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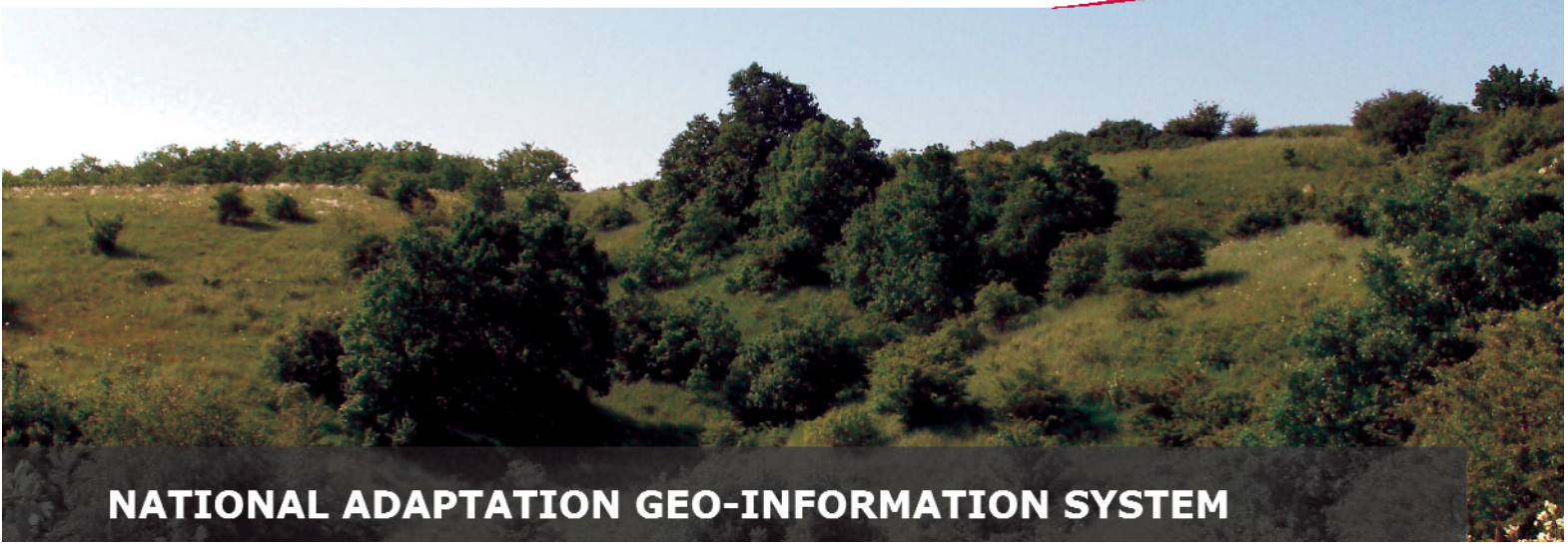

NATIONAL ADAPTATION GEO-INFORMATION SYSTEM

CONTENT

Results of the flash flood hazard study obtained so far

One of the elements of the geo-spatial database developed within the framework of the NAGiS project is the flash flood hazard study of municipalities located on mountainous or hilly water catchment areas, which concerns almost 1800 Hungarian municipalities.

Flash floods are caused by extreme quantities of precipitation falling down during a short period of time (a few hours), but the extent of such floods is determined by the combination of several other factors: the dimensions, shape and gradient conditions of the sub-basin, together with the surface run-off and groundwater recharge affected by the conditions of vegetation and soil-geological characteristics. Therefore our study approaches the topic from two directions. One of them is based on aspects of land coverage, morphometric and geological aspects, while the other one ranks each water catchment area according to the expected spatial and temporal changes in the prevalence of precipitation events resulting in flash floods.

The analysis process was performed with the ArcGIS geographical information system software program. Ensuring the repeatability of the process was a consideration of key importance in order to make the process repeatable using new, more precise input data as well. The demarcation of the water catchment areas and determining the shape factors were carried out by using an improved digital terrain model with a 10-metre horizontal resolution.

The demarcation, starting from the deepest outflow points of the watercourses passing through the municipalities took place using a classical procedure, which calculates certain grid points of the terrain model using the grid points sloping towards the given point from the environment (accumulating precipitation).

Following the demarcation, the statistics of the characteristics of the water catchment areas considered important from the aspect of flash floods was prepared with the help of the toolkit built into the applied GIS-application. At the same time, based on the data of the climate model provided by the Hungarian Meteorological Service, the spatial distribution of the frequency of extreme precipitation events was calculated for the 1961–90 reference period and for the future periods of 2021–50 and 2071–2100.

On karstic areas water catchment areas are to be interpreted in an entirely different way. Ground water recharge into water catchment areas that can be derived from the terrain of the surface may be significantly influenced by the sinkholes and cracks opening the way to the karstic system.

The Project is supported by a grant from Iceland, Liechtenstein and Norway.
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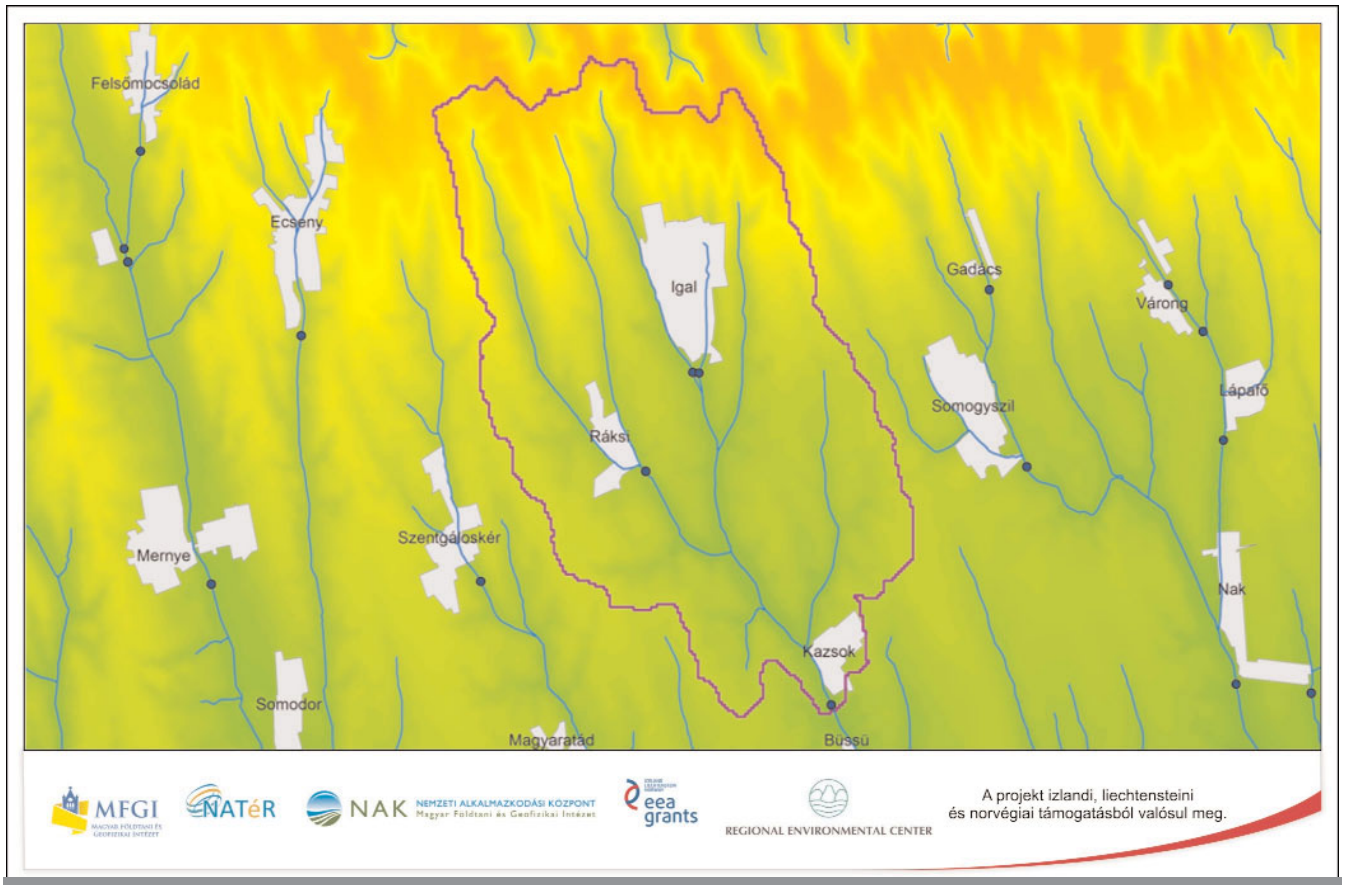
ICELAND LIECHTENSTEIN NORWAY eea grants

REGIONAL ENVIRONMENTAL CENTER



Demarcation of the water catchment area around the outflow point that belongs to the municipality of Kazsok

The water catchment area belonging to the outflow points of the karstic area is independent from the terrain of the surface, thus surface precipitation even in significant distance should also be reckoned with. The established methodology does not yet manage this complex process, therefore water catchment areas affected by karstic areas are not processed within this present sphere of analysis.

The final result is going to be a combined categorisation system incorporating both aspects, based on which water catchment areas and the municipalities located on them are going to be classified.

Zsolt Mattányi, Gábor Turczi

Hydro-geological results

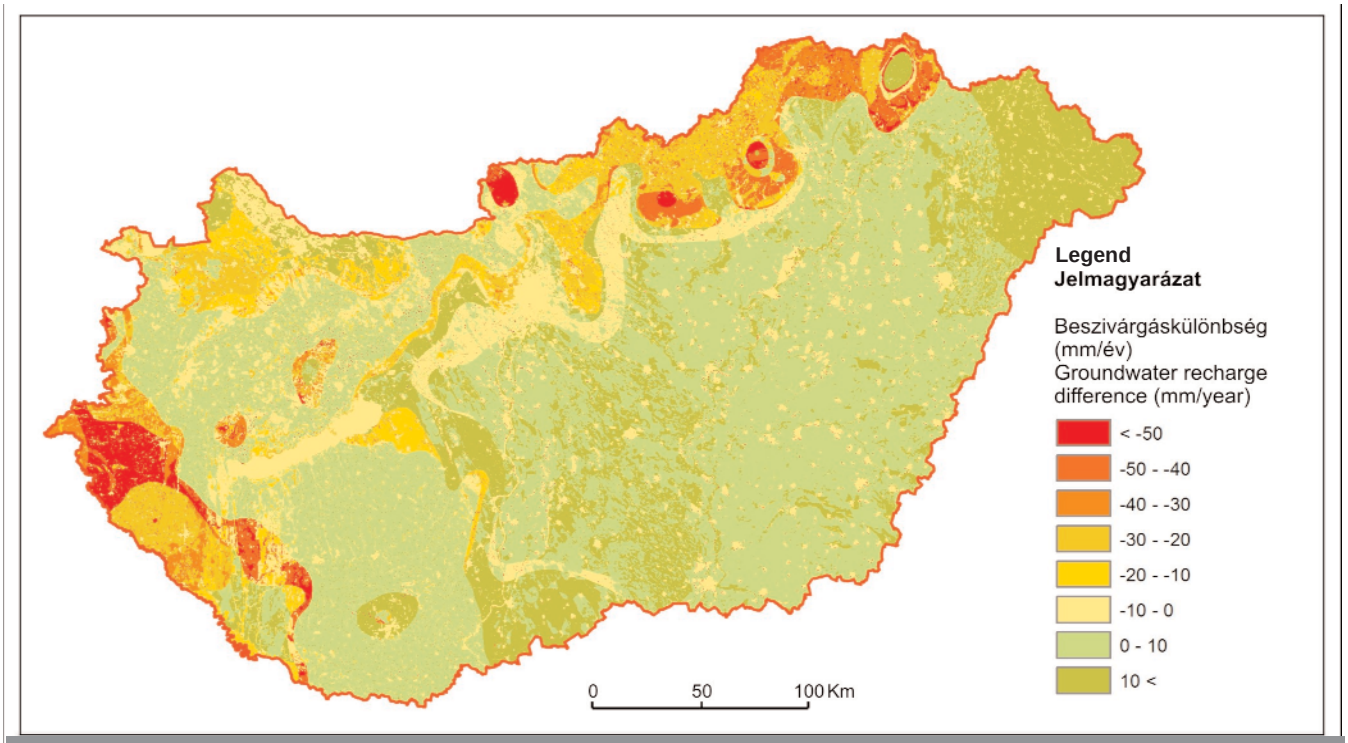
Assessing the effects of climate change on groundwater with hydro-geological models

The objective of the modelling assessments was to develop a methodology for characterising the sensitivity of groundwater to climate change. In order to simulate the distribution of groundwater, a dynamic hydro-geological model was built.

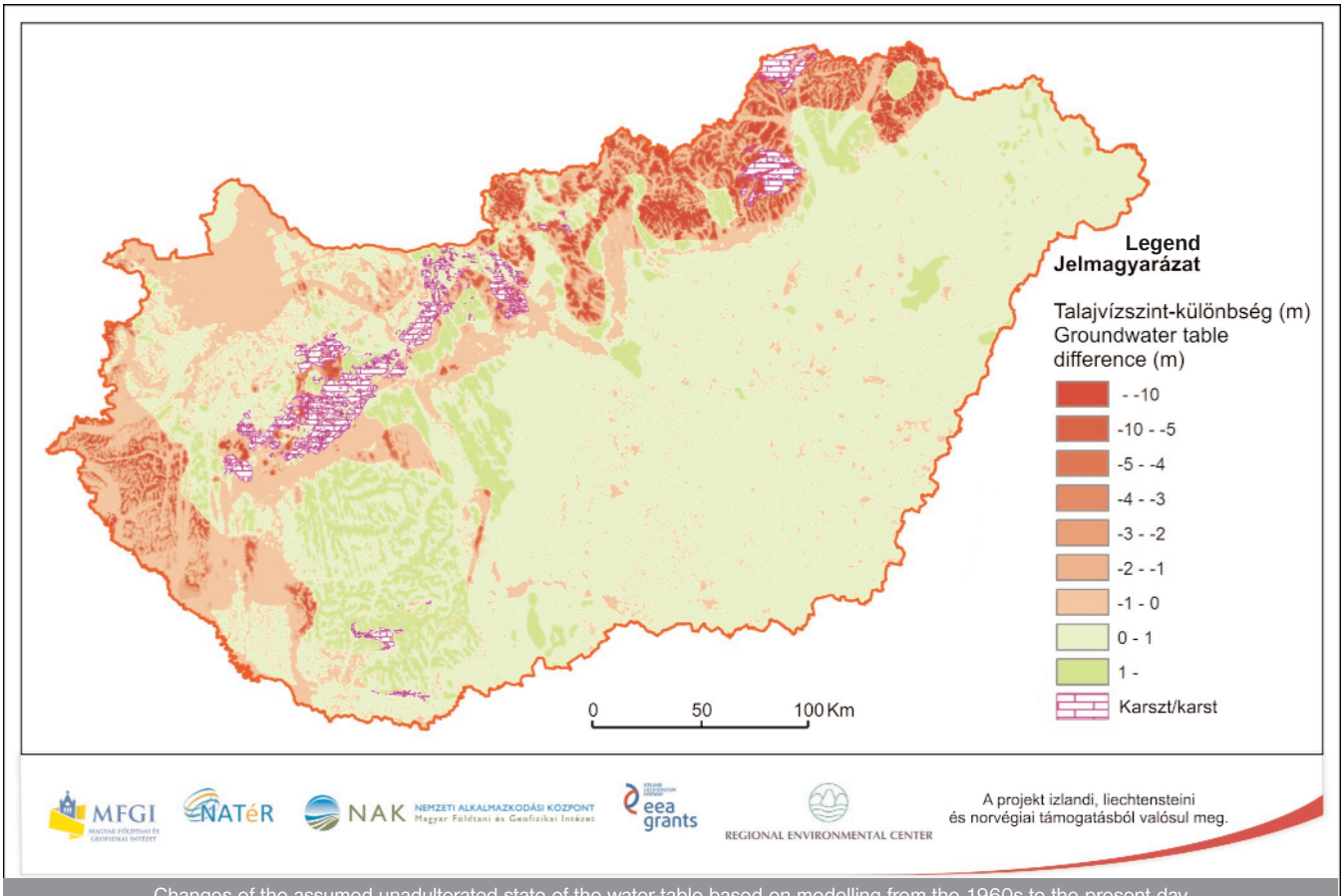
The applied models can reproduce the changes of groundwater caused by climate change, on a national scale. Based on the developed methodology the precise determination of water-tables and any changes thereof may become possible with the use of high-resolution, local models. The unadulterated model was calibrated based on data from the national water-table monitoring system and the water cadastre. The groundwater recharge applied in the hydro-geological model was calculated according to the measured and modelled climate parameters, with the help of hydrological models. The changes in infiltration caused by climate change were calculated using the measured or modelled climate parameters of the different time periods.

The effects of climatic conditions were examined with the help of modelled scenarios. The various infiltration values of the changing climate conditions affect groundwater, which effect was simulated for different time windows. Based on the measured climate parameters, the average water-table distribution of the periods between 1961–65 and 2005–2009 were determined. The simulation of future changes of the water-table was also carried out, for which the output data of the ALADIN climate-models run by the Hungarian Meteorological Service were used. The predictions were carried out for thirty-year time windows. The modelled changes of the water-table provide information about already existing and expected effects of climate change.

Attila Kovács



Changes of groundwater recharge conditions from the 1960s to the present day, based on modelling



Changes of the assumed unadulterated state of the water-table based on modelling from the 1960s to the present day

Examination of the sensitivity of water reserves to climate change

Areas with various geological and hydro-geological conditions and drinking water reserves also differ in their sensitivity to climate change. Alterations caused by extreme climate conditions and the permanent changes of the climate are usually not as direct and extensive in the ground waters as they are in the case of surface waters. Furthermore, in a lot of cases only the results of several years of exposure to such changes can be observed. In the case of more sensitive areas, however (e.g. open karst areas), changes occur at once and in a great extent, often directly jeopardising the local population and the drinking water supply.

At the same time, it is very hard to separate the effects of climate change from anthropogenic effects. Water (over)extraction, urban development, agricultural activities (chemicalisation, irrigation), damming, surface water diversion may significantly affect the flow and chemical conditions of subsurface waters, which are further enhanced by the consequences of climate change. The effect on subsurface waters results in further socio-economic changes, during which area use changes and the demand for irrigation and residential water demand increase further.

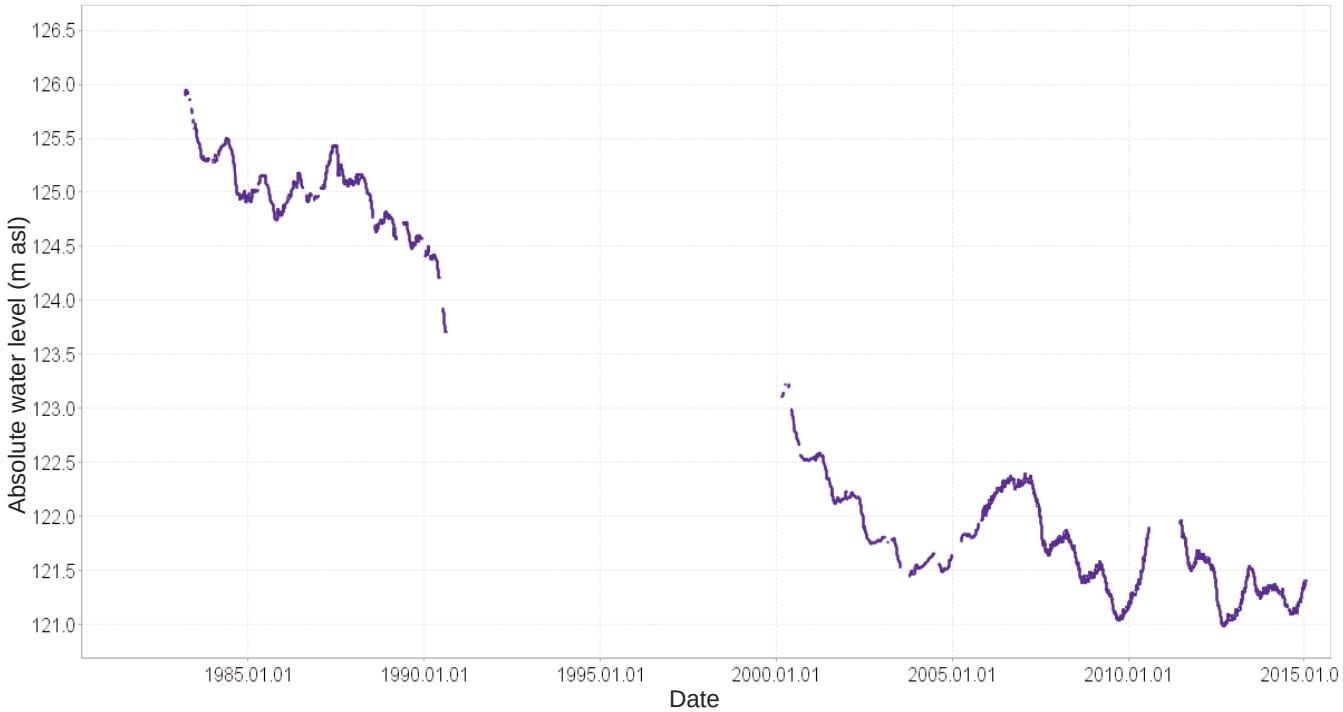
An example for this phenomenon is the regional decrease of the water-table and deep groundwater levels in the Duna–Tisza Interfluve region, which is also proved by the permanent decrease of several metres in the water level measured in the MFGI Jánoshalma–2 observation well. The following figure shows the aforementioned tendency for the past 30 years, based on the standing water levels concerning the range of depth most frequently used by the waterworks (148.73–164.43 m under the terrain).

In the light of the fact that the drastic decrease of the water-table and deep groundwater levels experienced at the aforementioned location is the combined consequence of human activity and climate change, both the data of groundwater-, deep groundwater- and thermal water-extraction and the climatic factors needed to be taken into consideration while planning the possible interventions.

Therefore within the framework of the NAGiS project, besides monitoring the changes of the climate indicators, the resulting complex, nature-related, economic and social consequences are also examined. The climate-vulnerability of water reserves are characterized by using the method for examining vulnerability to climate change based on regional exposure, sensitivity and adaptability (the CIVAS-model) and by summarising its results, while qualification of the water reserves according to their climate-sensitivity is going to be based on the country-wide categorisation system.

The sample area allocated within the framework of the co-operation with the Duna Menti Regionális Vízmű Zrt. (DMRV—Danube Regional Waterworks, DMRV Zrt.) provides appropriate ground for determining the adaptive capacity of the society and the economy in detail, thus providing an opportunity to increase adaptability.

Ágnes Rotár–Szalkai



Hydrograph of water levels measured at the MFGI Jánoshalma–2 observation well

Development of the NAGiS database

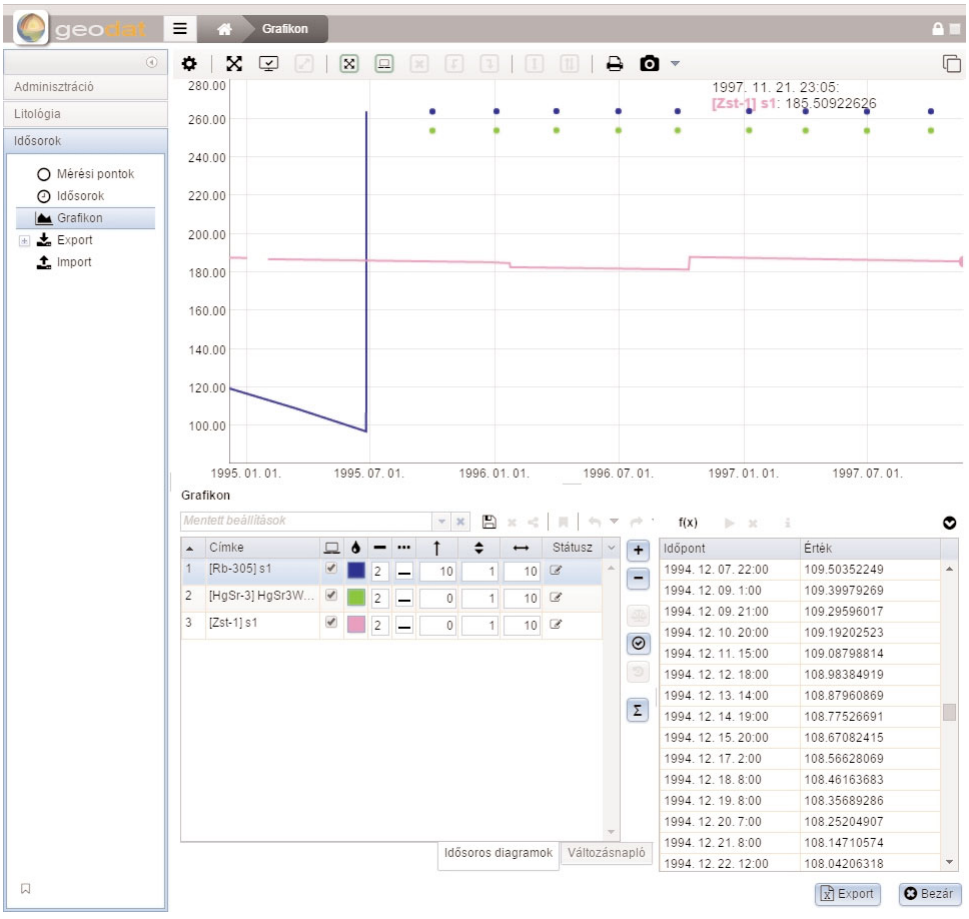
The NAGiS database can be interpreted in multiple ways: there are map-based databases and non map-based, so-called "raw" databases, and external and internal data systems. This short article intends to discuss this topic in detail.

Among the end-products of the NAGiS project, the map-based portal is of particular importance. This is where the results of the project are introduced in the most spectacular way. Nowadays there are databases behind web maps in almost every case; in fact, maps themselves are the manifestations of the databases containing the actual spatial data (skins). This also applies for NAGiS - for example the map of Hungary's administrative units can be found in one of the charts of the database.

Databases containing raw data (which, in a way similar to map databases, are structured databases), can be found next to map databases, but as opposed to spatiality, the primary feature of databases containing raw data is temporality (e.g. water levels or a sequence of temperature data). The database structure of NAGiS can incorporate both of these systems.

Different geo-IT software programs have been released for map databases, but for the raw database containing a large number of thematic data, which constitutes the basic data of NAGiS, there is no off-the-shelf interface available. On that account the NAGiS project is having the GeoDat database management software program developed in a target-oriented manner, which is capable of receiving any kind of data and data series of any point-like object. The software also includes a module displaying time sequences, which allows for the spectacular comparison of the identical parameters of one or more objects for the users, or even the comparison of different parameters of the same object. The bilingual software includes the required authorisation management environment, it is able to operate the different versions even in the case of master data attributes, all this in a modern format executable in an internet browser.

In addition to the brief description of databases containing map and raw data, the ambiguity mentioned at the beginning of this article can be fully resolved by describing the distribution according to the conditions required by the heterogeneous group of users. Databases have an internal (for the participants of the project and the data administrators), and an external version (intended for the public). Although the interface is identical,



Screenshot displaying 3 pieces of time-series data in the GeoDat software program

the data content is different in each case. While the internal databases also contain the basic data, the external databases only contain derived and standardised data.

Transparency, comprehensive documentation and ensuring the repeatability of processes are the main criteria concerning the structure of the NAGiS database-system. The system is going to be developed in this spirit in the future as well.

László Orosz

Assessment of the adaptability of the Hungarian habitats for NAGiS

The adaptation of wildlife to the events of climate change is an issue of fundamental importance. Several research projects have been started also in the field of ecology in order to forecast, or at least assess future changes. This is the aim of the vulnerability analysis of natural habitats, which is a part of the NAGiS project. Components of vulnerability: exposure (to what extent the examined system is going to be exposed to the expected climate impacts), sensitivity (the amount of constraint exercised by the effects of small-scale climate changes from the aspect of the survival of the system), adaptability (the ability of the examined system to adapt to the changes affecting it). Our research contributes to the assessment of our vulnerability by examining the adaptability of the country's habitats. The changes of the habitats may primarily be traced via the reactions of living beings. The adverse effects of climate change can be compensated by the given system to a certain extent, but when a certain threshold limit is reached, biodiversity starts to decrease. The species or biomes can react in three different ways:

1) migration-based adaptation (favourable circumstances are followed by migration), 2) refuge-based adaptation (adverse circumstances are weathered out in refuges), 3) local resilience (the chances of survival are higher at habitats with better natural states).

In this case the adaptability of habitats and biomes are examined, which is analogous to the adaptability of species, assuming that the species of the biomes move together. This is a realistic assumption concerning the time horizon of the climate projections available within NAGiS. Various indices are used to quantify adaptability. The first one, which belongs to local resilience, is the index of natural capital. Its objective is to provide an easy-to-understand, but also professionally relevant picture about the condition of the wildlife. In the case of refuge-based migration one of the best methods to measure the diversity of regions is to apply the Shannon diversity index. In order to estimate migration-based adaptation, measuring the permeability between habitats may be considered as a good solution, for which the connectivity index is used. These indices are applied for the entire territory (habitats) of the country. Therefore the objective is to create a map-showing the adaptability of the habitats of Hungary. The results obtained this way provide a useful basis to other researchers for the further steps of vulnerability analysis.

Nikolett Lepesi, Ákos Bede-Fazekas, Bálint Czúcz, Imelda Somodi

Promotion of the project
Presentations

This year the 20th Meeting of **EPA/IG-CCA** (the group of the network of the leaders of the European Environmental Agency dealing with climate change and adaptation) was the first one in a series of events also introducing NAGiS.

At the meeting held between March 4th – 6th in Rome, NAGiS was introduced as one of the main projects of the National Adaptation Centre in the presentation of two associates of the MFGI–NAC, *Beatrix Kosztyi* and *Dr. Mária Csete.* Besides the more important indicators, the presentation focused on the possible purposes and areas of use of the geographical information system developed in the course of the project.

The next step of introducing the results was the professional event **"22th Conference On Ground Waters",** held between April 8th – 9th, 2015 in Siófok. The project was described to the audience in two consecutive presentations.

First *Dr. Teodóra Szőcs,* the head of the Hydro-geological Department of MFGI introduced the main objectives, the results of research on ground waters achieved so far, and further tasks.

Dr. Teodóra Szőcs is giving a presentation (photo: www.fava.hu)

Following that, *Dr. Attila Kovács* , senior research fellow of the department gave a presentation "The Effects of Climate Change on Shallow Ground Waters – the First Conclusions of the NAGiS Project" which provided an overview of the examinations carried out within the framework of the project, of the applied methodology and the model developed, which is suitable for predicting the sensitivity of shallow ground waters to climate change. The development of the NAGiS system is also supported by two projects under the direction of the Hungarian Meteorological Service: the RCMGiS ("New climate scenarios based on the change in radiative forcing over the Carpathian Basin") and the CRIGiS ("Vulnerability/impact studies with a focus on tourism and critical infrastructures") projects. These projects are also implemented with the support of the Adaptation to climate change programme of the EEA and the Norway Grants. NAGiS was introduced at the kick-off events and the impact assessment consultation workshops dealing with the major topics of the projects that started in the spring of 2015.

MFGI professional conference (photo: Villő Deák, MFGI)

At the **kick-off events** of the **RCMGiS Project** (April 27th) and the **KRIGiS Project** (June 1st) *Péter Kajner,* the general project manager of NAGiS outlined the potential use of the geographical information system being developed, identifying the contribution of the project to the preparation of the climate policy decisions and to the development of the strategies of adapting to climate change as the two most important pillars.

The impact assessment **consultation workshop** of the **RCMGiS** and **CRIGiS** projects organised by the Hungarian Meteorological Service was held on June 22nd in Budapest. *Dr. György Tóth,* senior research fellow of MFGI gave a presentation about NAGiS. His presentation primarily outlined the national groundwater-topography model prepared from the measured and modelled climate parameters, which model provides an opportunity to analyse the effects of climate change on the conditions of groundwater recharge and water tables.

In the second quarter of 2015, the tasks and results of the project's IT-background were mentioned at two professional conferences.

The opening conference of the CRiGIS project (photo: www.met.hu/KRITeR)

At the **30th GIC** (Geoscience Information Consortium) **Conference** between 4–8 May in Hannover, the presentation prepared by *Dr. Gábor Turczi,* the assistant director of MFGI and research fellow *Benedek Simó,* focused on the issues of optimising and modernising the IT-background, the organisation and management of GIS-data, and the results obtained so far in this field.

At the "Web-based Geoinformatics" section of the **6th Hungarian GIS Conference and Exhibition** *László Orosz,* the head of the Geoinformatics Department of MFGI introduced NAGiS, primarily focusing on the development of the database, the types and structure of data and the planned operation of the system.

Between May 21st – 23rd the 6th **Hungarian Conference on Landscape Ecology** took place in Budapest, which provided an opportunity to shed light on the role of the National Adaptation Geo-information System also with respect to the expected effects of climate change on semi-natural vegetation.

On the first day of the conference, in the section "Modern methods and measurements in landscape research", *Ákos Bede-Fazekas*, an associate of MFGI–NAC reviewed the fine-scale ecological database of input data developed in the project, which database is intended to lay the foundations of modelling the expected changes of the vegetation due to climatic impacts and further ecological analyses. The poster presenting the possibilities of binarising the probabilistic predictions of the models forecasting the changes of the vegetation, prepared by the associates of MFGI–NAC, was also connected to this topic.

In the program series of the "European Sustainable Development Week" the MFGI also organised a professional conference: **"Natural resources, geological risks, climate change: where does the 'geological path' of sustainability lead?".** At the event on June 4th, NAGiS was introduced by *Péter Kajner*, general project manager, highlighting its importance in the development of the actual climate adaptation tools.

Similarly to those of the CRIGiS and RCMGiS projects, the results of the project "Prediction of the long-term social and economic development path of Hungary", which start-

ed in May 2015, are also to be used to extend the NAGiS database. This is the reason why the National Adaptation Geo-information System was reviewed also at the opening meeting held on June 23rd in Budapest, presented by the general project manager at this time, as well. The presentation emphasised the significance of the connected projects and the expansion possibilities they provide.

Publications

The research work carried out for the NAGiS project has produced many results. The majority of these results are expected to be published at the end of this year and in 2016. The following few publications and abstracts, however, have already been published.

Bede-Fazekas, Á., Czúcz, B., Somodi, I. 2015: Development of fine-scale ecological database for the National Adaptation Geoinformatic System (NAGIS), Hungary. Poster H-01 (young scientist). Session: Data sources for broad-scale vegetation studies. — In: *58th Annual Symposium of the International Association for Vegetation Science: Understanding broad-scale vegetation patterns. 19–24 July 2015, Brno, Czech Republic. Abstracts.*
http://www.iavs2015.cz/files/IAVS-Brno-2015-Abstracts.pdf

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Bede-Fazekas Á., Somodi I. 2015: Éghajlati adatok statisztikai leskálázása a Nemzeti Alkalmazkodási Térinformatikai Rendszer (NATéR) keretében megvalósuló ökológiai modell számára. — In: *X. Magyar Ökológus Kongresszus. Pannon Egyetem, Veszprém, 2015. augusztus 12–14. Conference papers.*
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Lepesi N., Botta-Dukát Z., Somodi I. 2015: Prediktív modellek valószínűségi becsléseinek binarizálási lehetőségei a NATéR elemzések megalapozására. Conference abstract. — In: *VI. Magyar Tájökológiai Konferencia 2015. Tájhasználat és tájvédelem - kihívások és lehetőségek. 2015. május 21–23.*
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http://www.iavs2015.cz/files/IAVS-Brno-2015-Abstracts.pdf

Lepesi N., Botta-Dukát Z., Somodi I. 2015: Prediktív ökológiai modellek valószínűségi becsléseinek binarizációs stratégiái a Nemzeti Alkalmazkodási Térinformatikai Rendszer (NATéR) számára. — In: *X. Magyar Ökológus Kongresszus. Pannon Egyetem, Veszprém, 2015. augusztus 12–14. Conference papers.*
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Orosz L., Mattányi Zs., Turczi G., Kajner P., Simó B., Vikor Zs. 2015: A NATéR (Nemzeti Alkalmazkodási Térinformatikai Rendszer) fejlesztés. — In: Boda J. (szerk.): Az elmélet és a gyakorlat találkozása a térinformatikában. *VI. Debreceni Térinformatikai Konferencia és Szakkiállítás. Conference papers. Debrecen Egyetemi Kiadó, 2015.*
http://geogis.detek. unideb.hu/Tkonferencia/2013/ Kotet.php

Rotár-Szalkai, Á., Gál, N., Szőcs, T., Tolmács, D. 2015: Characterization of climate change sensitivity of Drinking Water Protection Areas (poster presentation). — In: *EWA Spring Days 2015 Budapest Water Conference, 2015. március 4–6.*

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