LIMITS AND PRESUPPOSITIONS ON CREATING AND USE OF THE REGIONAL HYDROGEOLOGICAL MODEL OF LATVIA

Ierobežojumi un pieņēmumi radot un izmantojot Latvijas hidroģeoloģisko modeli

Aivars Spalvins,
Environment Modelling Centre,
Faculty of Computer Science and Information Technology
Riga Technical University

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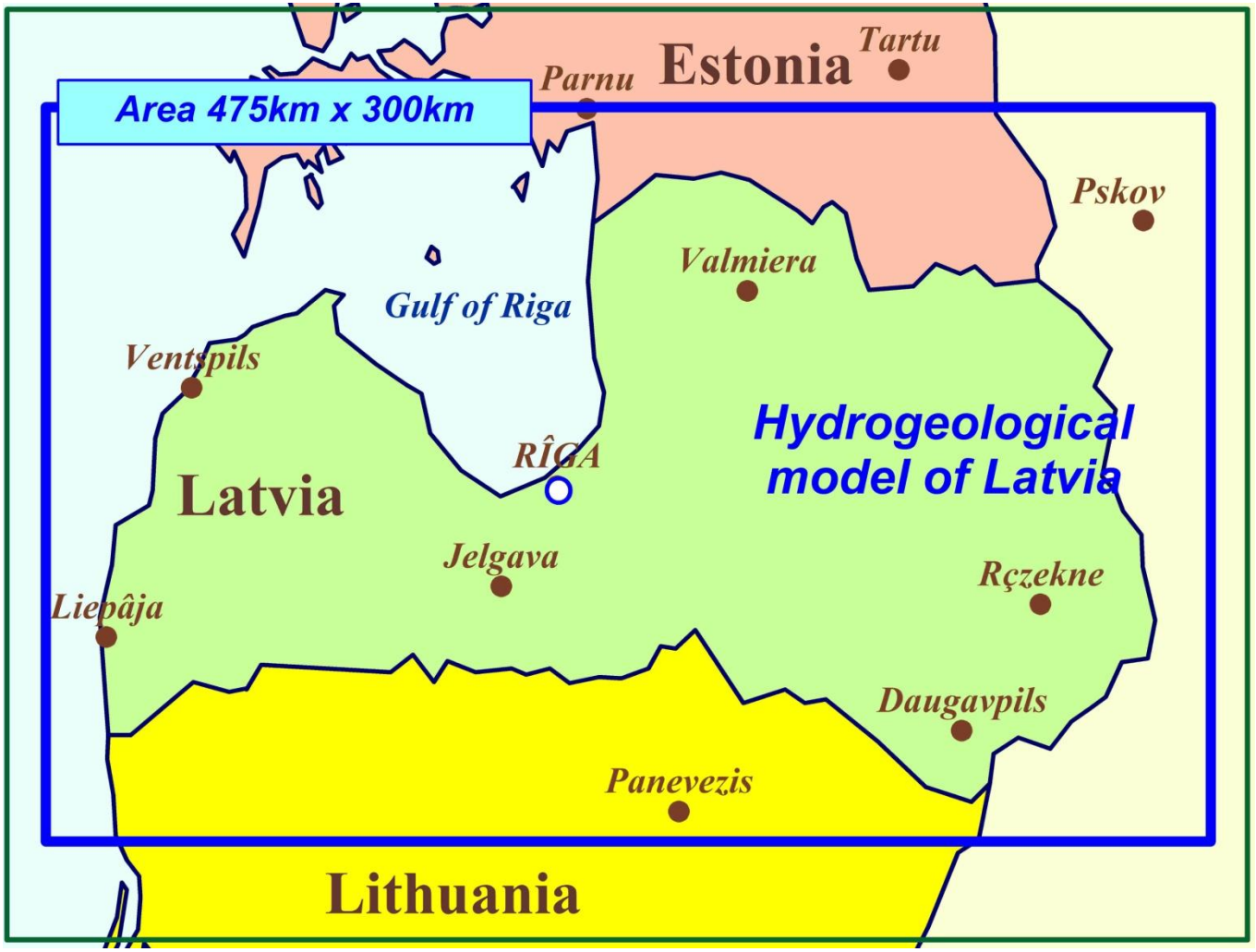
Section „*Groundwater in Sedimentary Basins*”

A hydrogeological model (HM) of Latvia will be established during 2010-2012 by the Environment Modelling Centre (EMC) team of the Riga Technical university

Location of Latvia HM



Te main limits regarding the regional hydrogeological model (HM) of Latvia are, as follows:

- HM will be used for management of drinking groundwater resources of Latvia;
- HM is created by the Environment Modelling Centre team of the Riga Technical University (RTU) ;
- the project is co financed by the European Fund of Regional Development;
- the project duration is 24 months; in 2013, HM must be established;

Geological and hydrogeological information, needed for establishing HM, is provided by the Latvian Environment, Geology and Meteorology Centre (LEGMC).
Principal parameters of HM must be agreed between RTU and LEGMC;
Data carried by HM must be publicly available as a part of Latvia environment information system; the system is supported by LEGMC.

HM of Latvia will generalize geological and hydrogeological information accumulated by LEGMC. HM will also serve as the base for creating more detailed local HM.

It is not possible to incorporate into regional HM all data that can be provided by LEGMC. Reasonable reduction of HM complexity can be achieved by implementing the following presuppositions: complexity and dimensions of HM must not exceed feasibility of a modern personal computer used to run HM; HM simulates the steady state average regimes of the groundwater flow;

Vertical schematization

HM of Latvia is steady state. Its 3D finite difference grid contains 601×951×25=14288775 nodes. Plane approximation step of HM is 500 metres

-united aquifer; #z – united aquitard

 - aquitard

Model plane No		Name	Geolo-gical code	Model plane code
1.		Relief	relh	relh
2.		Aeration zone	aer	aer
3.		Unconfined Quaternary	Q4-3	Q2
4.		Upper moraine	gQ3	gQ2z
5.		Confined Quaternary or Jura	Q1-3 J	Q1
6.		Lower moraine or Triass	gQ1-3 T	gQ1#z
7.		Perma Karbons Šķerveles Ketleru	P2 C1 D3šķ D3ktl	D3ktl#
8.		Ketleru	D3ktl	D3ktlz
9.		Žagares Svētes Tērvetes Mūru	D3žg D3sv D3tr D3mr	D3zg#
10.		Akmenes	D3ak	D3akz
11.		Akmenes Kursas Jonišķu	D3ak D3krs D3jn	D3krs#
12.		Elejas Amulas	D3el D3aml	D3el#z
13.		Stipinu Katlešu Ogres Daugavas	D3stp D3ktl D3og D3dg	D3dg#
14.		Daugavas Salaspils	D3dg D3slp	D3slp#z
15.		Pļaviņu	D3pl	D3pl
16.		Pļaviņu Amatas	D3pl D3am	D3am#z
17.		Amatas	D3am	D3am
18.		Augšējā Gauja	D3gj2	D3gj2z
19.		Augšējā Gauja	D3gj2	D3gj2
20.		Apakšējā Gauja	D3gj1	D3gj1z
21.		Apakšējā Gauja	D3gj1	D3gj1
22.		Burtnieku	D2brt	D2brtz
23.		Burtnieku Arikula Narvas	D2brt D2ar D2nr3	D2ar#
24.		Narvas Narvas	D2nr2 D2nr1	D2nr#z
25.		Pērnavas	D2prn	D2pr

The model is created in environment of the comercial program Groundwater Vistas (GV). It includes broadly used software tools: MODFLOW, MODPATH, MT3D and others.

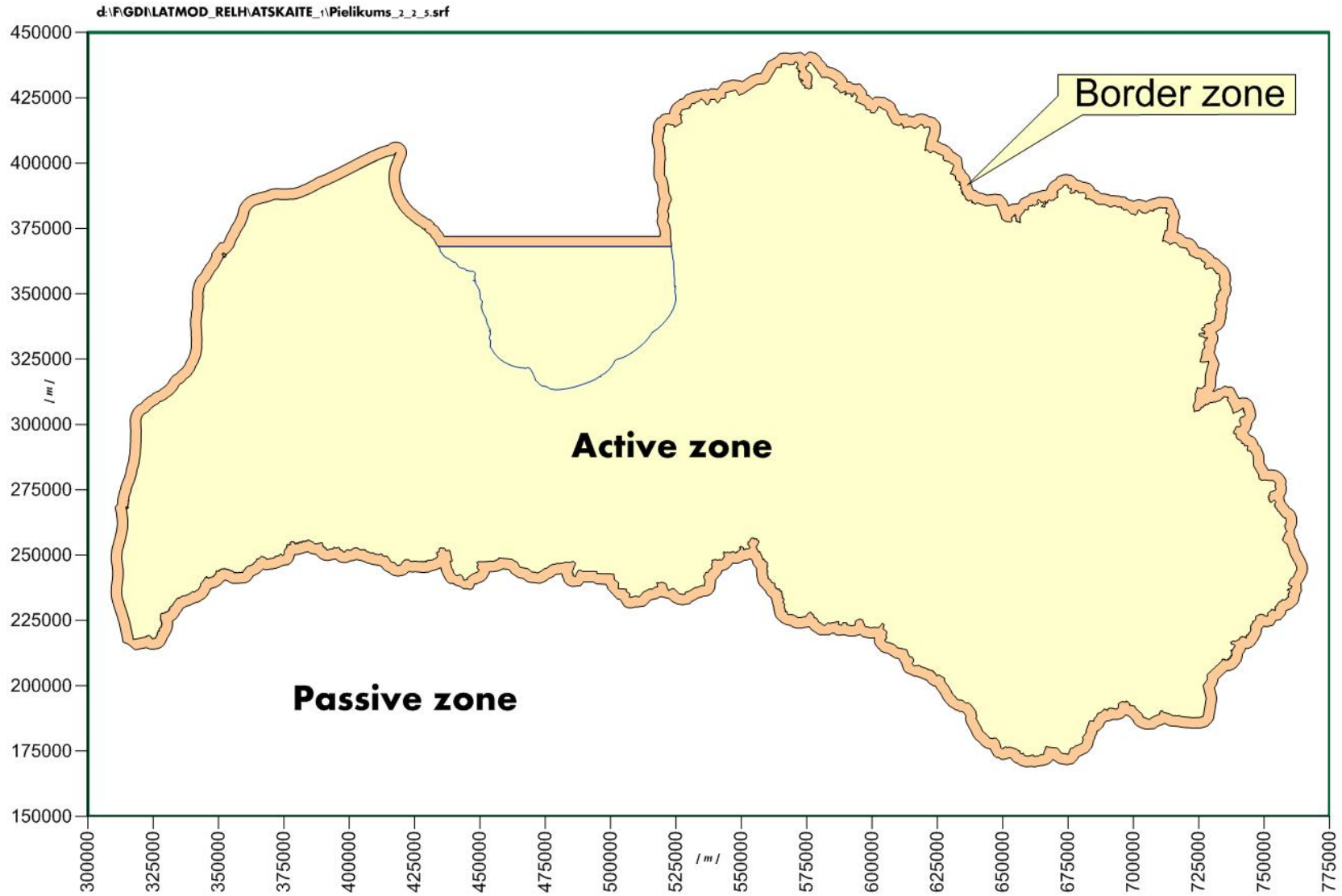
Novel methods and tools will be applied to create the highly complicated model:

- The map of ground surface elevations is applied as the boundary condition;
- Original software tools for data interpolation are applied;
- In initial phase, the actual model geometry may not be applied.

HM consists of its active and passive parts; the active part includes the land territory of Latvia and the Gulf of Riga; the passive part represents border areas of neighboring countries.

However, HM is open for trans boundary modelling projects; then a neighboring country provides data for activating the HM area involved.

Location of Latvia HM active and passive zones



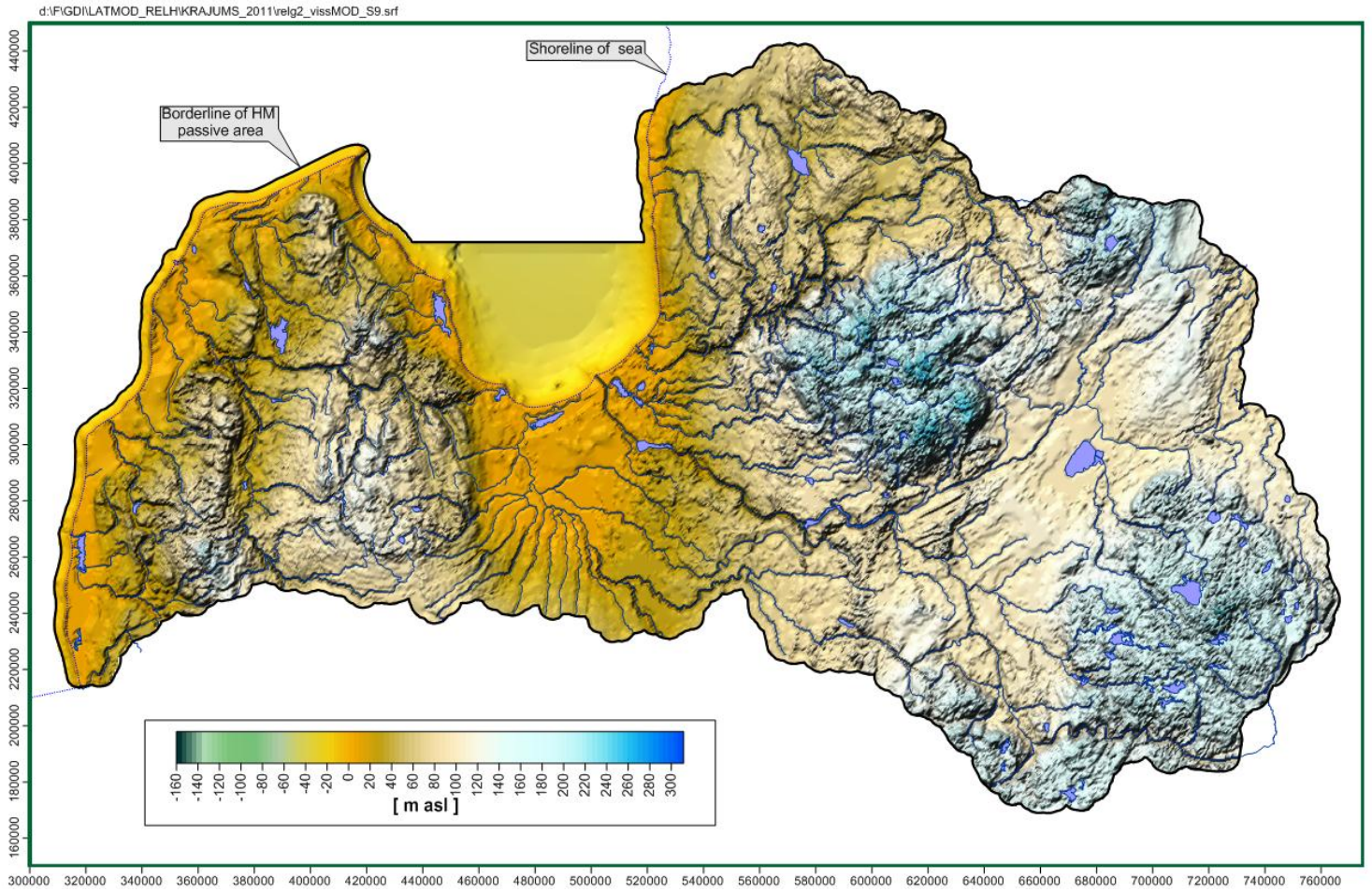
Three elevation surfaces of HM are especially important:

- the hydrogeological relief *relh* that represents the ground surface where the hydrographical network is incorporated;
- the geological relief *relg* that gives land surface elevations;
- the sub Quaternary surface *subQ* that covers the system of basic geological layers.

Lakes and rivers (hydrographical network) are accounted by GV system conventionally. The network is a part of the digital relief map

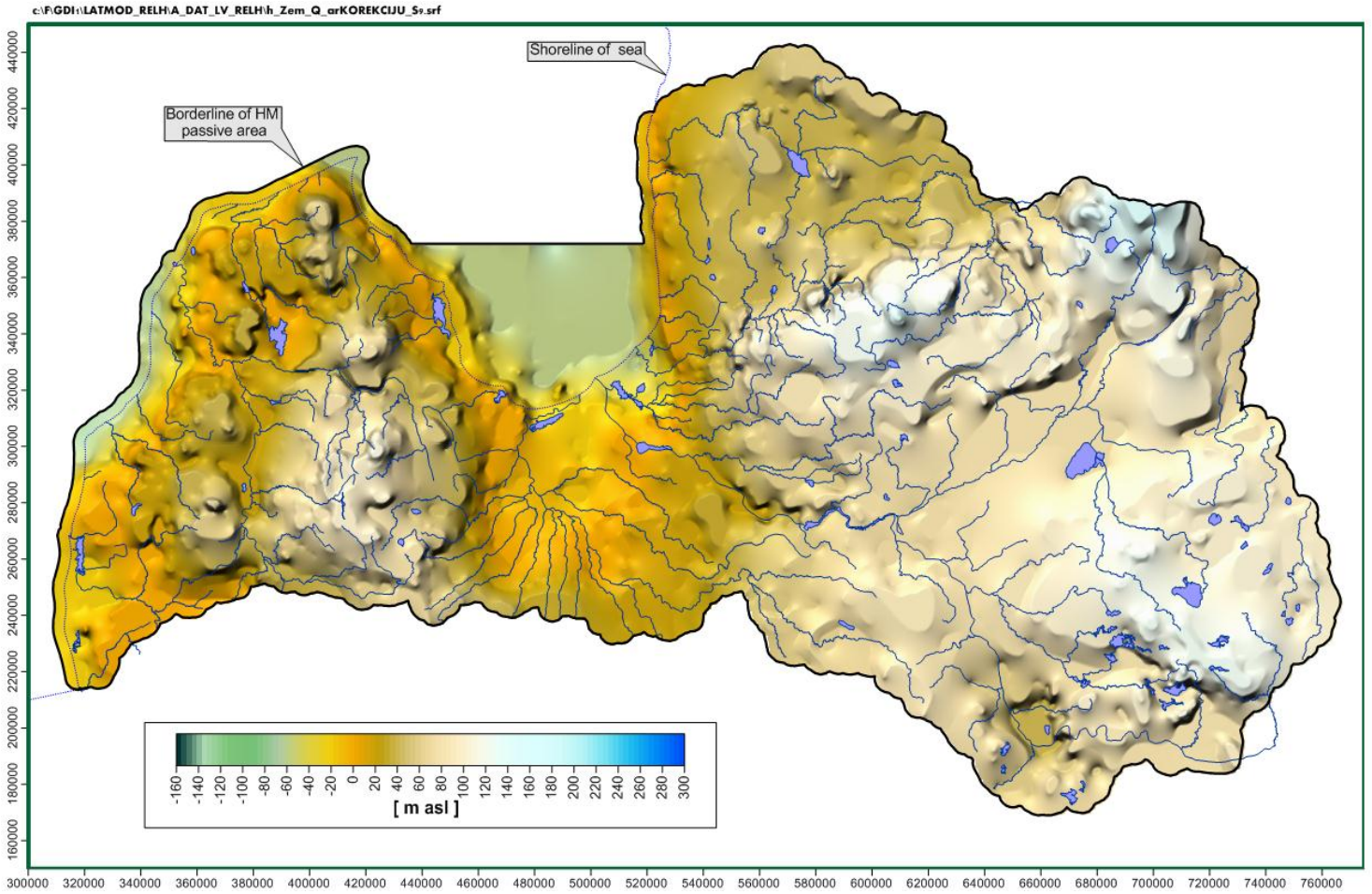
The difference m_w=*relh-relg* is the thickness of surface water bodies. (in HM, m_w >0 for the sea area and for the Daugava river with its three lakes of hydroelectric power stations); for other water bodies (lakes, rivers), m_w =0.

The digital relief *relh* used in Latvia HM



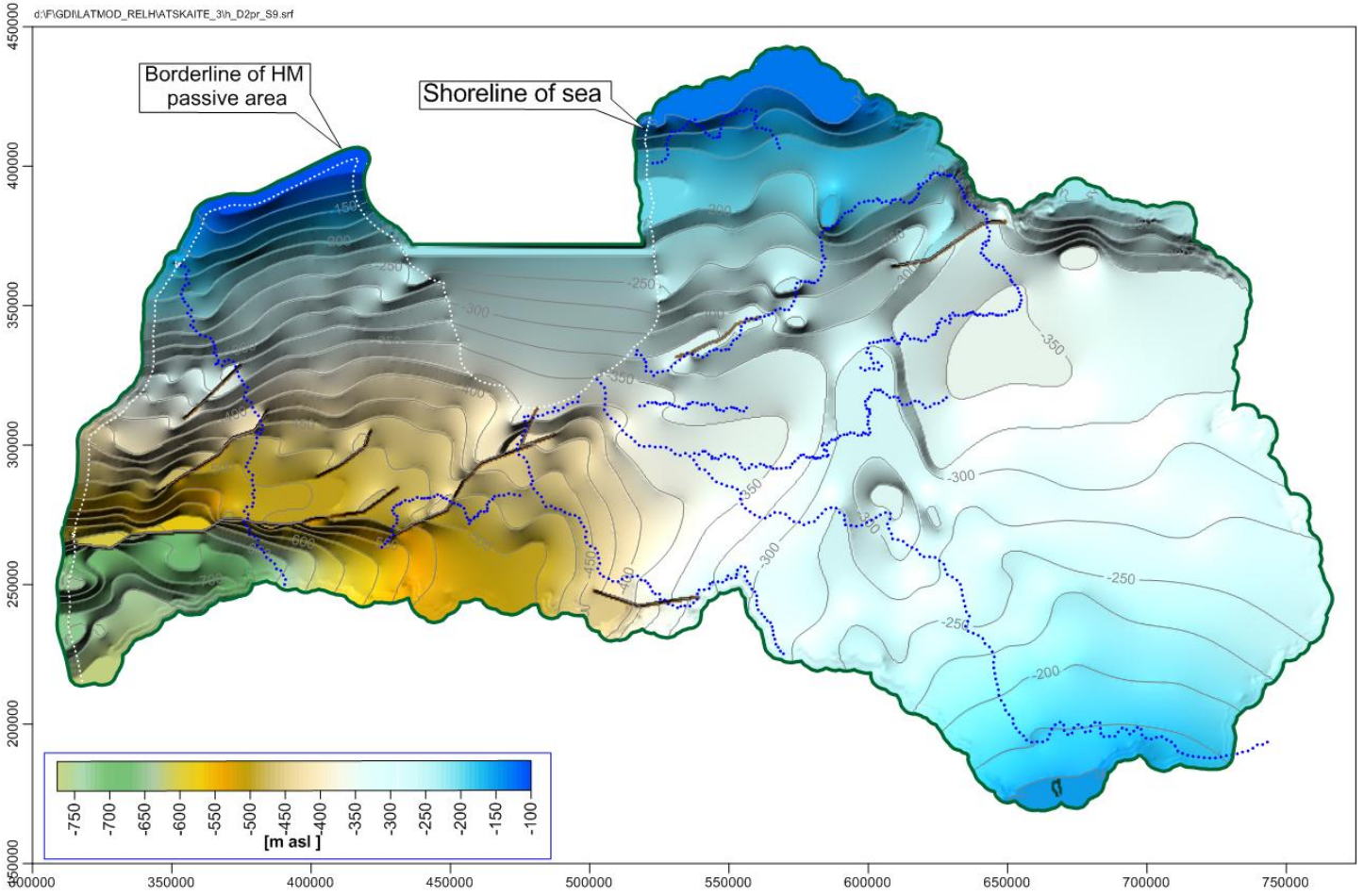
The difference $\Delta = relg - subQ$ is used for obtaining the Quarternary system thickness m_Q:
$m_Q = \Delta$ if $\Delta > 1.0$; $m_Q = 1.0$ if $\Delta \leq 1.0$ and $relg = subQ + 1$;
by correcting *relg*, along the river valleys where $\Delta < 0$, the *subQ* surface remains unchanged (no deep valleys are cut into it); otherwise, the grid nodes will be lost where river long lines elevations must be connected
(option River of GV).

The subquaternary surface used in LAMO

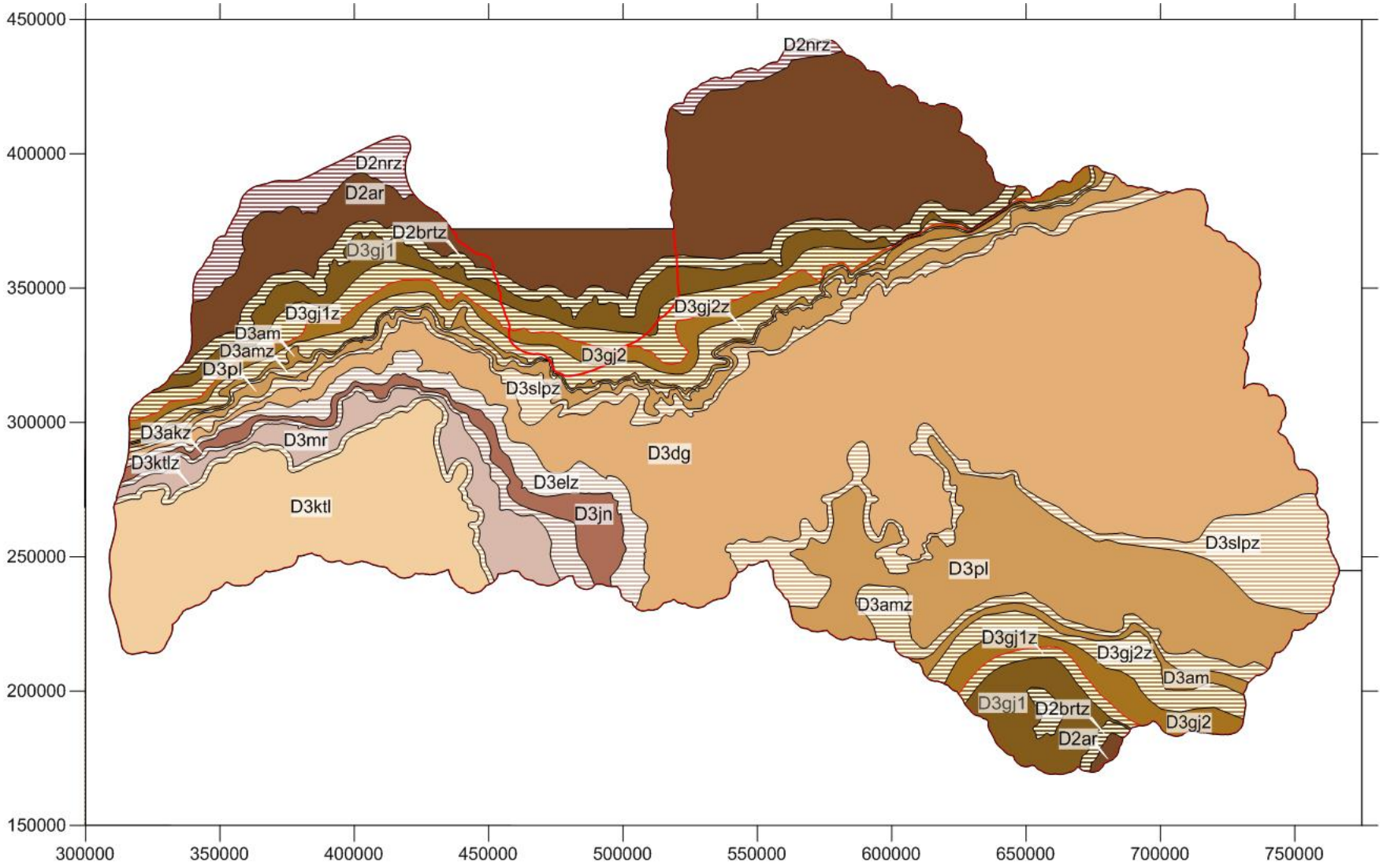


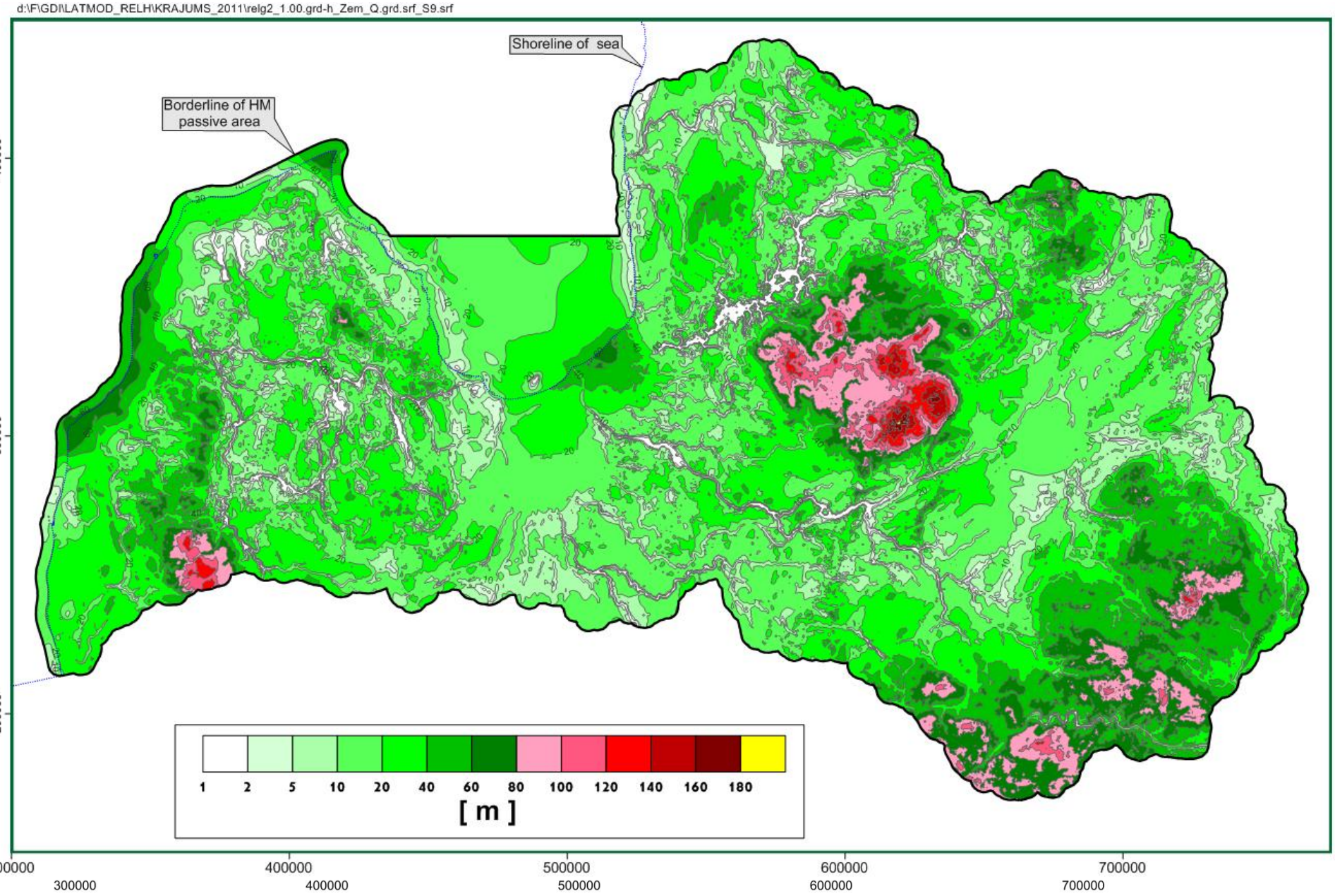
In HM, only the Narva aquitard is continuous; the other geological layers are discontinuous, because they include areas with a zero thickness; for the model, these areas have the thickness 0.02 meters, their permeability is 1.0m/day;

The top surface of the Pernava aquitard



The set of geological borderlines




d:\F\GDI\LATMOD_RELH\KRAJUMS_2011\relg2_1.00.grd-h_Zem_Q.grd.srf_S9.srf
Shoreline of sea
Borderline of HM passive area
1 2 5 10 20 40 60 80 100 120 140 160 180
[m]
400000
300000
200000
300000 400000 500000 600000 700000

The *relh* map serves as the piezometric boundary condition, on the HM top; due to this condition, HM automatically creates a feasible infiltration flow distribution;

No real thicknesses of bogs, of the aeration zone and of the unconfined Quaternary aquifer are used during the HM calibration; the aeration zone of the thickness 0.02 meters acts as a formal aquitard that controls intensity of the infiltration flow; the bogs are located within this formal layer; if necessary, the real thicknesses of the above mentioned layers can be restored;

In HM, real thicknesses are used for layers (bogs, the aeration zone and the quaternary unconfined layer are exceptions). To account for admixtures that exist in the layers, the maps of their permeability are corrected.

For aquifers, along the borderline of the HM active part, piezometric boundary conditions (heads) are applied.

An impervious border surface cannot be used, because the cross border groundwater flow is notable everywhere.

As the piezometric boundary condition, on the HM bottom, the Pernava aquifer map of its head distribution is used.

GDI mainly applies line data, because they are much more informative. To prepare the line data, original CRD program has been developed.

The GDI program is mainly applied in the sequential mode. During the current interpolation step, new information is used, but the results of the previous source, as the base. In this way, much simpler set of initial data can be applied.

Calibration of HM will never succeed if serious HM errors are present (wrong initial data). To overcome possible problems regarding quality of initial data, the EMC team is going to apply already tested sophisticated methods and software tools.

Conclusions

During two years (from 2010 till 2012) the EMC team of the Riga Technical university should establish the regional hydrogeological model of Latvia.
To create the model, the EMC team is going to use innovative methods

This presentation is a part of the Project entitled “Creating of hydrogeological model of Latvia to be used for management of groundwater resources and for evaluation of their recovery measures” (agreement Nr.2010/0220/2DP/2.1.1.1.0/10/APIA/VIAA/011. The Project is being co-financed by the European Fund of Regional Development.