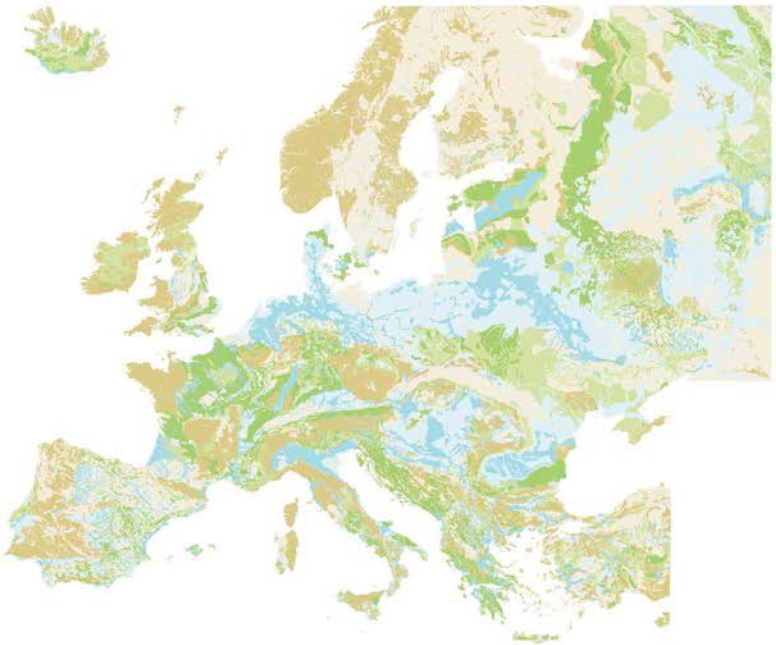
International Workshop on

Groundwater Systems in Europe

On the occasion of the completion of the

International Hydrogeological Map of Europe (IHME)

22 – 23 August, 2013 at BGR Branch Office Berlin



Occasion, Objectives & Resume

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based on the notes of the rapporteurs

Content

Occasion & Objectives

The map series of the International Hydrogeological Map of Europe (IHME) was completed in August 2013 by printing the map sheets D5 Budapest and E5 Bucuresti. With its 25 sheets printed, the IHME series presents a unique, seamless and homogeneous picture of the hydrogeological conditions, lithological composition and structure of near surface deposits throughout Europe. Furthermore various hydrological, geological and water management topics with significance to groundwater are depicted. The most relevant features e.g. spatial hydrogeological structures with attributes concerning productivity, type and lithology of aquifers will be available in a digital format as GIS layers soon.

On the occasion of the completion of the IHME map series BGR convened this workshop to discuss future perspectives of cooperation on hydrogeological mapping issues in Europe.

The workshop was organised jointly with *the Geological Surveys of Europe (EuroGeoSurveys)* and the *UNESCO International Hydrological Programme (IHP)* in association with the *European Topic Centre on Inland, Coastal and Marine Waters (ETC/ICM)*, the *Commission for the Geological Map of the World (CGMW)*, the *International Association of Hydrogeologists (IAH)* and the *International Groundwater Resources Assessment Centre (IGRAC).*

The workshop served as a platform to discuss a number of topics related to hydrogeological mapping:

- Approaches of classification and delineation of groundwater systems in Europe, including transboundary aquifer systems;
- Significance of the hydrogeological setting and natural groundwater flow systems in river basin management, integrated water resources management, modeling and decision support systems;
- Challenges and opportunities for harmonised data handling in Europe for natural resources management and to sustain European land, water and soil policies;
- Needs and requirements for underpinning policy approaches by appropriate data, tools and information to bridge the gap between science and policy stakeholders.

Workshop Resume

The ”International Workshop on Groundwater Systems in Europe” gave an overview of current activities regarding groundwater assessment with special focus on international respectively transboundary aspects and on the need for new groundwater data.

The upcoming reporting of the second River Basin Management Plan according to the Water Framework Directive (WFD) constitutes a major impulse for ongoing national and European-wide groundwater projects. The CIS Working Group C (WG C), which is addressing WFD groundwater issues, will continue to provide its service.

The history, the approaches and the instruments used in groundwater assessment strongly vary between the European countries as was illustrated by the examples of e.g. Albania, Czech Republic, Denmark and the United Kingdom.

The printing of the 25 IHME sheets was completed and digital layers of aquifer types and lithology derived from the IHME will be available soon. This will provide the first European-wide harmonised spatial groundwater dataset. BGR also compiled the WFD Groundwater Body (GWB) layer on behalf of the ETC/ICM. The layer shows that the datasets, currently reported by the EU member states, are not consistent. However, a future amended and coherent GWB layer will support the European-wide groundwater survey substantially.

The IHME GIS layers may form a valuable instrument in several research fields as for instance the harmonisation of WFD data, the assessment of transboundary aquifers and the filling of gaps concerning groundwater model components. In particular the IHME lithology layer has already been required for use in other disciplines at European level, such as soil mapping, geochemistry and land slide hazard assessment.

The participants agreed that the quality and quantity of aquifer data must be further improved. This is essential for a precise characterisation and delineation of aquifers including transboundary groundwater resources and the accuracy of hydrogeological models.

Assessment of transboundary aquifers is carried out at different scales as demonstrated for river basins, continents and at a global level.

The development of improved groundwater models including 3D will enhance the understanding of hydrogeological systems, their controlling processes and future developments. Especially in a combination with models of interacting media groundwater models operate as important decision support tools.

Finally, the hydrogeological information must be easily accessible for data users and the public. Tools of data exchange via the internet as for instance Web Map Services and interactive information platforms are available, but require further development and adaption by hydrogeologists.

Theme 1 Groundwater and EU Policy

Rapporteur: Klaus Hinsby (GEUS / EuroGeoSurveys)

Resume

The presentations of workshop theme 1 focussed on activities resulting from the implementation of the WFD. Structure, tasks and the assessment results of European institutions related to groundwater in the WFD and the key aspects in the upcoming mandate period of the ETC/ICM and the WG C - …Groundwater were presented. This was endorsed by the discourses of concepts and new developments concerning groundwater survey in Czech Republic and Denmark. Both EU member states sketched different approaches to fulfil the obligations of the WFD in combination with further national assessment targets.

Thus the first workshop section provided an overview of current joint activities to implement the WFD augmented by examples of the variety of methodical and technical approaches adopted by the EU countries.

Anita Kuenitzer (ETC/ICM) : Significance of groundwater in the European environmental policy

Described the integration of groundwater in the environmental legislation of the EU, which is focussed on the WFD obliging the member states to report River Basin Management Plans including groundwater data to the European Commission. The WFD establishes the objective of reaching a good groundwater status – chemically and quantitatively, whereas the daughter directive Groundwater Directive (GWD) lays down detailed quality criteria for the assessment of the chemical groundwater status. Nevertheless threshold values determined by the member states vary considerably and delineation of GWBs is still subject of discussions. Several example maps, which are publicly accessible by the groundwater viewer in the Water Information System for Europe (WISE), were displayed. Some further maps and graphics highlighted the evaluation results of the current chemical status of GWBs e.g. by regions or river basins.

Johannes Grath (UBA, AT / Chair WG C): Groundwater Common Implementation Strategy for the WFD

Presented past and future activities concerning the Common Implementation Strategy (CIS) of the WFD, groundwater issues of the `Blueprint to safeguard EU Waters´ and elements of the next mandate of the WG C - Groundwater.

Blueprint analysis of current available data reveals variations between the EU member states. This results in several recommendations for a future focus of groundwater survey on aspects as dependent ecosystems and surface waters, protection of drinking water, threshold values and trend assessment. These issues also form crucial tasks of the next mandate of WG C during 2013 – 2015.

Hana Prchalova (CENIA, CZ): Groundwater body systems in the Czech Republic

Sketched the importance of groundwater issues and the history of groundwater survey in the Czech Republic. An already existing, well-developed classification system of groundwater entities was adjusted to requirements of the WFD including aspects as public participation and a direct link between status and measures. Several examples illustrated the methods applied as for instance the groundwater delineation concept. Resulting maps of aquifer characteristics and of features like background concentration and groundwater vulnerability were depicted.

Anker L. Højberg & Klaus Hinsby (GEUS, DK): National Danish Water Resources Model - An integrated groundwater - surface water model for decision support in a changing climate

Described the structure and the operating of the Danish National Water Resources Model. This physically distributed coupled groundwater – surface water model serves as a groundwater management tool and is in many respects the way forward in Danish WFD implementation and climate change impact assessment. The model has been improved since the first version in 1996. Besides supporting concepts of groundwater monitoring, the model has been applied in several studies for purpose of prognoses as concerning nitrogen loads and groundwater floodings.

Theme 2 History and lessons learnt of the IHME

Rapporteur: Anita Künitzer (ETC/ICM)

Resume

The final sheets D5, Budapest, and E5, Bucuresti, of the map series "International Hydrogeological Map of Europe 1 : 1,500,000" (IHME) were printed in August 2013. After an exceptional long processing period of more than 40 years the completion of the print map accompanied by the provision of digital GIS layers of selected map features was an occassion to discuss the relevance of these products e.g for trans-border groundwater survey in the frame of this international workshop.

The chronicles of this project and the map composition were introduced. The inherent information is an outcome of a long-term cooperation of many contributors. As the only European-wide coherent hydrogeological map the IHME constitutes a valuable tool for international research. In particular the digitised GIS layers of aquifer types and lithology open a wide field of potential use in domains such as water management, evaluation of groundwater recharge and groundwater contamination, natural risk assessment or engineering. The digital data also permits a continuous updating in a more harmonised way and cross-validation respectively combination with other maps. As revealed by the case study of Albania the IHME may also support national mapping projects.

Wilhelm Struckmeier (BGR): The IHME project and results

Presented an historical overview of the IHME project starting from the methodical discussions in the very beginning to the sequential publishing of single maps and the latest developments. The organisational background and the structure as well as the content of the printed maps were explained. Furthermore relevant map charachteristics as in particular coherency, application fields and the move from the "traditional analogue IHME" to the digital IHME era were illustrated also mentioning intentional future steps to improve the IHME GIS layers. The digital IHME consists of polygons (aquifer type, lithology, sea intrusion), lines (faults) and points (springs).

Romeo Eftimi (former Albanian Geological Survey): Hydrogeological mapping in Albania – From the IHME contribution to larger scale national maps

Outlined the geological respectively the hydrogeological conditions and the history of groundwater monitoring in Albania starting in the end of 1950ies. A team for groundwater mapping in Albania was established in 1974. Requests to contribute to the IHME in the same year enriched the national mapping project aiming at a hydrogeological map of a larger scale. The hydrogeological map 1 : 200,000 of Albania, published in 1985 is based on the principles of the IHME, but comprises more detailed information. The compilation of IHME Sheet D6, Athina, lasted more than 40 years with corrections of the Albanian shares to better fit the neighbouring countries and and to adopt new perceptions.

Andreas Günther (BGR): A new European digital lithology layer derived from IHME

Described the postprocessing of the digitised IHME lithological information. A geometrical aggregation of in total 1290 lithological units resulted in 672 classes. This was performed in two steps applying defined constraints. Subsequently a semantic aggregation was conducted starting with translation into an universal taxonomy schema having 204 classes. This semantic Level 1 aggregation was followed by four further stages until the basic ternary classification of Level 5. Diagrams of the semantic aggregation of Level 1 to Level 5 (”Consolidated”, ”Unconsolidated” and ”Partly consolidated”) lithological units were presented.

Klaus Duscher (BGR): IHME and the European Groundwater Body layer - Comparison, applications, synergies

Elucidated the compilation of the Groundwater Body (GWB) GIS layer by BGR on behalf of the ETC/ICM respectively the EEA and compared the project outlines as well as features and elements of the IHME and the GWB dataset. GWBs serve as flexible data container, but they are not reported coherently. The composition of the IHME polygon layer is static and includes only selected attributes, but the spatial and attribute data are quality assured and consistent. Several options to apply in particular the IHME polygon layer by means of geoprocessing with other spatial information e.g. in risk assessment or water balance models were presented. Synergies between the GWB layer and the IHME layer arise from creating new GWB characteristics derived from the IHME as for instance lithological information.

Theme 3 Transboundary Aquifers (TBA) in Europe

Rapporteur: Annuka Lipponen (UNECE)

Resume

Transboundary Aquifers (TBA) are of particular importance for the Integrated Water Resource Management (IWRM), because they challenge bilateral cooperation and multilateral harmonisation of definitions, terms and descriptions concerning aquifers.

The lectures illustrated various strategies of TBA management on different scales. Several approaches by multinational cooperations including the activities on a global and a continental scale of UNESCO were portrayed.

Although considerable progresses have been made so far, the presented results, current status and future scope of research projects revealed gaps in the current TBA inventory with a request for methodical adjustments. The IHME may serve as a tool for alignment of the inventories of aquifers and GWBs and to identify priority regions for TBA assessment in Europe.

Holger Treidel (UNESCO - IHP): UNESCO-ISARM and the GEF-TWAP project of transboundary waters

Explicated the structure, aims and accomplishments of two global multi-agency research projects concerning transboundary water resources and in which UNESCO is playing a major role. The groundwater section of the newly formed Transboundary Water Assessment Programme (TWAP) is building on what has been achieved by the elder initiative Internationally Shared Aquifer Resources Management (ISARM) launched in year 2000. TWAP pursues the ISARM aquifer description implementing an indicator-based inventory. A multitude of partners contribute to TWAP and the TBA assessment based on existing information will integrate their expertise and research findings like respective maps of BGR and IGRAC.

Neno Kukuric (IGRAC): Assignment of transboundary aquifers in Europe - Methodology and current status

Pointed out the activities of the International Groundwater Assessment Centre (IGRAC), which has been involved in TBA survey as an ISARM partner. A definition how to classify a TBA and certain points of relevance for TBA assessment were indicated. Next, several maps as a result of continental ISARM TBA evaluation were presented. The steps of European TBA assessment were illustrated with evolution from depiction as dots through circles to delineated TBAs, documented as well in several publications. A certain emphasis was put on the explanation of options how to integrate transboundary groundwater bodies (TBGWBs) resulting from WFD reporting, because these units are not necessarily delineated by using hydrogeological criteria. All in all the current TBA maps of Europe have to be considered as a first step demanding an improved cooperation between the countries and the international organisations.

Jacques Ganoulis (UNESCO - INWEB): Open-source Web GIS Cooperative Information Systems for transboundary groundwater management

Introduced the INWEB network in the Balkan countries aiming at the improvement of cooperation in water management with a focus on transboundary issues. INWEB already implemented an information platform in the internet, which includes databases, interactive maps and water resource descriptions. These tools were generated using open source software. The provided information covers transboundary surface waters and aquifers in the participating Balkan countries and moreover shared aquifers in North Africa and the Near East. Further aspects as threats to water resources and coastal aquifers were presented making INWEB a positive example of the enhancement of multilateral cooperation in managing transboundary waters.

Andreas Scheidleder (UBA, AT): Managing transboundary groundwater bodies in the Danube river basin

Explained the handling of TBGWBs in the Danube river basin managed by the International Commission for the Protection of the Danube River (ICPDR), which comprises a groundwater task group. Eleven TBGWBs with a minimum size of 4000 km^2 or meeting other criteria for a high management relevance as interaction with ecosystems or high pressures were selected for a more detailed evaluation. The cooperation concept was presented in general and with three exemplary case studies. Finally the assessment results of groundwater quality for the eleven chosen TBGWBs were quoted. A future task will be the intensification of the efforts to harmonise the approaches and concepts for improvement of the data situation in the next River Basin Management Plan.

Theme 4 Hydraulic and geochemical characterization of groundwater systems and geological units

Rapporteur: Pierre Nehlig (CGMW)

Resume

The fourth workshop section aimed to illustrate selected approaches of the description of groundwater systems qualitatively or quantitavely. The three lectures singled out just some aspects of the broad research field of groundwater system characterisation. The scale of the contributions varied from a regional level to European-wide. The presentations addressed the problem of calculating groundwater recharge rates in karst aquifers, the computing and publishing of groundwater background values in Germany and, digressing from hydrogeological topics, the GEMAS activities to characterise soil chemistry.

Bartolomé Andreo Navarro (CEHIUMA, ES): Groundwater recharge assessment in karst aquifers by APLIS method and potential at European scale

Explained the APLIS methodology to determine groundwater recharge in karst aquifers based on data input of ground elevation, slope, lithology, infiltration properties and soil. These data were processed with a certain algorithm to produce recharge maps of several Spanish karst aquifers. As a further application of the APLIS method the calculation of the volume of groundwater resources by precipitation and recharge rates was demonstrated in a Spanish case study. Moreover APLIS has been applied for the assessment of karst aquifers in several other European countries and also outside of Europe. APLIS has been proposed as an option to compile an overview of the distribution of recharge rates and groundwater resources in the European karst aquifers. Nevertheless the quality of data input would be a crucial aspect.

Bernhard Wagner (LfU Bavaria, DE): Web Mapping Service of natural background values of groundwater

Described the activities of the German workgroup "Background values of groundwater“ to ascertain the natural concentrations of a number of major elements, trace elements and physicochemical parameters in the groundwater aggregated for certain hydrogeochemical units. The German approach separates the natural from anthropogenic components of substance concentrations using a graphical probability net methodology. The 90 % percentiles of the resulting „population“ of background values are then mapped for all of the hydrogeochemical units almost completely covering the whole of Germany. Several of these maps, which are available by a Web Map Service (WMS) of BGR, were shown. The main application is the determination of standards for GWB quality assessment according to the WFD. Several enhancements and integration of new data are currently ongoing.

Manfred Birke (BGR) et al.: Geochemical mapping at European scale - The GEMAS-project

Portrayed the assessment of European-wide topsoil samples (on average 1 sample/2500 km^2) with distinction of arable and graze land use by the EuroGeoSurveys GEMAS-project to replenish the FOREGS Geochemical Atlas. Several resulting maps were presented. The distribution of substances and the source of elevated concentrations was interpreted by other environmental factors influencing the soil chemistry as altitude, precipitation, climate, population density and mining industry. In this respect the lithological IHME units, which can be considered as a soil parent material map, show a remarkable correlation with some distribution patterns. The GEMAS data also allows risk assessment (PEC/PNEC) and suggests that the spatial distribution of most analysed substances is driven by natural processes, wheras anthropogenic influence is mostly restricted to certain regions.

Theme 5 Groundwater modelling as a basis for decision support

Rapporteur: Bernhard Wagner (LfU Bavaria, DE)

Resume

Groundwater models constitute an important tool to understand the complex processes in aquifer systems and their interaction with other environmental media. Furthermore they allow prognoses about the development of system status implementing different scenarios to assess e.g. the impact of measures. Thus, they are useful instrument to support decision makers.

The presentations of the final workshop theme demonstrated a wide range of groundwater model applications with specimen of European-wide water balancing, water resources management including implementation of scenarios, flooding of closed mining areas and aquifer protection vs. shale gas production.

Examples of 3D geological models with hydrogeological attribution were given at different scales. Apparently the linkage between groundwater resources and the interacting media is essential for achieving robust models and reliable results. It was pointed out that a balance between model details and simplification must be found to facilitate either information quality and software performance.

The lacking availability of harmonised hydrogeological data on a European scale was noted. The IHME digital data may fill this gap at least temporarily, possibly supplemented by data derived from the GWB GIS layer.

Ad de Roo (JRC): 1) Modelling groundwater for balancing water availability and water demand in Europe and
2) LISQUAL: Integrated water quantity & quality model including economic loss functions

1) Outlined in the first lecture section the activities of the Joint Research Centre (JRC) in water balance modelling based on the demand on information by the DG ENV (European Commission) concerning for instance the improvement of water efficiency and the reduction of water scarcity. Maps of current water abstraction and predicted change of consumption in Europe were displayed.
2) The second part of the presentation specified the LISQUAL model, which integrates the two models LISFLOOD (hydraulic share) and EPIC (substance fluxes). This is complemented by further components relating to the simulation of e. g. point sources and implementation of economic accounts. Exemplary outputs are calculations of nutrient concentrations and flood damage risk assessment. The groundwater part is currently not represented adequately in the model. Several scenario calculations were mapped pointing out the benefits of European-wide measures as urban greening. In a further step cost calculations were considered to describe the effect of certain scenarios in the Danube basin depending on the financial input.

It was discussed whether and how the IHME digital data may help to close the gap of hydrogeological elements in the model.

Alberto Lorenzo Alonso (ETC-SIA): Rough estimation of underground water resources in Europe based on IHME (inter alia)

Elucidated the approach of the EEA to determine water stocks per Functional Elementary Catchments (FECS), which are deduced from the European Catchment and River Network (ECRINS). For modeling of groundwater shares the precise information regarding aquifer properties as thickness, porosity, water table and geology would be required, but this is not available on a European scale. Auxiliary a draft of the digital layer of IHME aquifer types and lithological information from OneGeology was used to estimate hydrogeological relevant factors as porosity. The groundwater volume was calculated for GWBs in single countries, which provided thickness information, and was then assigned to FECS. The presentation revealed again the wide gap in the current information situation concerning groundwater conditions and the interaction with surface water on a European level. In this respect the new IHME GIS layers of aquifer type and lithology may at least serve as temporary tools until more precise and harmonised hydrogeological data is available.

Thomas Walter (LUA Saarland, DE): Closing down the mining in the Saar Region, Germany: Are we creating a transboundary "great man-made aquifer"?

Described the situation resulting from the closure of mining in the small German Federal State of Saarland leaving significant areas with a strongly lowered groundwater table due to pumping. Flooding of voids and unsaturated zones results in an anthropogenic chiselled aquifer system by e.g. shafts and goafs with hydraulic properties comparable to karst aquifers. Further problems are for instance ground subsidence and negative hydrochemical effects as acidification. A 3D model of the transboundary Saar region including French territory, which is integrating the relevant hydraulic factors, was implemented to calculate the rebound of groundwater level through flooding. It was stated that a very detailed structure of the model will not be practicable and possibly lead to overflow. Thus an balance between details and model simplification must be found.

Rob Ward (BGS, UK): 3D underground modelling in the UK

Illustrated the development of the 3D geological model of the UK having a countrywide coverage, but with varying spacing between the 84 sections, which consist of 227 rock types. Model attribution of aquifer types and combination with surface water models including simulation of interactions allows the use in water resource management in whole basins. These models are also applied to predict scenarios as the impact of extreme events. A further application of the 3D geological model aims at the occurence of shale gas. Surface of shale deposits were interpolated from model sections and were mapped in GIS. Finally a comparison of spatial distribution of aquifers and potential shale gas resources was presented supplemented by some example maps of selected units.

Klaus Schelkes (BGR): Coupled decision support systems for ground- and surface water

Presented a coupled decision support system (DSS) used as a water planning and management tool in technical cooperation projects in the Arab region. This DSS is based on the freeware WEAP, which models all processes relevant for the estimation of the water balance in a catchment by nodules and links. To receive precise information about groundwater drawdowns and flows WEAP has been coupled with the hydraulic model MODFLOW. Interfaces for connecting further software packages enable enhanced system analysis and improved data handling. Latest development is LinkKitchen which provides inter alia a GIS-comparable user interface. As a case study the results of applying this DSS in the pilot area of the Zabadani Basin in Syria were presented. The quality of prognoses of several scenarios depends on the amount and quality of data input to build up an adequate model. The effects on groundwater resources in several scenarios with assumption of impacts by droughts, increased abstraction or climate change were calculated and compared. The portayed DSS proved to be a powerful instrument applied in several projects to investigate water management problems, whereas the setup requires sufficient time of at least several weeks.