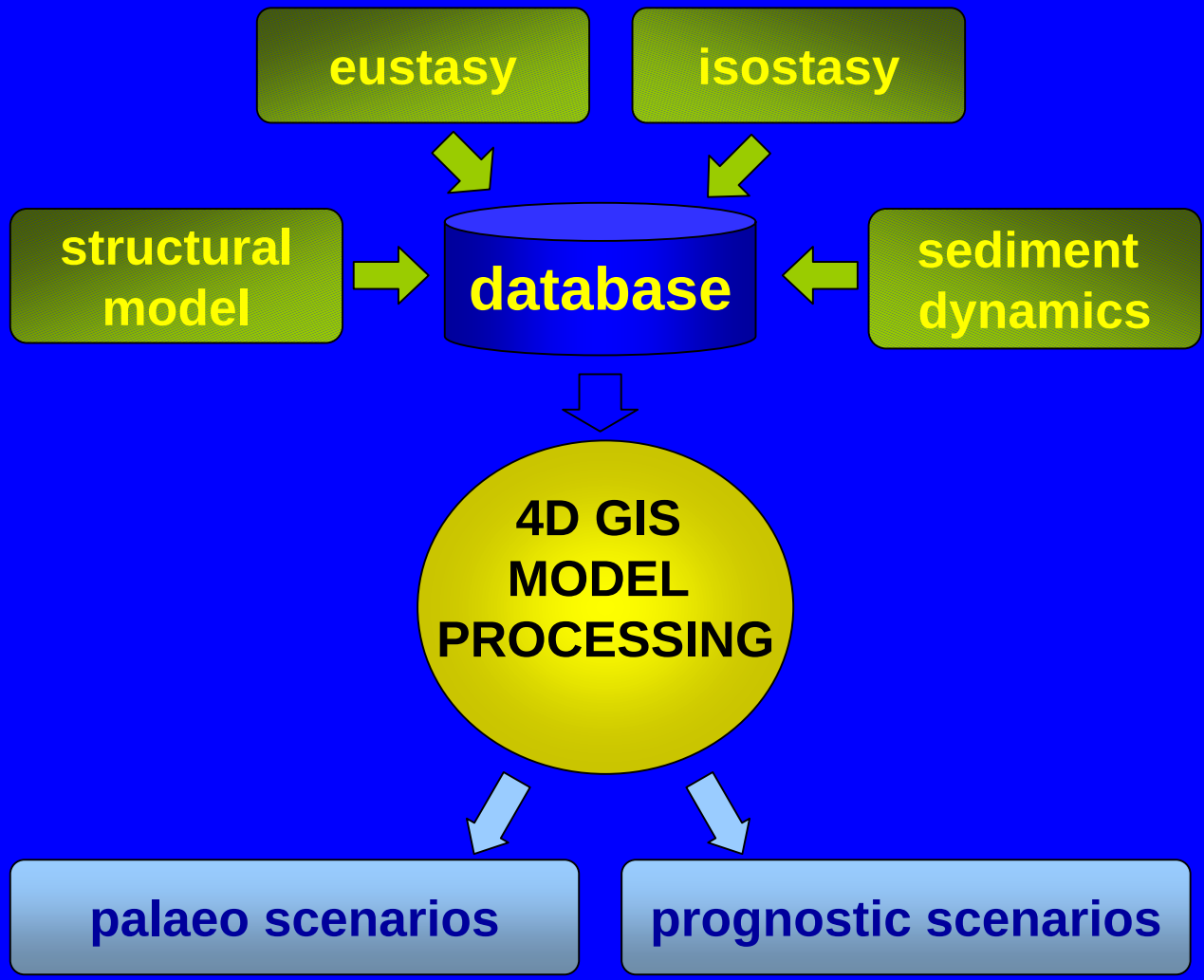


Eustatic factor



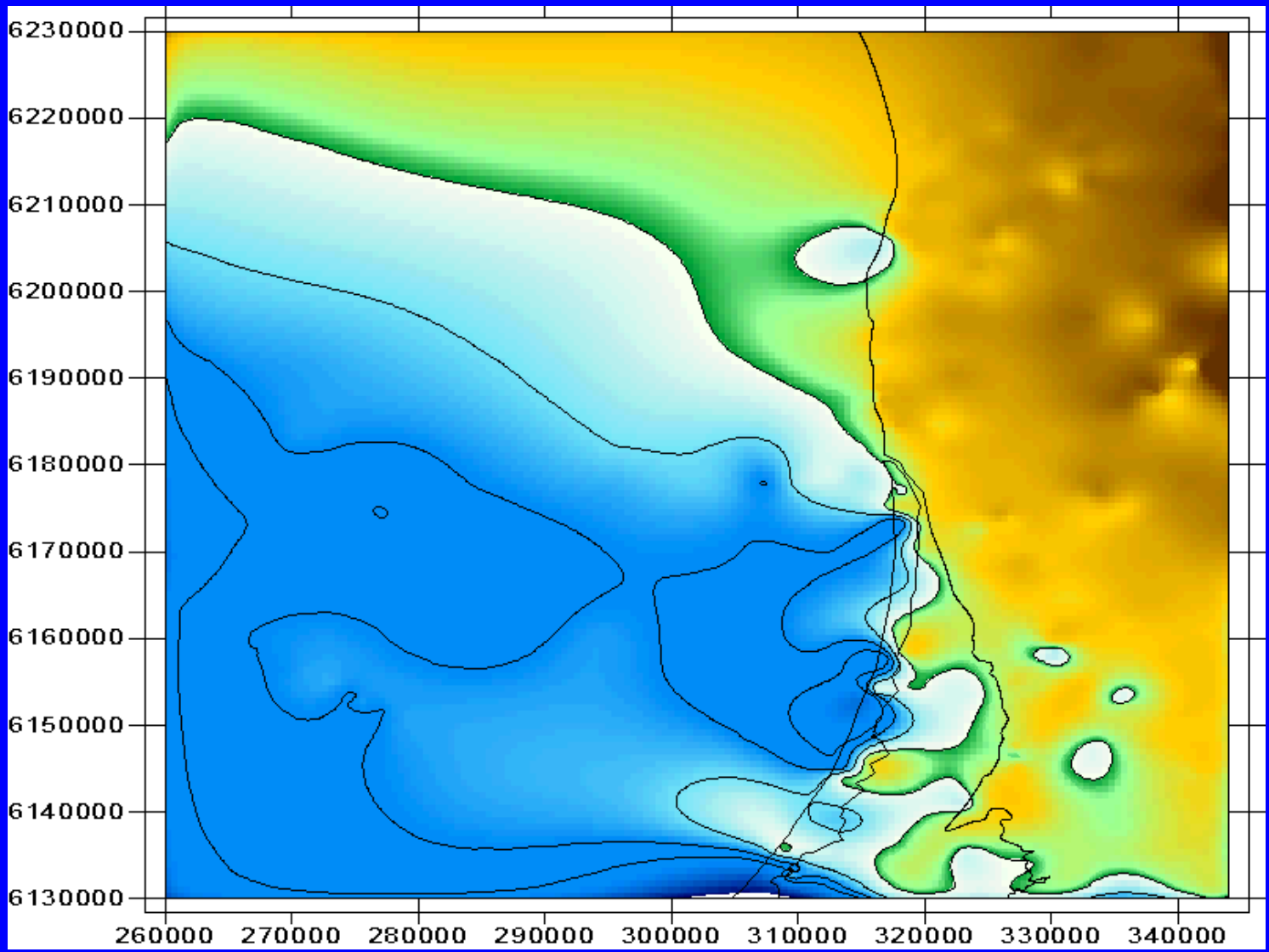
www.grida.no/climate/ipcc_tar/wg1/429.htm (IPCC 2001)

Model



Scheme of the model processing (after M. Meyer)

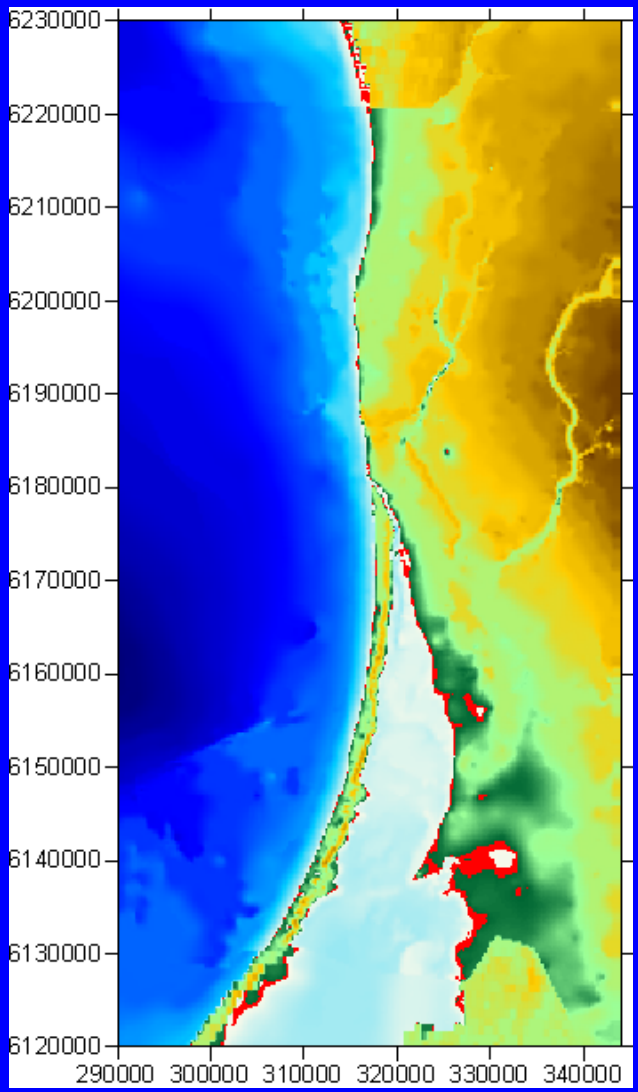
Model



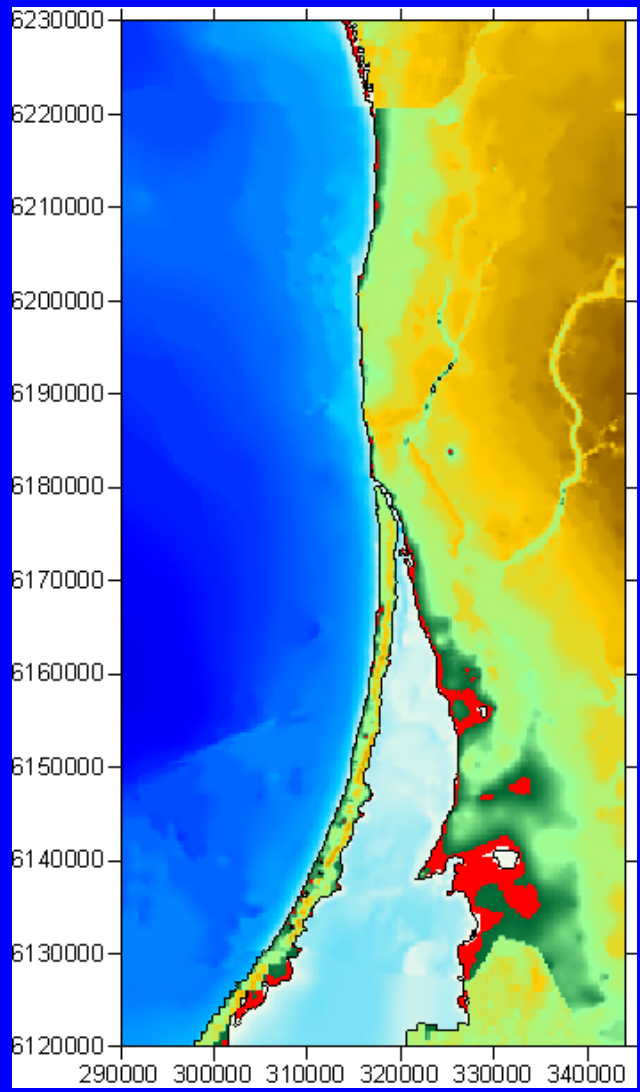
Model of the paleodevelopment of the Baltic Sea (DEM)

Model

Sea level rise – 30 cm



Water level rise - 100 cm



Legal framework

Main laws in Lithuania

* Law of the littoral zone of the Lithuania (2002);
* Program of the coastal management (2005);
* Cohesive development strategy (2003);

Needed legal framework

* Risk strategy of the littoral zone (for 25, 100 and 1000 years);
* Littoral zone should be extended to 300 m isobaths;
* Create the map of the primary recreational areas, which should be protected

Scientific research

Prompt maps

Offshore

* Monitoring of sedimentation processes (onshore and offshore);
* Maps of Baltic Sea landscape and biological habitats;
* Execution of the protected areas (geological-geomorphological geotopes);

Onshore

* Monitoring of sedimentation processes;
* Evaluation of the risk in the coastal zone and its protection;
* Rational use of natural resources;
* Economical development and recreational load

The authors are very thankful for colleagues dr. M. Meyer and dr. J. Harff from the Baltic Sea Research Institute Warnemuende (Germany)

Thank you for attention!