



International Groundwater Resources Assessment Centre

Report

2014

IGRAC (International Groundwater Resource Assessment Centre) facilitates and promotes international sharing of information and knowledge required for sustainable groundwater resources development and management.

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Government of
The Netherlands



United Nations
Educational, Scientific and
Cultural Organization



International
Hydrological
Programme



World Meteorological
Organization

IGRAC
PO Box 2807
2601CV Delft,
The Netherlands

T +31 15 215 2325
E info@un-igrac.org
I www.un-igrac.org

IGRAC Report 2014

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List of Acronyms

AGW-Net	African Groundwater Network
BGR	German Federal Institute for Geosciences and Natural Resources
BGS	British Geological Survey
CIWA	Cooperation in International Waters in Africa (World Bank trust fund)
CoP	Community of Practice
DGIS	Directorate-General for International Cooperation (Dutch Ministry of Foreign Affairs)
DIKTAS	Protection and Sustainable Use of the Dinaric Karst Aquifer System project
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GGIS	Global Groundwater Information System
GGRETA	Groundwater Resources Governance in Transboundary Aquifers project, a new name for the SDC project
GGMN	Global Groundwater Monitoring Network
GTN-H	Global Terrestrial Network - Hydrology
HYCOS	Hydrological Cycle Observing System
IAH	International Association of Hydrogeologists
IFAS	International Fund for saving Aral Sea
IGAD	Intergovernmental Authority on Development
IHP	International Hydrological Programme
IMS	Information Management System
INWRMP	Inland Water Resources Management Programme
IW-LEARN	International Waters Learning Exchange and Resource Network
ISARM	Internationally Shared Aquifer Resources Management
IWMI	International Water Management Institute
MAR	Managed Aquifer Recharge
MIM	Meta Information Module (a GGIS component)
OGC	Open Geospatial Consortium
SADC	Southern African Development Community
SAP	Strategic Action Plan
SDC	Swiss Agency for Development and Cooperation, in the past also used to indicate the SDC funded GGRETA project
SIDS	Small Island Developing States
TWAP	Transboundary Water Assessment Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
WB	World Bank
WHYCOS	World Hydrological Cycle Observing System
WHYMAP	World-wide Hydrogeological Mapping and Assessment Programme
WMO	World Meteorological Organisation
WPP	Water Partnership Programme

1. Summary

This document reports on IGRAC's activities in 2014. The activities were conducted according to the Work Plan 2014 and the Strategic Document 2012-2017.

Transboundary aquifer assessment remained the main IGRAC activity, executed in three long-term UNESCO projects. Since the contracting procedure with UNESCO speeded up to some extent, additional staff members were recruited in order to fulfil the contracting obligations and conduct other planned activities. This had an immediate effect of reducing work pressure and increasing motivation and productivity. Eventually, 2014 was a very productive and financially positive year.

Development of a new version of GGIS (Global groundwater Information System) was challenging also due to new software developers; in meantime first new GGIS modules became operational.

One of the characteristics of 2014 was certainly broad thematic assessment. Due to engagement of several interns, IGRAC was able to conduct assessment of a several global groundwater issues, including ecosystem-based adaptation in groundwater management, the groundwater-food-energy nexus and economics in groundwater governance.

Groundwater monitoring remained one of the main tasks of IGRAC; without knowing the current state and the trend of groundwater resources, no proper management measures can be taken. Implementation of the Global Groundwater Monitoring Network (GGMN) programme continued with a major introductory workshop in China.

A large number of groundwater governance and knowledge sharing activities took place in 2014, resulting in numerous publications, presentations and events. In 2014 IGRAC started promoting its activities on Twitter, Facebook and LinkedIn and with clear success. The campaign about 'Groundwater: The Hidden Resource' showed that making information on groundwater available through media is a necessary complementary activity to IGRAC content activities.

2. Organisational/Institutional Activities

In 2014, IGRAC continued the activities aimed at further strengthening the Centre's organisational structure as well as its links with various institutions and programmes.

In January 2014, an IGRAC presentation and a number of meetings were organised at the World Bank. Particularly a project Sustainable Groundwater Management in SADC Member States was discussed. Based on IGRAC's proven record with project implementation, the World Bank was assured that IGRAC can substantially contribute to this important project (12M USD); however an appropriate modality for involvement needed to be found. IGRAC could join a consortium of consultants but then the centre would be seen as a commercial party and not as a non-profit, independent UN centre, trusted by countries with their groundwater data. The other option to engage IGRAC would be for the bank to make a procurement agreement with UNESCO. Unfortunately, there was no support for this option from the UNESCO administration since IGRAC is not legally a part of UNESCO. The programmes supported by the Netherlands were also addressed with the World Bank staff, especially the Water Partnership Programme (WPP) and the Cooperation in International Waters in Africa (CIWA) programme.

Again, IGRAC involvement outside of a regular tender procedure would probably be possible only through the UN or when requested by recipient countries (the latter would probably be the option for the SADC project).

Cooperation between the World Bank and IGRAC continued throughout the year, exploring possibilities for common activities in the regions of Eastern Africa and Central Asia. On the longer term, it seems that the World Bank would be ready to support an international centre/institute with a relevant expertise. The best, and only possibly only, way to achieve that would be to build up a proven record in World Bank projects. The Dutch delegation at the World Bank is supportive of more water-related projects with involvement of expertise from the Netherlands. However, similar support would be required from the Government of the Netherlands when prioritising issues and related expertise.

UNESCO has a crucial role in the current IGRAC project portfolio. IGRAC's main activities are the projects executed through UNESCO, namely DIKTAS, TWAP and GGRETA. IGRAC does not have the status and impact of UNESCO to independently attract funding organisations such as Global Environment Facility (DIKTAS, TWAP) or Swiss Development Cooperation (GGRETA). Nevertheless, IGRAC is a UNESCO and WMO centre and that helps IGRAC to enter project consortia such as UPGRO and HELP (see the chapter 4). However, acquisition and execution of projects could be substantially improved if the status of category II centra at UNESCO were more precisely defined.

In accordance with the consensus of the last Governing Board meeting, IGRAC initiated increased cooperation with WMO. IGRAC is active in a number of WMO related networks (e.g. GTN-H and GCOS/TOPC) but not in WMO programmes like WHYCOS and IGAD-HYCOS. Hopefully, with a new WMO representative on the IGRAC Governing Board, new opportunities for cooperation will be created.

Regarding the internal organisational structure, required enlargement of the IGRAC Foundation Board is accomplished, now consisting of representatives from UNESCO-IHE, Deltares and Technical University Delft. Nevertheless, the current composition does not have to be definite; IGRAC will continue an active search for other knowledge organisations in the Netherlands potentially interested in joining the Foundation Board. In its August 2014 meeting, the Foundation Board discussed the performance of the IGRAC foundation and advised on several procedural and financial issues (e.g. a yearly report needs to be reviewed by the Founding Board before sending it to the Governing Board).

Contribution of the Netherlands to international groundwater programmes and projects was discussed in order to locate possibilities for IGRAC involvement. It is very difficult for IGRAC to become engaged in the Water OS programme of the Ministry of Foreign Affairs, Directorate-General for International Cooperation (DGIS) because of the procedures. The procedures for involvement in international programmes supported by the Netherlands, such as the WPP and CIWA are not favourable either. These are World Bank programmes and executed according to the World Bank procedures. Groundwater is included in these programmes but it is not a priority for the DGIS when it comes to the programme execution; the attention clearly goes to the other water sectors: flooding, sea water intrusion, sanitation, etc.

IGRAC intended to hold a meeting of the Technical Advisory Committee (TAC) during the IAH Congress in Morocco (September 2014) but only three members attended the congress. Organising a TAC meeting does not have a priority and is costly, having the members in various continents. IGRAC Strategy Document 2012-2017 was discussed with most of the TAC members individually, yielding useful contributions. Nevertheless, the TAC is a part of the envisaged IGRAC organisational structure and should have a face-to-face meeting planned for next year in Delft.

IAH Executive Board requested to nominate a member to the IGRAC TAC. A vice-president and two past presidents of IAH are already members of the TAC (but selected by the Governing Board on individual basis as prominent peers). Further, IGRAC suggested becoming an observer to the IAH Council in order to enhance information flow in both directions. IGRAC is an IAH corporate member and has excellent cooperation with many IAH commissions (e.g. Karst, MAR, Climate Change). For a newly established Commission on Transboundary Aquifers, IGRAC has provided one of the co-chairs.

The main organisational novelty with respect to personnel and ways of working at IGRAC in 2014 was engagement of interns. In total five young professionals received their first practical working experience at IGRAC in 2014. The benefits for both interns and IGRAC were obvious; nevertheless, guiding of interns is time-consuming and not more than two interns at the time should be at IGRAC with the current personnel capacity. At the moment IGRAC has seven staff members, including one PhD researcher. IGRAC aims to increase the number to around ten staff members in coming years.

3. Content Activities

IGRAC's content activities in 2014 were for the most part a follow up of activities in previous year, conducted in accordance with the Work Plan 2014 and the IGRAC Strategic Planning 2012-2017. IGRAC activities were also influenced by various external factors but there was no significant deviation from the yearly planning. This year, thematic groundwater assessments and knowledge sharing activities were more diverse and extensive than in previous years. The main activity structure remained practically the same as last year:

- Global Groundwater Information System
- Global Groundwater Assessment
- Global Groundwater Monitoring Network
- Knowledge Sharing Groundwater Governance

Next chapter contains an overview of the main activities and their outcomes. Additional information is available in project documents and other IGRAC products and services, as referenced in the overview below.

3.1 Global Groundwater Information System (GGIS)

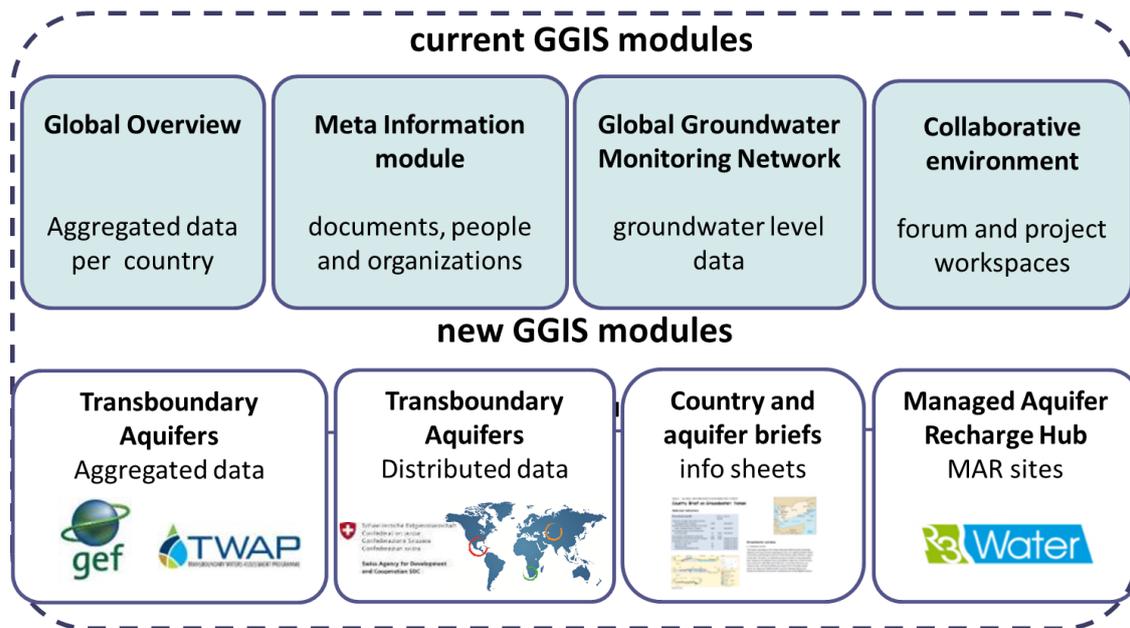
GGIS is IGRAC's web-portal to groundwater-related information and knowledge. It leads the user from available, aggregated global information, via related information sources, towards a direct information exchange. The software developed for monitoring (the GGMN application) and other IGRAC online databases are also considered a part of the GGIS.

3.1.1 Software update

In 2014, IGRAC completely redeveloped and expanded the GGIS using open and extendable state of the art technology, making it possible to connect to more varied external data sources and systems on the internet. The system has been expanded by two project based modules (TWAP and GGRETA) designed to

manage and view both aggregated and distributed information on transboundary aquifers.

The user interface has been upgraded following specific requirements for usable data types, general layout, GIS tools and web mapping services. All modules are built in the same environment to create consistency among user interfaces and possibilities to combine data from the various projects. The accessibility, performance and user friendliness of the refurbished GGIS have been improved while allowing for more interactive participation of its users.



Updates and changes of Global Overview

The global overview provides a general review of the groundwater conditions per country in an interactive map. It enables comparisons of groundwater characteristics between countries and searches for global patterns. The Global Overview module has been redeveloped, including contemporary GIS user interface functionalities, as well as improved functionalities to find and combine information.

The Meta Information Module

The Meta Information Module (MIM) contains groundwater related documents, reference documents, and information on groundwater specialists and organizations. The MIM has been redeveloped and includes improved search functionalities, as well as advancements in upload, storage and download of various types of documents. The MIM has been extended by a user account management system where IGRAC administrators can arrange the access rights to the GGIS users. As such, content updates in the renewed GGIS can increasingly be carried out directly by the GGIS user community and, depending on their access rights, allow GGIS users to work in protected workspaces within the GGIS for sharing and exchanging information.

Development of a TWAP Groundwater Information System

An information management system has been developed to upload and store the information collected in the groundwater component of the Transboundary Waters Assessment Programme (TWAP). The TWAP-Groundwater component is the first global baseline assessment of transboundary aquifers and includes the assessment of the 242 largest transboundary aquifers in the world and the aquifers of 43 small island developing states. The TWAP viewer contains aggregated data, variables and indicators, encompassing the hydrogeological, environmental, socio-economical and governance dimensions of the aquifer systems. This viewer enables users to make a global comparison and to discover data/information gaps.

Development of GGRETA Information System

The Groundwater Resources Governance in Transboundary Aquifers Project (GGRETA) information system provides detailed information on three transboundary aquifers. The project conducts in-depth assessment of three transboundary aquifers located in: Southern Africa, Central Asia, and Central America. The portal is developed to collect, store, visualise and share information in order to support transboundary groundwater governance. The system allows upload of various types of data, and the possibility to create overlays of data. Unlike TWAP, GGRETA does not deliver only aggregated data, but also spatially distributed information (maps).

WMS functionalities

The system is created in such a way that it allows to easily adding data from external sources using OGC web services. At the same time, data within the system can be easily shared with other groundwater systems or experts. It thereby makes use of the web mapping services (WMS) to distribute maps and web feature services (WFS) to distribute data.

Country briefs and transboundary aquifer briefs

The briefs are created within the GIS system in order to disseminate descriptions of aquifer or groundwater resources in a country in a structured but narrative way. The system automatically generates the brief extracting pieces of information from the various modules, while additional images and text can be added per brief.

Explore all modules

An additional viewer has been created to explore all available groundwater-related data on countries, transboundary aquifers and groundwater monitoring networks at once. The data from the various projects are combined in this viewer.

3.1.2 Content update

The main content update of GIS in 2014 consisted of the following:

Transboundary Waters Assessment Programme (TWAP)

Large amount of data was been collected/ estimated for all transboundary aquifers (approximately 250) larger than 5000 km² and 43 groundwater systems

on Small Island Developing States (SIDS). The data are collected/ estimated at the aquifer level. For more information see on the TWAP project description further on in the report.

Groundwater Governance in Transboundary Aquifers (SDC/GGRETA) project

The collection of spatially distributed data (such as shape files, geo-tiff and point data) in the three selected projects is an ongoing process. The first data has been added to the system. For more information see GGRETA project.

Transboundary and Country Aquifer Briefs

The first aquifer country briefs (Netherlands, Yemen, Botswana) have been added to the system. The output of transboundary aquifer briefs for the TWAP project started in 2014.

3.2 Global Groundwater Assessment

Groundwater assessment activities at IGRAC encompass country-based assessments, transboundary groundwater assessments and thematic assessments.

3.2.1 Global Country-based Assessment

In 2014, IGRAC continued development of country briefs. The briefs are a standardised overview of the groundwater situation by country presented in a narrative way. They are less 'technical' in comparison to the data in the GGIS and thus more appealing for general public. The main indicators and additional information on the groundwater conditions in the respective countries/aquifer are described. The briefs will also contain interpreted data linking the various attributes stored in the GGIS. In 2014, the framework for the development and a structure of the information was created, as well as outputs for a several country briefs.

3.2.2 Transboundary Aquifer Assessment

Transboundary Aquifer Assessment remained the main IGRAC activity in 2014. Commissioned by UNESCO-IHP, IGRAC concentrated its activities on three large projects: TWAP, DIKTAS and SDC. Additionally, Transboundary Aquifers of the World Map was updated. A brief description of main activities 2014 is given below.

Transboundary Water Assessment Programme (TWAP)

Recognizing the importance of transboundary water systems to humans and ecosystems; the fact that many of the water systems continue to be degraded; and that most are managed in fragmented ways, the Global Environment Facility initiated the Transboundary Water Assessment Programme (GEF TWAP) (www.geftwap.org).

IGRAC was previously involved in the TWAP medium-sized project (2009-2011) in which the methodology for an indicator based assessment was developed. In 2013 the TWAP full-sized project started. This two-year programme is the first global comparative assessment of five transboundary water system categories: groundwater, lakes, rivers, large marine ecosystems and open oceans. The assessment of each water system category is undertaken in five individual sub-projects (also called components) and the assessments are multi-disciplinary covering the hydro(geo)logical, socio-economical, environmental, legal and institutional aspects of the water systems. The envisaged outcome is to provide the GEF and other international organizations with tools and information for setting priorities in activities related to sustainable management of transboundary water systems. The assessment is executed through institutional partnerships aiming to also seed future follow-up assessments. The TWAP groundwater component (www.twap.isarm.org) is assessing 242 transboundary aquifers and 43 groundwater systems of Small Island Developing States (SIDS). Data have been collected through networks of regional and national experts. The project is executed by UNESCO-IHP in close cooperation with IGRAC.



The project started in April 2013 and will conclude in April 2015. Total budget for the project is about 36,8M USD (5M USD GEF grant, 13.1M USD co-financing and 18.7M USD in-kind). The budget for the TWAP Groundwater component is 12.6M USD and IGRAC's planned involvement is approximately 1M USD - partly funded by the GEF & co-financing and partly by in-kind contributions).

IGRAC's main responsibilities are in coordinating the global data collection process, setting up the TWAP-groundwater information management system (TWAP IMS), providing technical assistance to all parties and together with UNESCO-IHP taking care of the over-all project management. Like in 2013 TWAP activities in 2014 have been numerous and intensive:

- Together with UNESCO-IHP, IGRAC forms the project management team for the TWAP Groundwater component. As such IGRAC is involved in all aspects of the project's organisation. Activities include establishing the

network of regional and national experts, coordinating activities of these experts, reporting to UNEP (implementing agency for the GEF), etc. In the first quarter of 2014 there were personnel changes in UNESCO-IHP and IGRAC took over project management in the interim.

- Together with UNESCO-IHP, IGRAC represents the Groundwater component in the TWAP steering committee meetings. In 2014, remote meetings have been conducted using skype and conference calls.
- Participation in the cross-cutting working groups (with the other water systems) on Governance and Data & Information Management.
- Coordinating technical harmonisation with Frankfurt University for global groundwater modelling component and Simon Frasier University Canada for SIDS-groundwater assessment.
- IGRAC co-organised and presented at regional workshops for national experts:
 - o The regional workshop for Southern and Eastern Africa (Kenya – March 2014)
 - o The regional workshop for West and Central Africa (Senegal - July 2014)
 - o The regional workshop for Central, East, South and South-east Asia (Thailand-October 2014).
- IGRAC organised and guided the process of data collection through questionnaires (526 questionnaires have been sent out to 116 countries); provided technical support to regional coordinators and national experts; coordinated improving delineations of TBAs and digitising of maps; processed returned questionnaires including uploading of information into TWAP database and performing basic quality checks, calculation of indicators based on input from questionnaires, etc.
- IGRAC developed, tested and implemented of a pilot version of the web-based Information Management System (IMS) for the TWAP Groundwater component enabling future public access to all data collected in TWAP (maps, documents and graphics). The TWAP IMS is developed as a module of the fully upgraded and redesigned GGIS.
- IGRAC contributed to the draft component synthesis report, which combines and summarises the findings of the assessment of 242 transboundary aquifers, 43 SIDS groundwater systems and the results from the scenario studies through modelling.
- IGRAC conducted project communication including design, set-up and maintenance of webpage and workspace for the TWAP Groundwater component

The detailed TWAP Project Report for 2014 is prepared and available from IGRAC or UNESCO on request.

Protection and Sustainable Use of the Dinaric Karst Aquifer System (DIKTAS)

DIKTAS (<http://diktas.iwlearn.org>) has started in 2010 and it is the first GEF project executed by UNESCO. IGRAC provides project management and also contributes to various content activities. The total project budget is about 5.6M USD, wherefrom about 2.1M USD of the funding is from the GEF and 3.4M USD is in-kind co-financing by project partners. IGRAC's total contribution to the project is about 1M USD, wherefrom approximately 40% is funded by GEF and 60% is in-kind.

The Transboundary Diagnostic Analysis (TDA) has been finalized in December 2013 and adopted by the Steering Committee in June 2014. The TDA report is delivered with a total delay of about 12 months, comparing with the original the planning in the Project Document. The main reasons for the delay

were a complexity of the analysis and the numerous comments of stakeholders that needed to be discussed and processed. The TDA went through a very systematic reviewing process, being discussed by National Interministerial Committees (NICs) twice. The draft TDA report was already submitted to the Steering Committee in June 2013, but dozens of comments received from National interministerial Committees needed to be discussed, processed and included in the report. The report is quite comprehensive and well supported by the DIKTAS Database. At the time of writing (October 2014) the report awaits translation in five local languages.

Delay in delivering the TDA has also slowed down the work on SAP, Strategic Action Plan, but not substantially. At the Project Team meeting in Trebinje in March 2014, the content of the SAP report was discussed and writing tasks were assigned. The project manager compiled the first draft, distributed it to the SAP Writing Team, incorporated comments and prepared a final draft. The draft DIKTAS SAP awaits translation to be discussed by NICs in the meeting planned for Autumn 2014. Next to the conference, the SAP was the main activity in the first half of 2014 and will remain the main activity until the end of the project.



The DIKTAS Conference "Karst without Boundaries" was held in Trebinje, Bosnia and Herzegovina and Dubrovnik, Croatia in June 2014. The conference was organized in the framework of the DIKTAS project in partnership with the International Association of Hydrogeologists (IAH), in collaboration with the Hydropower System Trebišnjica (HET), Trebinje, Bosnia & Herzegovina and the University of Belgrade, Serbia and with support of UNESCO, IGRAC, and GWP-Med. The conference brought together 155 international karst scientists, engineers and DIKTAS stakeholders from 35 countries and was a huge success. The positive reactions were overwhelming. It was a major effort to organise the conference, that slowed down some other project activities but it was certainly worthwhile because it returned attention of international scientific community to this region after many years.



The detailed DIKTAS Project Report for 2014 (reviewed and approved by the DIKTAS Steering Committee) is available on request.

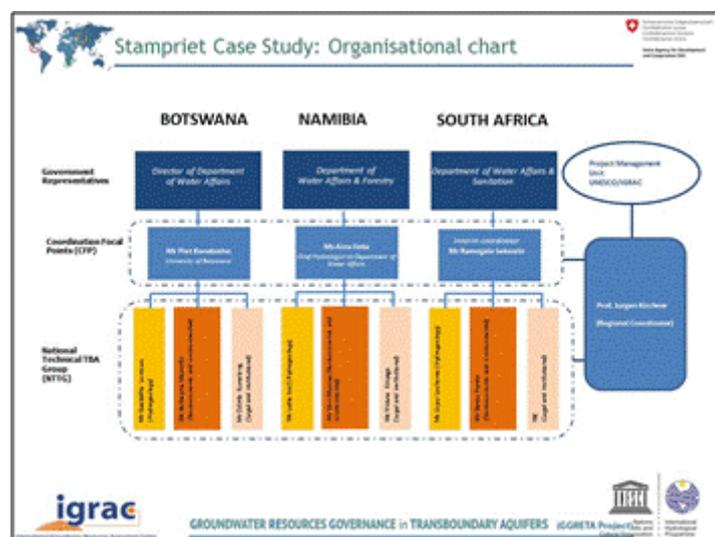
Groundwater Resources Governance in Transboundary Aquifers (SDC project)

Phase I of the project "Groundwater Resources Governance in Transboundary Aquifers" started in April 2013. The project, which will run until December 2015, is funded by the Swiss Agency for Development and Cooperation (SDC) with a

total budget of approximately 1,9M€ plus co-financing. It is executed by UNESCO-IHP with IGRAC as a major partner. The objectives of the project are:

- to improve the knowledge and recognition of the importance and vulnerability of transboundary groundwater resources;
- to establish cross-border dialogue and cooperation;
- to develop shared management tools;
- and to facilitate governance reforms focused on improving livelihoods, economic development and environmental sustainability.

The focus in Phase 1 of the project is on the joint assessment of the selected transboundary aquifers and to lay the first foundation for joint management. Three transboundary aquifers have been selected for the project: the Trifinio Aquifer between El Salvador, Honduras, and Guatemala; the Stampriet Aquifer between Botswana, Namibia, and South Africa; and the Pretashkent Aquifer between Kazakhstan and Uzbekistan.



IGRAC is responsible for data and information management and also provides technical support to the project management and transboundary aquifer teams. The main IGRAC activities in 2014 were:

- Developing a methodology brief and extensive methodology guidelines for the assessment, based on the TWAP methodology. The methodology brief informs managers of the project design, while the guidelines serve as a manual for the experts in the national teams to execute the data collection, processing and the final assessment.
- Developing, testing and implementing a pilot version of the web-based Information Management System (IMS) for the GGRETA project, enabling future public access to the final outputs (maps, tables, graphs, documents, etc.) produced in the three GGRETA case studies. The GGRETA IMS is developed as a module of the fully upgraded and redesigned IGRAC GGIS.
- Conducting a Stampriet Regional technical seminar (three days, Namibia - May 2014) to introduce the three national teams to the project's design, planning and methodology and to initiate joint data collection on hydrogeological, socioeconomic, environmental, legal and institutional aspects.
- Conducting the 3rd Stampriet Regional Technical Meeting (three days, South Africa - October 2014) to report to the three national governments

and the donor representatives on project progress in terms of data collection and processing of hydrogeological, socioeconomic and environmental and legal and institutional data. To assist and guide the teams of national experts in data harmonisation and processing.

- The Esquipulas-Ocotepeque-Citalá aquifer (Trifinio aquifer) made slow but constant progress in 2014, where consultants were engaged by IUCN to start the collection of existing data and identification of main data gaps and information needs. IGRAC keeps regular contact with IUCN and the consultants via teleconference, providing technical support and guidance.
- For the Kazakh part of the Pretashkent aquifer, most available data have been collected and interpreted in 2014. The project team still awaits a clearance from the Government of Uzbekistan to proceed with comparable activities in the Uzbek part of the Pretashkent aquifer.
- Providing project management support by contributing to documents such as Terms of Reference, project summaries, agendas for workshops and project planning, etc.

Transboundary Aquifers of the World Map

IGRAC published a new Transboundary Aquifers of the World Map (TBA Map) in August 2014. The TBA Map 2014 shows 608 identified transboundary aquifers, including 226 transboundary 'groundwater bodies' as defined in the European Union Water Framework Directive (EU WFD). The map is an update of the TBA Map 2012 and shows the state of information presently available on the occurrence and extent of transboundary aquifers worldwide. The map provides a global overview of these important shared water resources and intends to encourage further research and assessment thereof. The map is based on the most recent inventory results of many active working groups around the world (including the TWAP project). This map aims to contribute to raising awareness on the importance of the governance of shared aquifer resources and to building the much needed global knowledge base. Full details on the methodology creating this map as well as definitions and additional information such as on the legend are given on its backside. The map has already been distributed at various meetings/conferences such as IAH Marrakech, TWAP regional workshops, UNECE workshop on transboundary basins, etc.

3.2.3 Thematic Assessment

In the IGRAC thematic assessment, a global groundwater issue (such as a methodology or a pollution type) is chosen and assessed globally in more detail. In 2014, IGRAC carried out various thematic assessments, including studies on ecosystem-based adaptation in groundwater management, the groundwater-food-energy nexus, economics in groundwater governance and a global assessment of nitrate contamination.

Ecosystem-based Adaptation in Groundwater Management

IGRAC carried out a thematic assessment on ecosystem based adaptation in groundwater management. The report provides an overview of various ecosystem-based adaptation measures related to groundwater that could be implemented to improve ecosystems resilience and secure the ecosystem services. The report was part of the preparation phase for the project 'Ecosystem-based Adaptation in



Groundwater Management' a joint effort of UNEP, IGRAC, IWMI and UNESCO-IHP.

In May 2014, IGRAC attended the ecohydrology workshop and steering committee meeting in Paris, France. The meeting served as a start-up of the eighth phase of the UNESCO-IHP. The objectives of the meeting were to reactivate the Ecohydrology programme within UNESCO-IHP, seek partnerships and synergies to implement projects and to plan the activities within the Ecohydrology Theme 5 of the new IHP Phase 8.

The Groundwater-Food-Energy nexus

In 2014, IGRAC also started a thematic assessment on the role of groundwater in the water-food-energy water-food-energy nexus. The water-food-energy nexus elucidates the crucial links among the water, food and energy sectors and the importance of governance and management across sectors and scales to improve and secure water, food and energy resources. The report provides an overview of the role of groundwater in the water-food-energy nexus and is supported by two concrete examples in India and in Spain.



Groundwater Economics

Increasing pressures on groundwater and subsequent economic scarcities augment the importance of sustainable resource management. Knowledge about the economic value of water in its different uses can help to support allocation decisions, emphasize the importance of the resource itself, and consequently create a sound basis for negotiations. For this reason IGRAC started reviewing the current state of the art in groundwater valuation and deriving a theoretical framework. This framework was subsequently applied to the Stampriet and DIKTAS aquifers since they are both part of important projects within IGRAC. It was found that there are still frictions between disciplines when it comes to the integration of economic results into water governance. However, economic valuation might be a feasible way to consider all economic impacts of a project or policy by bringing them to a comparable basis. Nevertheless, additional data are necessary for any well-grounded conclusion.

Global Nitrate Assessment

Nitrate pollution is considered a major agricultural pressure on groundwater resources. In October 2014, IGRAC began to investigate groundwater pollution with nitrate in transboundary aquifers and to identify best management practices and future challenges. Reviewing, collecting and analysing available information produced an overview of large transboundary aquifers prone to nitrate pollution. Data was presented in GIS maps. To explore and stimulate possible future collaboration with University of Wageningen (UW), IGRAC deployed an MSc student from UW for this project.

Managed Aquifer Recharge (MAR)

In November 2014, IGRAC and Acacia Water started a consultancy project for the design and development of data systems for the application of Management for Aquifer Recharge (MAR) in the Horn of Africa. The project has been awarded by IGAD-INWRMP (Inland Water Resources Management Programme) to IGRAC and subcontractor Acacia Water. The project will cover a time period of three months.

The overall emphasis of the project is to identify and map the potential for different MAR applications within the transboundary Merti Aquifer, shared between Kenya and Somalia, and the development of a MAR data management system. In addition a conceptualized model is developed which couples climate scenarios to land surface characteristics, to test the impact on the runoff, recharge and MAR systems in the selected aquifer and its recharge area. One of

the objectives of the study will be to show the potential of critical groundwater zones for current and future water supply, and the potential of MAR to strengthen this resource. The study will lead to a GIS data system showing potential MAR sites and results will be presented in a final report.

3.3 Global Groundwater Monitoring

Global Groundwater Monitoring Network (GGMN) is a participative, web-based network of networks, set up to improve quality and accessibility of groundwater monitoring information and subsequently our knowledge on the state of groundwater resources. GGMN is a UNESCO programme, implemented by IGRAC and supported by many global and regional partners.

IGRAC, UNESCO-IHE, Deltares and Royal Eijkelpark joined forces to facilitate and promote advanced groundwater monitoring technology and innovative practices in China. On 17-19 March 2014, the workshop Advancing



Groundwater Monitoring in China was held in Beijing, China. The workshop was organised in the framework of the Global Groundwater Monitoring Network (GGMN) programme and in close cooperation with Geological Survey of China. The purpose of the workshop was to bring together national and international groundwater experts to review the state of groundwater monitoring in China and set future goals. In total, 46 groundwater experts attended the workshop. The Global Groundwater Monitoring Network (GGMN) programme was introduced and its relevance to groundwater monitoring in China was discussed. The workshop addressed new monitoring technologies, groundwater monitoring optimisation and other related aspects of monitoring networks. The workshop was also intended to build synergies and strengthen international cooperation.

A workshop Collation and Analysis of Multi-decadal Groundwater-levels Observations in Africa was held at the IAH Congress in Marrakech, Morocco to support the analysis of groundwater-level data by workshop participants. IGRAC contributed to the workshop introducing GGMN Programme. The workshop conclusion was to use the GGMN portal application as the groundwater portal for

the so-called Chronicles Consortium to store the multi-decadal records of groundwater levels in Africa. The Chronicles of Africa is a joint initiative of the AGW-Net, IAH Commission on Groundwater and Climate Change, and UNESCO-IHP GRAPHIC programme that is supported by the UPGro programme of the UK government and the LMI-PICASSEAU programme of the French government.

IGRAC contributed to the 16th session of the GCOS/TOPC Panel at the Joint Research Centre in Ispra, Italy. GCOS is a joint undertaking of the WMO, the Intergovernmental Oceanographic Commission of UNESCO, UNEP and the International Council for Science. Its goal is to provide comprehensive information on the total climate system where groundwater makes one of the essential climatic variables. IGRAC is responsible for the groundwater observations and it has contributed to the report 'Climate Observing Systems in the Netherlands, National Activities Contributing to GCOS'.

3.4 Knowledge Sharing and Governance

Knowledge sharing is a part of all IGRAC activities and involves creating networks of people and development of services for these networks. Some activities listed below can also be seen as thematic developments but they do not necessarily include assessment. These activities are dedicated to knowledge sharing (and governance) beyond the usual management structure, including public participation. In the chapter below, distinction is made between activities (mostly project-based) and dissemination and outreach through publications, social media, events, etc.

3.4.1 Governance

Groundwater Governance - A Global Framework for Action (2011-2014) is a joint project supported by the GEF and implemented by the FAO, UNESCO-IHP, IAH and the World Bank. The project is designed to raise awareness about the importance of groundwater resources for many regions of the world, and identify and promote best practices in groundwater governance as a way to achieve the sustainable management of groundwater resources. IGRAC has been involved throughout the project by co-authoring the thematic paper 'Groundwater Policy and Governance' and actively contributing to four regional consultations worldwide. In 2013 IGRAC was a part of the organising and hosting team for the 5th and last Regional Consultation for UNECE Region combined with a Private Sector Roundtable in The Hague in March 2013 (approx. 100 international participants). As a follow up of the consultation, IGRAC contributed to the reporting of sessions.

Groundwater Futures in Sub-Saharan Africa (GroFutures)

GroFutures - Groundwater Futures in Sub-Saharan Africa - is a project lead by Prof. Richard Taylor from the University College of London, in which IGRAC is involved. The project aims to develop the scientific basis and participatory processes by which groundwater resources can be used sustainably for poverty alleviation in Sub-Saharan Africa (SSA).

During 2014, IGRAC has been involved in the design of the project proposal. The design phase took in place under a one-year Catalyst grant from UPGro programme funded by the UK's Government. The objective of this preparation phase was to set up the scientific framework and network of the project, and design the proposal presented for the Consortium Grant. During this preparation phase, IGRAC attended the Consortium Proposal Development

Workshop in London and contributed to the preparation of the Consortium Grant preparation, which was approved in early 2015.

Groundwater Serious Game

As a contribution to the GroFutures project, IGRAC is improving the Groundwater Serious Game, developed by Frank van Weert and based on Garrett Hardin's theory and article 'The Tragedy of the Commons' (1968). The game will be used in the project as an awareness rising tool between stakeholders. It will help them to understand the dilemmas faced by small-scale farmers seeking effective and equitable ways to manage their groundwater resources individually and collectively to irrigate their land.

Currently the game has been modified to improve some basic aspects that will help model the reality of the groundwater management problem at household scale. The game still presents the core idea of 'The Tragedy of the Groundwater Commons', but it includes two more ideas, the importance of information availability and accessibility and the concept of long term depletion. The first concept is being implemented by the addition of development scenarios, through which the user has to take decisions based on different levels of data availability. On the other hand, the concept of long term groundwater depletion implies the adaptation of the original code, computing the drawdown.



Quantifying the benefits of transboundary water cooperation

In 2014, IGRAC provided a written contribution for the UNECE's draft report on quantifying the benefits of transboundary water cooperation. The contribution highlighted the current state-of-the-art in benefit assessment for groundwater and transboundary aquifers. It also recommended starting points for countries wanting to undertake such an assessment. IGRAC also participated in a UNECE hosted event, wherein examples and best practices were gathered from countries all over the globe. The final scoping meeting for the report is scheduled for early 2015. IGRAC may further enhance its contribution with the outcomes of the study of groundwater economics.

3.4.2 Knowledge Sharing and People Networks

Groundwater Community of Practice

In 2014, activities for the Groundwater Community of Practice (Groundwater CoP) continued primarily through face-to-face interaction. The third and final IW:LEARN Integration Dialogue took place in Athens. It brought together experts on coastal aquifers and groundwater in Small Island Developing States (SIDS) from all over the world. It was also an official event for the 2014 International Year of the SIDS. The purpose of these meetings was to facilitate enhanced dialogues between GEF groundwater and surface water projects for enhances sustainability of results. Although this phase of the IW: Learn Project is drawing to a close, the Groundwater CoP will continue its dialogues in the Forum. The Forum will continue hosting webinars of groundwater relevant topics. In 2015, there is a planned re-launching of the Forum which will include a new look as well as enhanced facilities that will facilitate participation in the CoP webinars and other online events. Additionally, a new phase of IW LEARN is anticipated. Therefore, online and face-to-face activities will continue with an emphasis on knowledge sharing via online platforms.

Hydro Open-source Platform of Experts (HOPE)

The UNESCO's Hydro Open-source Platform of Experts (HOPE) is a platform of experts that aims to provide an alternative to the commercial specialized engineering software in the field of hydrology (e.g. water resources, rivers and groundwater, etc.). In 2014, IGRAC participated in the Consultative Experts Working Group to finalise the evaluation form for the selection of Groundwater-related software and Data Management and Support software. In parallel, the working group worked on the evaluation of several water related software, publishing the first HOPE Kit.

FREE and Open Source Software for Water Resources Management (FREEWAT)

FREEWAT aims at promoting water management and planning by simplifying the application of the EU Water Framework Directive and other EU water-related Directives. FREEWAT will be an open source and public domain GIS integrated modelling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module. The Consortium is formed with partners from various water sectors from ten EU countries, Turkey and Ukraine. It will be executed under the support and collaboration of the UNESCO HOPE Initiative on Free and Open Source Software.



IGRAC together with UNESCO's HOPE Initiative prepared a case study for the Stampriet aquifer as a contribution to the project proposal. The case study will help test the application, while providing training on groundwater related software to National Experts working in the Botswana, Namibia and South Africa.

Currently the project proposal has been awarded with a Horizon2020 fund that will allow its execution starting the 1st of April of 2015 for duration of 30 months.

3.4.3 Publications and communications

Books and book chapters

- "Karst Without Boundaries" Proceedings International Conference and Field Seminar, Editors N. Kukuric et al, 431p, Trebinje June 2014. The DIKTAS Conference "Karst without Boundaries" was held in Trebinje, Bosnia and Herzegovina and Dubrovnik, Croatia in June 2014. There were 155 participants from 35 countries and five continents attended the conference which was organised around following topics: Aquifer Characterization and Monitoring, Aquifer Management and Legal Framework, Water Resources Engineering, Groundwater Sustainable Use, Protection and Remediation, and Awareness, Education and Outreach. The conference proceedings include 106 contributions on karst hydrogeology written by about 300 authors.
- "Field Trip Guide", Editors P Milanović DIKTAS Project/ Faculty of Mining and



et al,

Geology, Department for Hydrogeology, 69p. Trebinje/Belgrade 2014. Four field trips were organised during the DIKTAS conference (June 2014). This guide provides extensive information on the field trip routes and places to be visited. The guide was also used for the Summer Karst School, which was held back-to-back with the conference, and can be used in the future for the same purpose. The guide is the result of cooperation between the DIKTAS Project Team and the University of Belgrade and its Centre for Karst Hydrogeology.

- "Groundwater Security", K. Conti et al., is a contribution to the upcoming Global Water System's Project book on water security. This is the first research focused on groundwater security and discusses the physical and human dimensions of groundwater security at each geographic level. This includes how groundwater storage and flow patterns relate to security as well as how abstraction and global change dynamics may affect these patterns. It also discusses the human dimension of groundwater security including human uses and impacts of quality on those uses. Further, it presents the specific physical and human groundwater security challenges occurring at each geographical level: global, transboundary/regional, national and subnational. It finds that there are threats to groundwater security in specific transboundary aquifers and countries, but that these do not necessarily amount to a threat to global groundwater security as of yet.

Papers

- "Legal Pluralism and Groundwater" K Conti; in the Current Opinion in Environmental Sustainability Journal. The paper highlighted incongruences among developing groundwater governance regimes at the global, transboundary and national levels. The research showed that when legal regimes for groundwater governance are in place, it is unlikely that they are aligned across geographic scales and jurisdictions. Therefore, legal pluralism with respect to groundwater resources is more the rule than the exception. Yet, the literature so far had not compared how emerging governance principles relate to existing principles at local level. Examples from the Americas, Europe, South Asia and Sub-Saharan Africa, were presented to show the varying relationship between new rules and old, both coexisting over the same aquifer may affect the governance of groundwater.

Reports

- Factors Enabling Transboundary Aquifer Cooperation (IGRAC 2014). In this assessment, twenty cases of transboundary aquifer cooperation were identified and assessed. Based on this assessment, which was grounded by established and emerging concepts of water conflict and cooperation, IGRAC found that eight key factors lead to transboundary groundwater cooperation: Existing Regional Institutions, Funding Mechanisms, High Institutional Capacity, Previous Water Cooperation, Scientific Research, Strong



- Political Will, Third-party Involvement. The preliminary findings of this assessment were presented in 2013 Free Flow (the UNESCO Book for the Year of Water Cooperation) and presented at Stockholm World Water Week 2013. In 2014, they were published in full in as an IGRAC Report.
- Groundwater Monitoring in Latin America: Overview on the current state of national monitoring networks and their future challenges (IGRAC Publication, 2014).
 - Position Paper No. 1 on the Sustainable Development Goals (IGRAC 2014)
 - Ecosystem based adaptation for groundwater Management (IGRAC, UNEP, IMWI, 2014).
 - The Groundwater Food Energy Nexus, An Integrated Approach for Sustainable Groundwater Development (IGRAC, 2014).
 - Significance and State of Affairs of Groundwater Economics in the Governance of Transboundary Aquifers (IGRAC, 2014).

Abstracts and Presentations

- The DIKTAS conference Karst without Boundaries: DIKTAS, A Rocky Road to Cooperation; keynote speech. 2014.
- Conti, K. and Gupta, J. (2014). "Legal Pluralism and Groundwater: A Multilevel Analysis of Legal Institutions Applicable to Groundwater", presented at Responsible Development in a Polycentric World: Inequality, Citizenship and the Middle Classes hosted by the European Association of Development Research and Training Institutes (EADI), Bonn, Germany, June 26, 2014.
- Conti, K. and Gupta, J. (2014). "Drivers of Global Groundwater Use: Consequences for Access, Allocation and Availability", presented at the Norwich Conference on Earth Systems Governance, Norwich, UK, July 1, 2014
- Global Groundwater Information System 2.0, IAH Congress, Morocco (2014); The presentation showed the progress of the software developments for IGRAC's Global Groundwater Information System (GGIS) 2.0 and explained how the accessibility, performance and user friendliness of the refurbished GGIS will be improved.
- Transboundary Waters Assessment Programme, IAH Congress, Morocco (2014); The presentation was about a potential of the TWAP information system and the importance of assimilating the data into indicators. The TWAP indicators will allow comparison between transboundary aquifers globally, representing the first global assessment of transboundary aquifers.
- Global Groundwater Monitoring Network, IAH Congress, Morocco (2014); The presentation "Groundwater Monitoring: Building Blocks for International Water Cooperation" gave an overview of the Global Groundwater Monitoring Network (GGMN), which facilitates periodic assessments of changes in groundwater quantity and quality by aggregating data and information from existing groundwater monitoring networks and regional hydrogeological knowledge.

Public Relations and Social Media

Increasing visibility of IGRAC activities was one of the objectives for 2014; therefore a communication specialist was contracted in July 2014. Hiring the specialist resulted in more frequent updates of the website. For example, in the

specialist's first three months, sixteen news items were published. This was already more than has been published in 2013 over an entire year. Consequently, from July 2014 onwards the number of IGRAC website page views increased significantly.

Until mid-2014, IGRAC was not using social media for communication purposes. There was a company page on LinkedIn, although not actively used; however, there were no Facebook or Twitter accounts. Since then, every news item placed on the IGRAC website was also shared on LinkedIn. In addition, these items were posted on several LinkedIn groups related to the topic in order to reach a larger audience and to increase the number of IGRAC followers. Although IGRAC usage of LinkedIn and social media in general is still in an initial phase, each IGRAC's post was viewed by 200-300 people on average. This tripled a number of followers on LinkedIn.

IGRAC has received 185 likes on Facebook since it has opened its account in July 2014 and has 53 Twitter followers moment. This is good progress considering that even for large NGO's it took much time before their number of followers grew substantially. Considering that the IGRAC Twitter account was only created in July 2014, it is very likely that the number of followers will grow in the near future. The new and improved newsletter has been sent out bimonthly to our 1,936 subscribers.

IGRAC Newsletter July 2014

[View this email in your browser](#)



IGRAC at IAH Congress

IAH International Congress will be held in Marrakech, Morocco

From 15 to 19 September 2014, the IAH International Congress will be held in Marrakech, Morocco. The main theme of this 41st edition of the congress will be 'Groundwater: Challenges and Strategies'. Neno Kukuric and Laura del Val Alonso will lead several sessions during this events. More information about these sessions and a link to the full programme are now available on our website.

[Read more here](#)

3.4.4 Events

This brief overview includes only the events that were not a part of IGRAC content activities described in the chapter 3.2 and 3.3.

- International Association of Hydrogeologists (IAH) organised its 41st Congress in September 2014. The venue of this IAH Congress annual event was Marrakech, Morocco. IGRAC contributed to the congress with three abstracts and several presentations, also during the side- event on groundwater monitoring.
- On invitation of the Government of Uzbekistan, an IGRAC representative attended the International conference "Development of cooperation in the Aral Sea Basin to mitigate consequences of the environmental catastrophe". IGRAC was provided an opportunity to meet with water ministers of several Central Asian countries and to give interviews for national and international newspapers and TV stations.
- IGRAC participated in the 5th UNECE workshop on climate change adaptation in transboundary basins (October 2014, Geneva). IGRAC was invited to present on Managed Aquifer Recharge and Ecosystem based adaptation as a climate change adaptation measure during this workshop.



- Groundwater and Climate Change: Comparative and International Law and Policy Dimensions - Lessons for India, Workshop; IGRAC was able to contribute its knowledge on transboundary aquifers and aquifer assessment as well as legal issues to the discussion, London, January 2014.
- First Coordination Meeting of the project "Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region", IGRAC represented UNESCO, May 2014 Vienna, Austria.

4. Budgeting

The state of IGRAC's budgetary affairs at the end of 2014 is summarised in the table below. There is a Financial Statement Report (in Dutch, 26p) produced by an external bureau for the IGRAC Foundation Board and it is available on request.

Budgetary items (amounts in Euro)	
	Calendar year 2014
INCOMES	
Base subsidy	500000
Projects and Services*	257596
Total incomes	757596
EXPENSES	
Direct project costs	236777
Gross company result	538790
Wages and salaries	163373
Social security contributions	39064
Pensions	38425
Staff subcontracted (advisory, PhD, interns)	37390
Staff costs - miscellaneous	22327
<i>Total staff costs</i>	<i>300579</i>
Software development costs	41945
Office rent	17688
Office costs	21841
General costs (insurance, fin. admin, etc.)	43386
Total company expenses	425439
Bank account interests and costs	9469
Result 2014	122820
Previous year balance	295104
General reserve condition	417924

Annex: The Minutes from the Governing Board meeting, Dec. 2014