GLOBAL PROJECTS ON RESTORATION OF DEGRADATING GROUNDWATER RESOURCES

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Abstract. Depletion and pollution of groundwater, the largest and most accessible fresh water supply on Earth, is a global sustainability challenge. Currently, the works and projects being carried out to preserve and restore degraded underground water sources indicate the relevance of these processes. A changing climate characterized by frequent and severe hydrological extremes threatens groundwater recharge and increases groundwater use. This article summarizes some of the promising management strategies developed by the GEF (International Groundwater Project), the SADC-Groundwater Management Institute (SADC-GMI) and the Aquifer Diagnostic Analysis (SADA) by each country's ministers. such world-class projects and their working processes were discussed. In addition, SAP (strategic action program) was discussed. Also below are presented the works of water projects in the form of tables and maps.

Key words: Pumping, subsidy, degradation, transboundary, association of hydrologists, GEF (international groundwater project), SADC-Groundwater Management Institute (SADC-GMI), global projects.

Introduction.

Observing and understanding the human and natural dynamics (e.g., biology, physics, chemistry, economics, and sociology) of groundwater systems in response to climate change and regional human activities is important for developing appropriate management strategies and predicting societal outcomes . Significant advances have been made in hydrogeology, geophysics, geostatistics, remote sensing, and applied research in areas of greater groundwater availability. Similar advances in the social science literature have documented the role of various instruments (eg, distribution, regulation, enforcement, pricing, and market relations). Nevertheless, in many cases, groundwater remains invisible at the spatial and temporal scales of management. Aquifers, groundwater users, and pollution sources are diverse. Linking water use and pollution data to human and natural impacts at the appropriate spatial and temporal resolution is challenging. This common pool resource problem is difficult to predict and manage. In the following sections we will:

trends of use of underground water in the national economy ,

(b) various organizations established for global projects and groundwater protection, We synthesize (c) examples of groundwater management features and promising strategies, and (d) support for enhanced regional and national cooperation on groundwater basins .

RESEARCH MATERIALS AND METHODOLOGY

Groundwater resources account for 99% of the surface's fresh water, but only a fraction of it can be used without incurring huge pumping costs and overpumping the aquifer. Therefore, although the volume of underground water accumulated on our planet is very large, only a small part can be used every year without exhausting this vital resource. Nevertheless, global groundwater extraction has more than quadrupled over the past 50 years [1]. Pumps use large amounts of energy, but this energy is often heavily subsidized, so the true costs of groundwater extraction are nearly impossible to calculate.

Groundwater is the world's most extracted raw material, with a current withdrawal rate of 982 km3 per year [1]. About 70% of groundwater extracted worldwide is used in agriculture. Groundwater supplies nearly half of the world's drinking water and directly supplies 24 percent of industrial supplies. About 38% of the irrigated land in the world is equipped for irrigation with groundwater [2]. The total volume of groundwater in the upper 2 km of the Earth's continental crust (excluding the high latitudes of North America or Asia) is about 22.6 million km3, of which 0.1 million km3 to 5.0 million km3 is less than 50 years old. it is timely.

(rated as "modern" or recently charged). [3] The volume of modern groundwater is equivalent to a water basin with a depth of about 3 m spread over the continents. [2] Groundwater is also an important source of drinking water for cities. Some large urban centers depend mainly or entirely on groundwater.

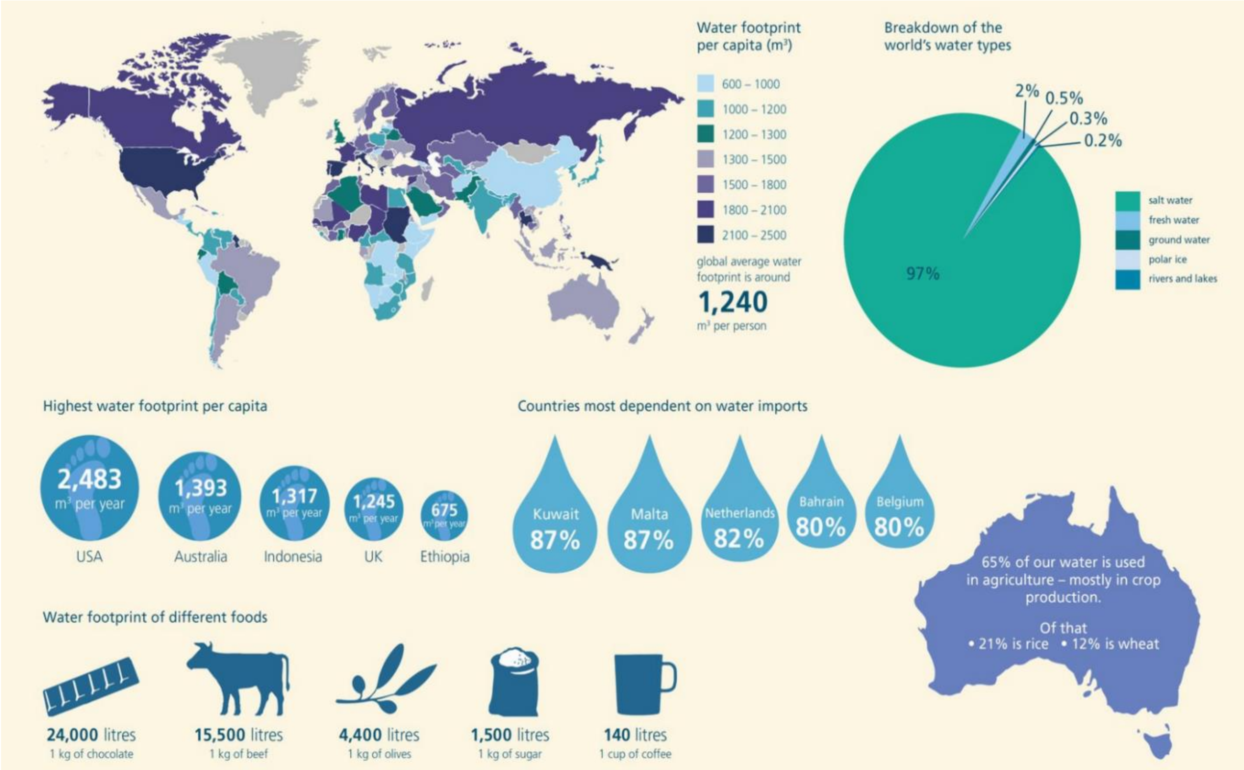

Figure 1. World water use.

(https://australian.museum/get-involved/citizen-science/streamwatch/water-catchment/streamwatch-water-around-the-world/)

Because of its often invisible nature, groundwater management has been neglected. Lack of effective groundwater management is one of the main causes of groundwater depletion and aquifer degradation. In addition, interactions between groundwater and surface water systems (rivers, wetlands, lakes) are not adequately addressed at the national level or in many transboundary river basin management initiatives. . At the same time, as the need for water increases, users often turn to groundwater without a clear management strategy. There is a significant gap in knowledge of the groundwater resource base and its relationship to surface water, its use, and aquatic ecosystems. Surface and groundwater should be managed together, which is often referred to as "integrated surface and groundwater management" [4].

If it is necessary to reverse the current trends in the state of groundwater resources, urgent measures should be taken. The cost of inaction can be enormous. In order to integrate global knowledge and formulate targeted actions, GEF collaborates with FAO, the World Bank, UNESCO and the International Association of Hydrologists to analyze and advise on the state of groundwater resources around the world and its challenges, and solutions for global groundwater management. conducted [5]. The project was prepared as an urgent call for collective and responsible action on global groundwater management by 2030 through a global consultation. A framework for global action on groundwater management, including a framework and governance principles for coordinated action between GEF and its partners, as well as governments at all levels, the private sector, municipalities, civil society and international organizations, to achieve results professional associations were launched.

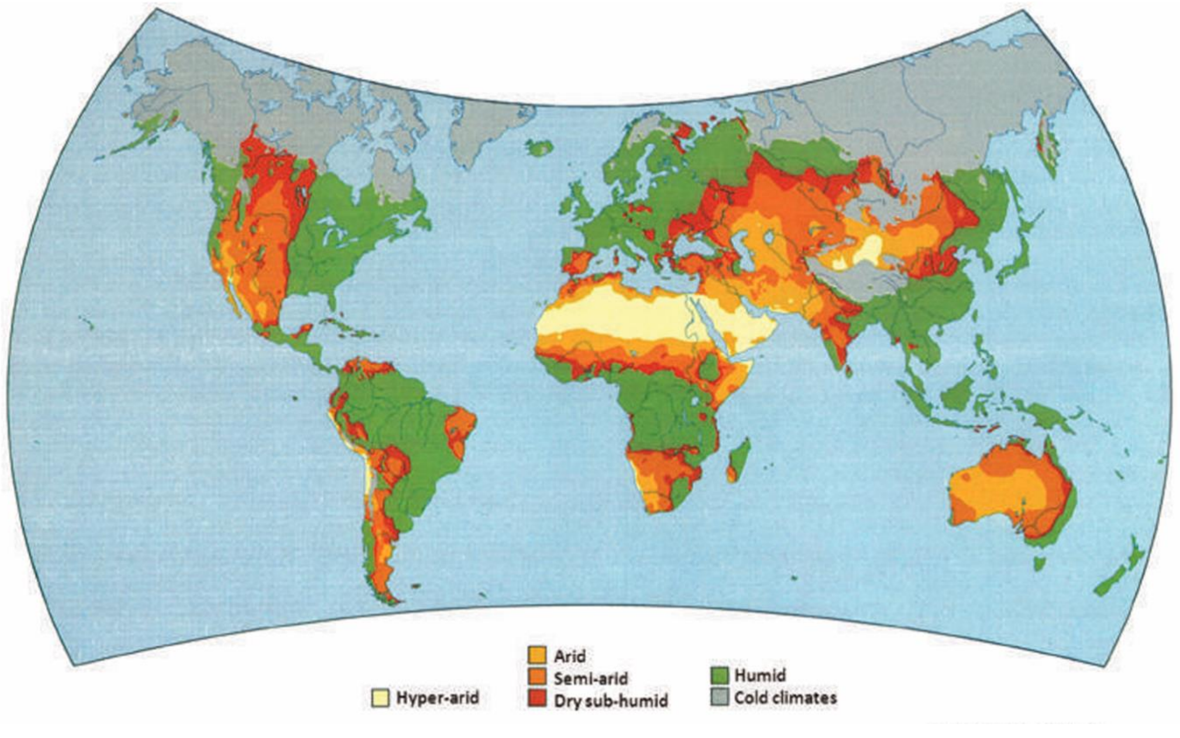

Figure 2. Distribution of arid and semi-arid regions of the world. [Source: UNESCO (2018). (Groundwater_around_world.pdf (un-igrac.org)).

GEF (International Groundwater Project) has and supports a number of groundwater related projects in all regions. For example, in South Africa, groundwater plays an important role for drinking water in rural and urban areas, agriculture, energy and mining. Together with its partners, GEF supports sustainable groundwater management at the national and transboundary levels, and GEF support helped establish the SADC-Groundwater Management Institute (SADC-GMI), a center of excellence for the region [6] . SADC-GMI is an important platform for cooperation in the Southern African region on broad regional issues related to water conservation and integrated management of water resources, including groundwater. With joint funding from GEF and CIWA projects, SADC-GMI will undertake analyzes supporting SADC member states in individual and regional contexts. SADC-GMI conducts thematic conferences, workshops and trainings and is currently engaging all SADC member states in the preparation of 'pilot' small grants focused on groundwater management capacity and infrastructure . This project was launched globally from December 31, 2020 [4].

RESEARCH RESULTS

There are dozens of transboundary aquifer management treaties around the world. For example, the Guarani aquifer system is a transboundary groundwater body that contains a large portion of the groundwater in Argentina, Brazil, Paraguay, and Uruguay. The Guarani aquifer system is one of the largest underground water reserves in the world. The GEF International Groundwater Project for Environmental Protection and Sustainable Development of the Guarani Aquifer System helped develop and adopt a strategic action plan for the long-term sustainable use and protection of this vast freshwater resource, as well as the completion of the Guarani Project. 2010 Aquifer Agreement (GAA). The agreement entered into force in 2018 [6].

Another example is the Nubian Sandstone Aquifer System (NSAS), which covers an area of approximately 2.6 million km ^{2} in Chad, Egypt, Libya, and Sudan, and is one of the largest fossil freshwater aquifer systems in the world. The above four countries face problems such as arid climate, scarcity of surface water resources, persistent drought and fragile ecosystems. The aquifer is a very important source of water in this arid desert region and is under increasing demand due to increasing pressure on alternative water sources combined with increasing population and increasing demands and further pressures of climate change. will have Recognizing the importance of these shared resources, a major successful initiative under NSAS management was the establishment of a joint agency for the study and development of the Nubian Sandstone Aquifer System in the 1990s. With GEF support, it led to the formulation of a Common Aquifer Diagnostic Analysis (SADA) and adoption of a Strategic Action Program (SAP) by ministers of each country in September 2013. In 2018, the GEF approved another project to support the implementation of priority actions, the SAP (Strategic Action Program).

Country	Population 2010 (in thousands)	Groundwater extraction			
		Estimated groundwater extraction 2010 (km^3/yr)	Breakdown by sector		
			Groundwater extraction for irrigation (%)	Groundwater extraction for domestic use (%)	Groundwater extraction for industry (%)
India	1224614	251.00	89	9	2
China	1341335	111.95	54	20	26
United States	310384	111.70	71	23	6
Pakistan	173593	64.82	94	6	0
Iran	73974	63.40	87	11	2
Bangladesh	148692	30.21	86	13	1
Mexico	113423	29.45	72	22	6
Saudi Arabia	27448	24.24	92	5	3
Indonesia	239871	14.93	2	93	5
Turkey	72752	13.22	60	32	8
Russia	142985	11.62	3	79	18
Syria	20411	11.29	90	5	5
Japan	126536	10.94	23	29	48
Thailand	69122	10.74	14	60	26
Italy	60551	10.40	67	23	10

Figure 3. 15 countries with the largest annual groundwater extraction (2010).
(https://www.ngwa.org/what-is-groundwater/About-groundwater/facts-about-global-groundwater-usag).

DISCUSSION

Emerging hotspots are most prominent in Africa, the Middle East and North Africa, and sub-Asia, where extreme events can lead to severe water shortages, along with increasing water needs for cities, food and energy. will remain. Water challenges in these areas are exacerbated by climate variability and change (e.g. sea level rise), population growth, urbanization, and increased demand for food and energy. increasing with increasing hunger. Water cooperation in these regions is needed to support the need for water, food, energy and ecosystem security and related measures for each country.

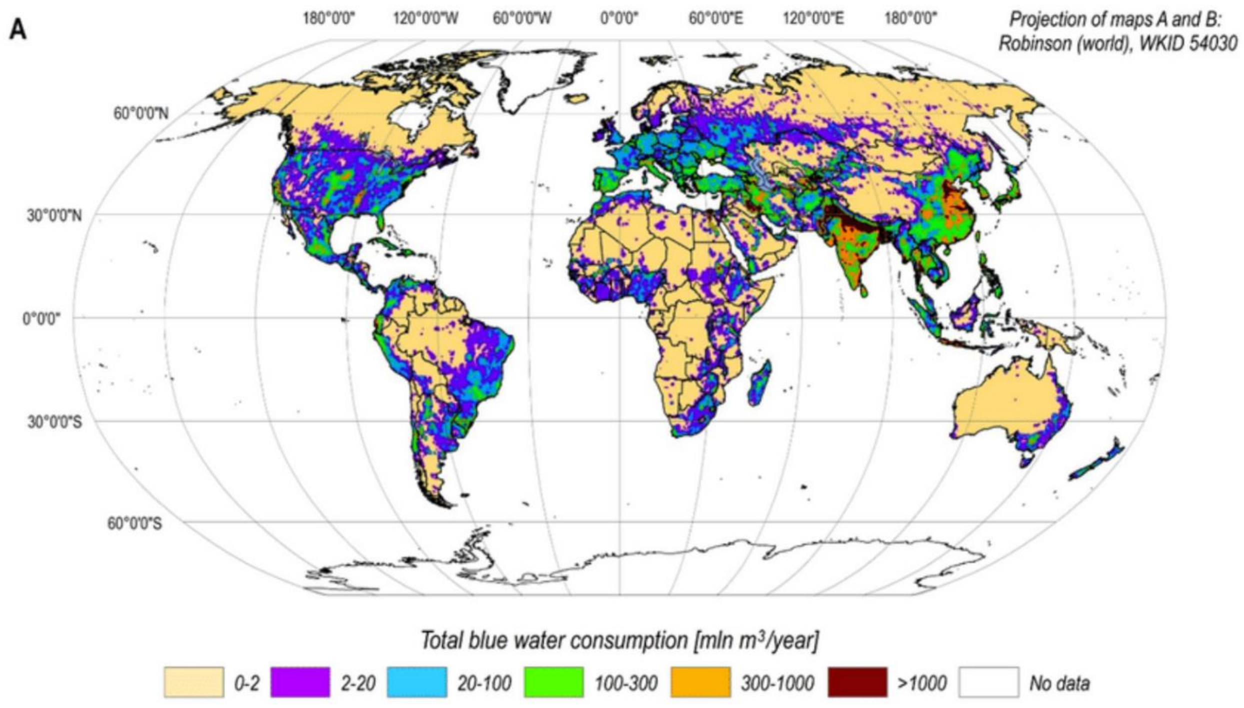

Figure 4. Total Freshwater Consumption Levels.

(https://www.researchgate.net/figure/A-Global-map-of-human-water-consumption-from-agricultural-industrial-and-domestic_fig2_343054513)

GEF-7 focuses on the following priorities to support enhanced regional and national cooperation on common freshwater surface and groundwater basins: [7].

- Common, participatory fact-finding and agreement on cooperation opportunities and common constraints, and a common future vision (for example, through the formation of a common TDA/SAP);
- Capacity-building efforts to level the playing field across countries, including negotiation skills and international water law;
- Processes of formation and formalization of legal and institutional foundations of cooperation;
- Identifying and using resources for investments that meet the priorities set by SAP;
- National reform of policies, strategies and regulations in line with regional agreements and MEA commitments;
- Policy-making processes and co-management of surface and groundwater resources at national and regional levels;
- Periodic update of existing TDA/SAPS or their equivalents;

- Collaborate with national, regional and global stakeholders to increase cooperation and mutual support for investments and processes through IW-LEARN.

In short, the GEF, GMI, SAP projects show the ways to reduce and protect groundwater depletion with the help of research. Nevertheless, the consequences of decline and management challenges are largely local and regional. Perhaps global attention to these regional problems will help to better understand the state of resources. In this case and under these circumstances, the challenges associated with anthropogenic groundwater pollution and increased water use, given the costs associated with chronic pollution remediation, which appear as cumulative effects over space and time with the fact that the mobilization of geogenic pollutants can actually occur poses a greater challenge. Climate variability and change will exacerbate these negative groundwater dynamics, resulting in worsening groundwater conditions over time due to limited runoff saturation and the addition of pollutants. Few of the resource problems can be solved, requiring spatial data and conclusions that link the results of the analysis. Synthesis of models in this field includes the process from academic research to their regular application in practice. In the last few decades, the importance and relevance of model synthesis has been shown in science. Therefore, much work remains to be done, to make policy decisions based on important information on resource management and regulation, and to reduce uncertainty for the future of groundwater resources with greater confidence. Using model synthesis as a researcher to better understand climate change adaptation and action on groundwater issues would be appropriate in this regard.

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