



Groundwater in a Changing World

IGRAC Strategy 2019–23

Delft – The Netherlands

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Table of Contents

1.0 FOREWORD	2
2.0 CONTEXT FOR STRATEGY	3
2.1 IGRAC AS A UN CENTRE	3
2.2 GLOBAL WATER RESOURCE SITUATION	3
3.0 IGRAC'S CORE AGENDA	4
3.1 RAISING GLOBAL AWARENESS OF RESOURCE VALUES AND RISKS	4
3.2 IMPROVING ASSESSMENT AS BASIS FOR SOUND POLICY	5
3.3 STRENGTHENING MONITORING TO INFORM MANAGEMENT	6
3.4 CATALOGUING EXPERIENCE ON MANAGEMENT AND GOVERNANCE	7
4.0 IGRAC'S OPERATIONAL PLATFORM	8
4.1 STRATEGIC PARTNERSHIPS AND EXTERNAL SYNERGIES	8
4.2 NURTURING AN ENABLING ENVIRONMENT AT DELFT OFFICE	9

Acronyms

BGR	Federal Institute of Geosciences & Natural Resources, Germany
BGS	British Geological Survey
GCF	Green Climate Fund
GEF	Global Environment Facility
GGIS	Global Groundwater Information System
GGMN	Global Groundwater Monitoring Network
GRIPP	Groundwater Solutions Initiative for Policy and Practice
HLPW	High Level Panel on Water of the United Nations
IAH	International Association of Hydrogeologists
IGAD	Intergovernmental Authority on Development
IHP	International Hydrological Programme
ISARM	Internationally Shared Aquifer Resources Management
IWA	International Water Association
IWMI	International Water Management Institute
MFA	Ministry of Foreign Affairs of the Netherlands
MI&W	Ministry of Infrastructure and Water of the Netherlands
MRC	Mekong River Commission
SADC	Southern African Development Community
SADC-GMI	SADC Groundwater Management Institute
SDGs	UN-Sustainable Development Goals
TWAP	Transboundary Waters Assessment Programme
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNECA	United Nations Economic Commission for Africa
UNESCWA	United Nations Economic Commission for Western Asia
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WEF	Water-Energy-Food Nexus
WMO	World Meteorological Organization

1.0 FOREWORD

by IGRAC Strategic Advisory Committee

Groundwater systems constitute the predominant reserve of freshwater on our planet, amounting to 95-97% of total stocks. The vast storage of many aquifers provides an effective 'natural buffer' against climatic variability, but the long-term sustainability of groundwater will depend on controlling abstraction, managing recharge and protecting quality. In the 20th century there was an enormous boom in water well construction and groundwater became a key resource supporting social well-being and economic development. In 2010 global withdrawals reached 900 km³/a and provided 36% of potable water-supply, 42% of water for irrigated agriculture and 24% of direct industrial water-supply. Despite this groundwater is too often an 'overlooked resource'—inadequately monitored, assessed and managed.

IGRAC was created in 2003 specifically to help remedy this situation by promoting improved knowledge and understanding to support sustainable utilisation and management of groundwater resources, with an emphasis on developing countries. For 16 years now IGRAC has played a unique role in global and regional assessment, and monitoring, of groundwater – providing practical inputs to transboundary aquifer projects, producing numerous technical manuals and training courses, and raising awareness of across UN-Water. It occupies a 'critical niche' at the international level, and succeeded in 'making invisible groundwater more visible' at this level. We consider that this mission is more relevant today than it was when the idea for a UN Centre was first discussed, because of the critical role that groundwater resources have to play in climate-change adaptation, in order to face the challenge of global warming.

We strongly endorse this IGRAC Strategy 2019-23: 'Groundwater in a Changing World' and wish to draw particular attention to the following elements, which we regard of high priority for support by both direct core funding and external collaborative agreements and contracts. First, analytical work on groundwater assessment should focus at global, regional, transboundary and large-aquifer scales, but training courses on groundwater monitoring need to continue to be offered at national level to improve basic data collection. Second, much more emphasis should be put into monitoring and assessing trends in groundwater quality. Third, the GGIS and GGMN should be updated and strengthened as fundamental IGRAC services. Fourth, continuing efforts should be made to raise awareness of the socio-economic and environmental importance of groundwater resources, and the growing threats to their sustainability.

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¹ IGRAC-Strategic Advisory Committee members act in an individual capacity in this function, and not on behalf of their named parent organisations

2.0 CONTEXT FOR STRATEGY

2.1 IGRAC as a UN centre

IGRAC is an international non-profit-making organisation (that operates under the auspices of UNESCO and WMO) based at Delft in The Netherlands. The Centre is founded under Dutch Law and independently overseen by an International Governing Board and aided by a Strategic Advisory Committee. IGRAC core operations are financed by the Netherlands Ministry of Infrastructure & Water, and the Centre also attracts external project funding (often through cooperation with UNESCO-IHP, WHO or other international organisations), and works closely with the IAH and its in-house partner IHE-Delft.

The IGRAC core mission is to improve worldwide availability of information, knowledge, understanding and awareness on groundwater resources (with emphasis on developing countries) so as to facilitate their sustainable utilisation, to highlight the role of groundwater in integrated water resources management and to elucidate the importance of groundwater for aquatic ecosystems. The approach taken is to promote systematic groundwater monitoring and assessment as indispensable for informed resource management and protection, and to encourage information sharing, appropriate training, awareness raising and strategic partnerships.

The Centre was launched in 2003 – and now 16 years later presents the IGRAC Strategy 2019-23: Groundwater in a Changing World, which adapts its work programme to the challenges of a world in which water scarcity is growing under global warming and innovative technology is facilitating new approaches to its core agenda.

2.2 Global water resource situation

Globally, water scarcity already affects about 2.7 billion people for more than 1 month per year, and by 2025 this situation is predicted to worsen significantly as a result of global warming and population growth. Surface-water droughts will become more frequent and water-supply availability also decrease due to growing pollution. Thus, reliance on groundwater, which increased greatly during the 20th century is likely to grow even faster, and groundwater storage is certain to be critical for enhancing water security in the climate-change adaptation process.

By 2010 groundwater already provided 36% of potable water-supply, 42% of water for irrigated agriculture and 24% of direct industrial water-supply, and also sustains many vital aquatic ecosystems, maintains the baseflow of rivers and prevents land subsidence and seawater intrusion. Despite this groundwater remains an 'invisible resource', out-of-sight and out-of-mind for most people, with groundwater resources themselves being increasingly subject to physical depletion due to inadequately-controlled abstraction and quality degradation due to uncontrolled subsurface- pollution loads. Society is simply not managing and protecting aquifers adequately.

Groundwater resource assessment has been a core IGRAC activity since foundation, and it is closely linked with groundwater monitoring to indicate the changes being induced by anthropogenic factors (abstraction and pollution) and by land-use change and climatic variability. To facilitate the sharing of information (developed from improved assessment and monitoring) a Global Groundwater Information System (GGIS) has been developed, regularly up-dated and enlarged. To support countries efforts to embark on groundwater management and protection programmes, IGRAC has also been cataloguing international experience of strengthening governance provisions to promote effective demand-side management measures and managing enhanced aquifer recharge.

As the global water situation is worsening, and the recognition of the groundwater role is growing, IGRAC recognises that it must do more to:

- bring groundwater stakeholders together and help facilitate cooperation
- address groundwater in the context of relevant societal and environmental issues
- promote integration across sectors, disciplines, scales and boundaries
- consider groundwater supply and demand management as 'two side of the same coin'.

Since global depletion and pollution of groundwater resources are still on the increase and the resource is vital for human climate-change adaptation, IGRAC needs to intensify its activities (and grow in size) to fulfil its clearly defined role as the only global groundwater centre.

3.0 IGRAC'S CORE AGENDA

The IGRAC objectives and core agenda are clearly aligned with the UN-Sustainable Development Goals for 2030 (especially those of SDG-6: Clean Water & Sanitation) and the UN-SDGs make a core reference for all major IGRAC activities.

For the period 2019-23 IGRAC is aiming to:

- amplify products and services which support groundwater assessment, monitoring and management
- intensify strategic partnerships to achieve a stronger societal impact of its outputs
- improve the Centre in terms of increasing institutional strength and effectiveness.

These objectives are interrelated and can be addressed by clusters of activities grouped around the six sub-themes in this Strategy.

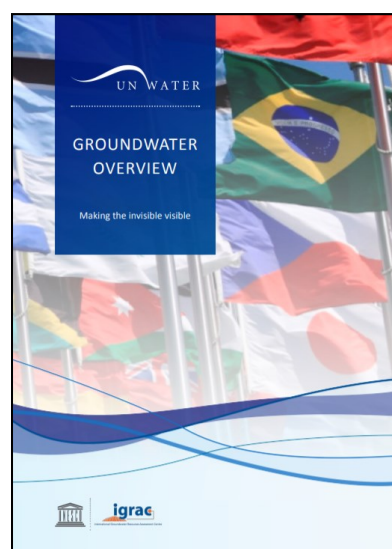
IGRAC is frequently invited by national governments to focus more at the level of local groundwater problems. While it is justified to support specialist training courses on groundwater assessment and monitoring at national level (since this is a route to augmenting the quantity and quality of groundwater data available globally), it is essential for IGRAC to concentrate its data compilation and interpretation activity at world, regional, transboundary or major-aquifer level, since it is the only global groundwater centre (and its human resources are relatively limited).



3.1 Raising global awareness of resource values and risks

What can be done to improve the visibility of groundwater resources? A significant recent advance is the UN Groundwater Overview (compiled by IGRAC as a UN-Water Publication), which showed that more than 40 UN agencies and affiliated organisations need to deal with some 65 groundwater-related topics. These topics can be split into the following groups: environment, climate-change, natural disasters, human-rights conflicts, governance, water law, transboundary waters, sanitation, health, pollution, food-energy nexus, human settlements and water economics. The Overview showcased groundwater importance in a broad spectrum of activities of UN-Water Members and Partners, so as to enhance knowledge exchange, agency cooperation and groundwater awareness.

Clearly improved assessment of groundwater resources leads to better understanding of groundwater issues, which is prerequisite for informed management and better governance of the resource. However, the current level of investment on monitoring (an essential prerequisite for better assessment) widely remains inadequate, and will only be generated when the socioeconomic importance of groundwater, and the very real risks of resource depletion and pollution, are better appreciated. The challenge is to provide sufficient evidence to decision-makers so that they are convinced of the need to increase investment. Thus, building the case for groundwater resource management through awareness



raising, political lobbying and information sharing is a key activity for IGRAC, which deserves continuing attention.

SPECIFIC OBJECTIVES: RAISING GLOBAL AWARENESS (subject to core-funding levels and co-finance/collaboration with external agencies)
<ul style="list-style-type: none"> • further advance 'groundwater resource awareness' in UN-Water member/partner agencies • inject a component on 'groundwater resource awareness' into the existing Netherlands MFA water diplomacy programme

3.2 Improving assessment as basis for sound policy

To develop sound groundwater policy the relevant stakeholders need improved assessment of the status of groundwater resources – but in large parts of the world this information remains insufficient. IGRAC promotes and facilitates international information sharing, focusing particularly on large regional and/or transboundary aquifer systems – and will in future focus on collecting, processing, harmonising and disseminating information in areas where a global centre can contribute most (due to its independence, past experience and wide networking).

Among IGRAC products and services the GGIS (Global Groundwater Information System) is the best known and represents the Centre's window to the world. It makes a major contribution to information sharing on groundwater, and as such needs to be maintained, improved and extended. In a world of rapid technological development this is costly, since the life-time of software applications is no more than a few years. Major refurbishing of this information portal is likely to be necessary in the planning period of this strategy.

SPECIFIC OBJECTIVES: IMPROVING ASSESSMENT (subject to core-funding levels and co-finance/collaboration with external agencies)
<ul style="list-style-type: none"> • improvement of groundwater assessment guidelines (with related information on societal and environmental context and issues) and disseminate their application through the GGIS • successful engagement in more regional, transboundary and large-aquifer groundwater assessments as opportunities arise • substantial contribution to global groundwater quality assessment (through the UN-Sustainable Development Agenda-2030 & Global Water-Quality Assessment Programme) • GGIS updated according to user needs and requirements of contemporary technology, as the key information system on global groundwater issues

Significant progress has already been made in the inventory and assessment of transboundary aquifers, considering that very little was known about them internationally 15-20 years ago. Further assessments are required to raise awareness on the state of the groundwater resources, and any insidious trends of depletion and/or pollution, to ensure informed management and governance, and avoid potentially major irreversible environmental damage and its social consequences. This will also require better embedding of groundwater assessments in the context of the relevant societal and environmental issues (climate change, water-supply security, food-energy nexus) with which they are linked. Each new regional assessment will need a 'diagnostic component' on the most significant threats and opportunities related to groundwater resources. IGRAC proposes to develop an easily-accessible groundwater-related SWOT analysis (Strengths, Weaknesses, Opportunities & Threats) for this purpose.

There is very limited reliable information available on the state of groundwater quality globally. IGRAC has been conducting a global assessment of arsenic and fluoride in groundwater, and another one on saline groundwater, but a more comprehensive assessment of groundwater quality is still lacking. In the framework of UN SDG-6, 'Indicator 6.3.2' has been included to define the state of ambient water quality, and includes groundwater. IGRAC has been involved in SDG-6 implementation and proposes to put a considerable effort into the UN Global Water Quality Assessment Programme.

3.3 Strengthening monitoring to inform management

The state of aquifers (in terms of both groundwater quality and quantity) changes gradually with time, as a result of anthropogenic factors (groundwater abstraction and land-use) and environmental processes (changes in precipitation pattern and surface-water regimes). Thus, systematic long-term monitoring is required to establish current status and to identify trends, and there remains insufficient information globally. In addition, monitoring of groundwater use is an indispensable input to resource management. A slogan frequently used by IGRAC is ‘you can’t manage what you don’t measure’. Concern must also be expressed over abandonment of monitoring networks, and over-reliance on proxy information derived from uncalibrated remote sensing and regional modelling. IGRAC will also continue with regional monitoring training and awareness campaigns, in cooperation with WMO, UNESCO and other global and regional partners.



SPECIFIC OBJECTIVES: STRENGTHENING MONITORING (subject to core-funding levels and co-finance/collaboration with external agencies)

- data collection and processing procedures recommended by IGRAC used as standard practice by a significantly larger number of countries, with more data-sharing through web-based portals and transboundary aquifer project involvement
- improved national monitoring networks established by optimisation of measurement density and frequency, more automatic measurement and data, and systematic data processing
- GGMN improved and extended with new functionalities and used by more countries as a component of national systems
- IGRAC becomes the focal point/clearing house for national groundwater depletion reports to facilitate the production of global overviews
- IGRAC continues to provide national and regional training courses on groundwater monitoring (including information systems)

In 2007, IGRAC initiated the GGMN (Global Groundwater Monitoring Network) to improve the reliability and accessibility of groundwater monitoring information. Since 2011 the GGMN has been introduced to specialists from more than 50 countries in Africa, Asia and America, and in 2016 a new GGMN-portal was finalised using state-of-the-art technology. The related software development and majority of monitoring activities have been financed from IGRAC core budget.² The GGMN will be up-dated with additional quality control and processing tools, data sharing functionality according to international standards and a mobile app. for upload and analysis of data. More groundwater quantity data will be added to the system, including groundwater abstraction and quality data stored in GEMS-Water database (managed by UNEP).

² GGMN has to be regarded as the most critical component of IGRAC development, since improving the reliability and global coverage of monitoring is vital for future assessment of groundwater resource status and quality trends at all scales – nevertheless it has been the most problematic component of the IGRAC core programme in terms of mobilising extra-budgetary co-funding to complement limited available in-house financial resources

A comprehensive overview of national groundwater monitoring programmes will be incorporated (including information on data collection, processing and accessibility).

3.4 Cataloguing experience on management and governance

Gradually IGRAC has started to support international efforts to strengthen groundwater governance by providing introductory guides to the concepts. And in the coming years, the IGRAC contribution in this area needs to promote further integration across sectors and to embed groundwater in the context of relevant societal and environmental issues.

Valuable publications have already been produced by the groundwater community³ with this purpose, and these require much wider dissemination and tailoring to the needs of specific stakeholders in given settings. The GEF (in collaboration with the World Bank, FAO-UN, UNESCO-IHP and IAH) have published a shared 'Global Vision' and 'Framework for Action on Groundwater Governance'. Nevertheless, their implementation requires careful elaboration of steps and measures, taking the area-specific context fully into account. The challenge is to involve all stakeholders, including those with conflicting interests, to reach a consensus on good groundwater governance. The processes of engaging the public sector, private sector and civil society to agree on groundwater management requires coordinating administrative action, information availability, respect of customs and legal instruments.

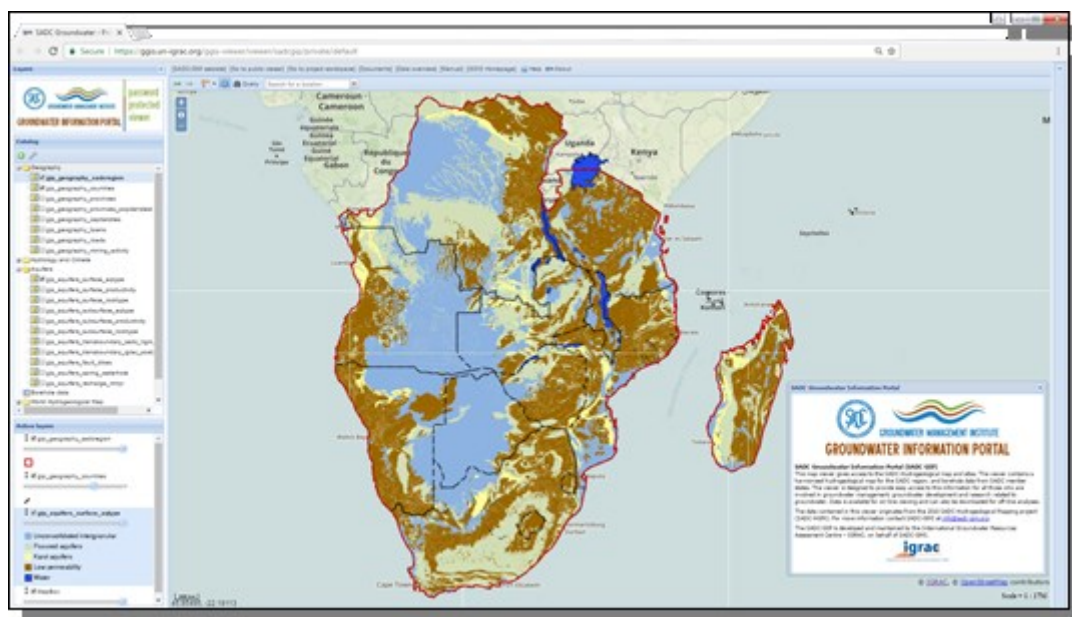
SPECIFIC OBJECTIVES: CATALOGUING MANAGEMENT EXPERIENCE (subject to core-funding levels and co-finance/collaboration with external agencies)
<ul style="list-style-type: none">• provide a systematic framework for the consideration of groundwater resources in a broad socio-economic and environmental context (building on GW-MATe & IAH Strategic Papers)• elucidate a science-policy-practice interface model to convey how improved groundwater resource understanding can be translated into more sustainable management• develop a comprehensive catalogue and overview of international experience in groundwater demand-side/supply-side management and quality protection

Although groundwater management policy and legislation have been prepared by an increasing number of countries, the practical international response to concerns about groundwater resource depletion and pollution is still inadequate and too often only crisis-driven. Groundwater depletion and pollution are still considered by many as local issues, limited to the more arid regions of the world. However, in a rapidly-changing world, surface-water drought and unexpected large-scale water pollution are becoming far more widespread.

Many groundwater management measures are demand-side related (e.g.: drip irrigation, smart crops, water metering and water markets), but are often being advocated and applied without sufficient consideration of groundwater system response, and in some instances are counter-productive in terms of resource conservation.

As regards supply-side management, IGRAC will continue global mapping of zones of potential MAR (Managed Aquifer Recharge) suitability, and the cataloguing MAR case-studies (there are already 1200 available on the corresponding IGRAC Portal). MAR is a very important climate-change adaptation tool, and needs further integration with managing landscapes and infrastructures as part of 'ecosystem-based adaptation'.

³ during 2000-11 the World Bank-Groundwater Management Advisory Team (GW-MATe) provided an original contribution to the understanding of groundwater aimed at the water-sector in general, focusing on groundwater resource sustainability – the more recent IAH-Strategic Overview Series aim to inform professionals in other sectors of key interactions with groundwater resources and aid hydrogeologists in their outreach efforts – another useful publication is a book on 'Advances in Groundwater Governance' edited and published with IGRAC participation



4.0 IGRAC'S OPERATIONAL PLATFORM

4.1 Strategic partnerships and external synergies

Raising international concern about 'invisible groundwater' cannot be successful without strategic partnerships. These are needed to strengthen networks and to build trust. The human dimension of decision-making in the water sector is often as large a barrier as engineering challenges or financial restrictions. Groundwater, as a 'common-pool resource' is inherently vulnerable to selfish behaviour by one or more of its diverse group of stakeholders. Synergies between public and private sectors on water-supply and industrial water-use often do not take groundwater sustainability considerations into account. Moreover, some so-called 'water-resource efficiency measures' are introduced in irrigated agriculture without adequate appreciation of their impact on groundwater recharge and quality.

SPECIFIC OBJECTIVES: PARTNERSHIPS & SYNERGIES (subject to core-funding levels and co-finance)
<ul style="list-style-type: none"> • agree at least one new strategic partnership, and progress cooperation with existing partners, to clearly enhance IGRAC objectives and outreach • investigate and cautiously advance a strategic partnership at CEO level with a major groundwater-using international industry • explore synergies with regional organisations and major generators of international groundwater data with aim of developing specific data-processing initiatives to complement IGRAC work

At the international level IGRAC will seek to forge synergies and partnerships in the interest of bringing sustainable groundwater management to the fore, including:

- cooperation with regional organisations (such as MRC, SADC, IGAD), the UN Economic Commissions (UNECA, UNESCWA) and generators of major international groundwater datasets (such as BGR, BGS, BRGM and eventually USGS) – including the possibility of staff secondment to work closely with IGRAC

- consolidating alliances with the groundwater community through GRIPP⁴ and beyond, exploring relations with large private-sector groundwater consumers via the 'CEO Water Mandate'
- seeking additional UN inter-agency projects or activities (via UN-Water) which link groundwater more strongly to the UN-SDGs for 2030, and ensure that groundwater is on agenda of UN High-Level Water Panels (as was done in 2017-18) and international development agencies.

4.2 Nurturing an enabling environment at Delft office

The IGRAC Delft Centre needs an enabling environment to function effectively, and this includes a suitable organisational set-up, high-quality staff, efficient supporting office and high-level services and equipment.

IGRAC is a small organisation with only 5-7 full-time professional staff, sometimes supported by research students on a temporary basis. A reduction of just 1-2 staff can thus have a serious impact on core activity and institutional memory. Since 2016 the core-budget has only been sufficient to cover the cost of 4 staff, and project cooperation with core partners (UNESCO-IHP, WMO and IHE-Delft) has provided funds just 1-2 additional staff. Optimally, IGRAC needs 8-10 full-time professional staff to achieve long-term institutional robustness and critical mass.

The IGRAC website and social media are updated as often as possible and has an ever-increasing number of visitors, followers and downloads – more than 30.000 used the website in 2018, and the aim is to attract an even larger and broader public to groundwater-related issues.

Since 2011, IGRAC has been hosted in the IHE-Delft building, with the intention of developing close cooperation between the two organisations, which are both UNESCO centres. Cooperation has increased recently but programmatic cooperation is really needed (e.g.: by involving IGRAC in IHE activities requested for the MFA).

SPECIFIC OBJECTIVES: ENABLING ENVIRONMENT (subject to core-funding levels and co-finance)
<ul style="list-style-type: none"> • increase IGRAC turnover to allow employment of 2-3 more qualified staff • IHE-Delft and IGRAC work more closely together on assignments both from Dutch ministries and international institutions

IGRAC needs to increase income from appropriate projects, so as to increase its capacity by 2-3 full-time professional staff. This may be possible through the acquisition of major long-term projects, especially in cooperation with UNESCO-IHP (perhaps in GEF or GCF projects) and IHE Delft (for Dutch ministries). Recently IHE-Delft and IGRAC signed a cooperation agreement, which provides a possible avenue for broad engagement on Dutch national priorities. If the Netherlands Government decides to continue supporting IGRAC for the funding period 2021-25, the current grant mechanism needs to be transformed into programmatic support, as exists for other 'knowledge foundations' in The Netherlands.

In 2019 IGRAC will start evaluating the options for GGIS re-development, with preference for open-source software, which is now competitive with commercial custom-made applications. Data and information sharing via web services needs to continue and intensify, adapting more to mobile devices. IGRAC communication specialists and strategic partners should explore possibilities for joint development of news items and other communication services (video-clips, tailor-made publications, etc) and public-relations material to improve the outreach of the 'groundwater message'.

⁴ *Groundwater Solutions Initiative for Policy and Practice (GRIPP) is an independent open global consortium of partners set up to connect, strengthen, expand and connect groundwater-related projects and initiatives.*