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EVALUATING INTERNATIONAL SUPPORT FOR TRANSBOUNDARY AQUIFER MANAGEMENT PROGRAMMES

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Introduction

Over the past two decades there has been growing recognition of the transboundary nature of aquifers – systems that cross the borders of at least two countries – and a corresponding increase in international support for managing these complex systems. This chapter considers these shared groundwater resources within the broader, global context of potable water supplies and intensifying water stresses. The chapter notes the legal and development assistance frameworks for international support to developing countries on transboundary aquifer issues and examines a subset of five transboundary aquifer projects implemented with Global Environmental Facility (GEF) support. Evaluative evidence from these projects is used to highlight common issues and lessons for consideration in future transboundary aquifer projects.

Significance of transboundary aquifers

Water scarcity¹ is adding to the difficulties of supplying potable water to poor persons; increasing demand and shifting weather patterns are exacerbating these difficulties. UN-Water notes that

around 1.2 billion people or almost one-fifth of the world's population, live in areas of physical scarcity, and 500 million people are approaching this situation. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage (where countries lack the necessary infrastructure to take water from rivers and aquifers). (United Nations Educational, Scientific and Cultural Organization [UN-Water, FAO 2007: 4])

By 2025, water shortages are forecast to broaden, with as many as 1.8 billion people living in areas with absolute water scarcity and two thirds of the world's population living under water-stressed conditions (UNESCO 2012).

The confluence of poverty and water scarcity exacts a heavy toll. The ‘water poor’ in water-stressed areas face persistent threats to their livelihoods due to hydrologic extremes. Excess pumping results in greater drawdowns, which increases energy costs to the poor. Persons forced to travel long distances to secure potable water face security risks and lose educational opportunities. There are elevated health risks from living in areas with high levels of water-associated diseases (e.g. bilharzia, cholera, guinea worm, malaria, trachoma, typhoid) (Puri and Aureli 2005).

Facing acute and growing water shortages, societies must consider all potential sources, and groundwater is an obvious choice where available. Aquifers contain almost 96% of the useable freshwater on earth (excepting freshwater locked up as ice; UNESCO 2012). Aquifers account for more than 70% of the water used in the European Union and are often one of the only sources – if not the only source – in arid and semi-arid zones. For example, aquifers account for 100% of water in Malta, 95% in Tunisia and 75% in Morocco (UNESCO 2012). Globally, 67% of groundwater is devoted to irrigation, 22% for domestic purposes and 11% for industry (Margat 2008; Integrated Groundwater Resources Assessment Centre [IGRAC] 2009; Siebert et al. 2010; Aquastat 2011; Eurostat 2013).

Aquifers underlying arid areas are typically (and logically) slow to recharge, and consequently are susceptible to rapid depletion. An analysis of global groundwater use and availability in six major aquifer systems (North Arabian, North China Plain, Persian, Upper Ganges, U.S. High Plains and western Mexico) found that all showed signs of acute overuse, that some recharge rates were inadequate to match withdrawals and that water tables were lowering precipitously (Gleeson et al. 2012). Some aquifers barely recharge at all. ‘Fossil’ aquifers, such as the Ogallala in the Midwest United States, the Sana’a Basin in Yemen and the vast Nubian aquifer system underlying parts of Chad, Egypt, Libya and Sudan are isolated from the streams that once fed them (Gleeson et al. 2012). In such systems, extraction equals depletion – the resource is non-renewable.

Most large aquifers are transboundary. The UNESCO–International Hydrological Programme has identified 273 transboundary aquifers in the world, which is roughly equal to the number of transboundary river basins: 68 transboundary aquifers are on the American continent, 38 in Africa, 65 in Eastern Europe, 90 in Western Europe and 12 in Asia. One hundred and sixty-six of these transboundary aquifer systems are larger than 5,000 square kilometers (GEF IEO 2018). At least 40% of the world’s population resides in areas underlain by transboundary aquifers (IGRAC 2009).

International community engagement

International law and conventions

There are no binding international agreements setting out how governments should cooperate in managing transboundary aquifer systems. This reflects the very limited international legal structures for shared waters as a whole. Efforts to build a stronger legal basis include two UN General Assembly (UNGA) resolutions. The first, passed in July 2010, recognizes ‘the right to safe and clean drinking water and sanitation

as a human right that is essential for the full enjoyment of life and all human rights' (UNGA 2010: 2) The second, a nonbinding resolution adopted by consensus at the General Assembly in December 2011, seeks to establish a law of Transboundary Aquifers (UNGA 2011). The resolution builds from the International Law Commission Draft Articles on the Law of Transboundary Aquifers (2008), which were formally annexed to the UNGA resolution. The resolution encourages states concerned 'to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers', including cooperation among states to prevent, reduce and control pollution of shared aquifers. Under this resolution, states are invited to consider the draft articles as a basis for the elaboration of a convention. The Law of Transboundary Waters has repeatedly come up for discussion in the General Assembly sixth committee; however, it has not progressed further, with some member states contending that bilateral and regional arrangements and agreements are more appropriate for addressing transboundary aquifer management issues.

Regionally, the body of transboundary aquifer legislation, treaties and other obligations is quite limited. This is not just a developing country phenomenon. Organisation for Economic Co-operation and Development (OECD) countries also generally lack formal treaties on aquifer management. For example, 36 aquifers have been identified as straddling the U.S.–Mexico border, many of which provide drinking water to large local populations. The need for a groundwater treaty between the two countries has been discussed and acknowledged as far back as 1973, through the International Boundary and Water Commission (IBWC 1973); yet the U.S. and Mexican governments have never signed an agreement or established guidance on how these systems should be managed (Eckstein 2011).

Official financial flows and international support for water and sanitation

International finance in the water and sanitation sector constitutes one of the largest areas of development assistance. Official financial flows in the water and sanitation sector have averaged 5% annual increases over the last decade, reaching US \$14.3 billion in 2014–2015. Official development aid during this period was \$8.2 billion, 58% of the total. Other official flows have averaged 13% increase per year since 2006–2007, and amount to \$6 billion. In total annual aid commitments for all official donors (OECD), Germany (1.67 \$billion) and Japan (1.1 \$billion) are the largest donors in the sector. Low-income countries received 22% of total aid in the sector, closely matching the regional breakdown of 21% going to sub-Saharan Africa.

UN and multilateral agency attention to groundwater and aquifer management

In 1997, the International Association of Hydrologists established a Commission on Transboundary Aquifer Resources Management, coincidental to the adoption of the UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention). In 2000, the UNESCO

Intergovernmental Council at its 14th session approved joint activities on trans-boundary aquifer issues among the International Association of Hydrologists, the UNESCO International Hydrology Programme, the Food and Agriculture Organization and the UN Economic Commission for Europe. This joint effort produced a framework document on Internationally Shared Aquifer Resource Management. Subsequently, the programme has grown to include regional initiatives in the Americas, the Balkans and Europe (Puri & Aureli 2005).

The International Atomic Energy Agency fills an important technical niche in the effort to better manage transboundary aquifers. Agency experts use isotope science to determine the origin, age and renewal rate of groundwater and whether aquifers face contamination risks. Isotope techniques are particularly useful for mapping slow-recharge and non-renewable groundwater resources, which are at risk of rapid depletion if not managed carefully. The Agency has worked to model, characterize and monitor transboundary aquifer systems for a series of projects in Africa, Asia, Europe and Latin America, including the Nubian, North-western Sahara and Iullemeden Aquifer systems of Northern Africa and the Guaraní Aquifer in South America (International Atomic Energy Agency [IAEA] 2013).

The global environment facility

GEF was launched as a pilot effort in 1991 and broadened into a major global programme in 1994 (GEF 2013). The GEF brings 183 countries together with international institutions, civil society organizations and the private sector in order to address global environmental issues and support national sustainable development initiatives. GEF is an independently operating financial organization that provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer and persistent organic pollutants (GEF 2013). GEF takes a multi-level approach in the international waters sector, providing support for global actions and conventions, regional (catchment) analysis and action planning, and support at national and local levels. By design, GEF is focused on achieving global environmental benefits, and its international waters portfolio covers nearly all large freshwater catchments globally, with 156 GEF recipient countries and 24 non-recipient countries cooperating on transboundary water resource management (GEF 2020).

Transboundary groundwater and aquifers were added to GEF programming during the 2nd fund replenishment (GEF-2), and now include 19 projects. Of these, all but two are focused on specific transboundary aquifers. Eight of the projects have been completed, using \$27.83 million in GEF trust fund grants and an estimated \$25.58 million in co-finance. The 11 with concepts or projects approved bring the total anticipated GEF trust fund commitment to \$83.84 million, with an estimated \$1.28 billion in anticipated cofinancing. Eight of the recently approved projects build from previous GEF transboundary aquifer projects (Guarani, Dinaric Karst, Nile Basin, Nubian Sandstone, Iullemeden Aquifer, SADC Groundwater, Nile Basin, Northwest Sahara).

The overriding development objective for most GEF transboundary aquifer projects is to help beneficiary countries jointly elaborate and implement a common institutional and technical framework for the management and preservation of the aquifer. The typical programme of support emulates the two-phase process developed and honed in the GEF International Water surface water programme: a transboundary diagnostic analysis is carried out to determine aquifer pressures and measures (Uitto 2004; Pernetta & Bewers 2012), then a Strategic Action Programme is drafted for partnering countries to agree on concrete actions designed to mitigate threats and protect the shared groundwater resource (Uitto 2004). Support is also provided for enhancing institutional capacities to manage groundwater and reduce pollutant risks. In addition, stakeholder awareness efforts are launched to change local perceptions in order to enable better groundwater management.

Evaluating GEF transboundary aquifer projects

For this analysis, five of the GEF transboundary aquifer projects that have been evaluated at project completion are presented: 1) The Iullemeden Aquifer System (Mali, Niger and Nigeria), 2) Northwest Sahara (Algeria, Libya and Tunisia); (3) Guaraní Aquifer (Argentina, Brazil, Paraguay and Uruguay); (4) Dinaric Karst Aquifer System (Albania, Bosnia-Herzegovina, Croatia and Montenegro); and (5) Southern African Development Community (SADC) Groundwater and Drought Management Project (covering 15 countries in Southern Africa and spanning 14 major transboundary aquifers).

The following is a brief explanation of each project and select evaluation findings.

Iullemeden aquifer system

The Iullemeden Aquifer System underlies Mali, Niger and Nigeria. These countries and the United Nations Environment Programme implemented a GEF-financed project from 2003 to 2007 (GEF provided \$1 million of the \$1.7 million project budget). The project was designed to establish joint mechanisms to identify risks and uncertainties relating to land use, climate change, extraction and other key drivers that could have an impact on the quality and quantity of water in the aquifer. The project was also expected to develop mechanisms to formulate policies for managing identified risks and uncertainties, and then to establish a legal and institutional cooperative framework among the three countries to address these risks (Hearns 2009).

An evaluation of the project was carried out in January 2009, taking into account the project's achievements beyond its June 2008 termination to include residual achievements through November 2008 (Hearns 2009). The evaluation methodology included interviews, site visits and a desk review of pertinent documents. In keeping with GEF evaluation guidance, the questions focused attention on a range of project design, implementation and outcome aspects (including efficiency, effectiveness and sustainability), the achievement of planned outputs and activities, the

catalytic role played by the project, the monitoring and evaluation systems used and the extent of engagement with stakeholders.

The evaluation rated the project satisfactory across most of the evaluation criteria. The evaluator noted in particular that there was good cooperation at the technical level, especially in the transfer of information and data, and good cooperation in the effort to identifying risks to the groundwater resource through a transboundary diagnostic analysis. The project was slow in getting started, requiring 18 months for the project team to get up and running (Hearns 2009). On the positive side, the countries then formed a tripartite steering committee supported by a technical and scientific committee. The evaluator noted a continuing need to provide support to the countries in order to maintain the momentum of the project's outcomes. In particular, the evaluation report highlighted the importance of reaching agreement among the countries to develop and implement measures to minimize the risks of pollution and excessive drawdown of the aquifer and to organize for future close cooperation through a suitable regional institution (either an existing institution or one newly configured for this purpose). Another notable recommendation was to extend the hydrology analysis work to better clarify interactions between surface water and groundwater (Hearns 2009).

A follow on project has been approved, in January 2018, entitled: Improving IWRM, Knowledge-based Management and Governance of the Niger Basin and the Iullemeden-Taoudeni/Tanezrouft Aquifer System (NB-ITTAS). The new project is designed to build on previously separate surface and groundwater projects, integrating their strategic action plan implementation.

Northwest Sahara

The Northwest Sahara Aquifer System underlies Algeria, Libya and Tunisia. It is considered a non-renewable water source, as most of the area has virtually non-existent precipitation and there is no significant surface/ground water mixing. From 2003 to 2006, the three beneficiary countries and the United Nations Environment Programme implemented a GEF project as the second of a two-phase project, using \$600,000 in GEF funding and an additional \$816,000 in co-financing. The project design included expanding the use of a previously developed multi-layer mathematical model for the aquifer system in order to determine the water balance and to identify risks to the aquifer (e.g. excessive water pumping depths, drying up of the Tunisian outlet and salinization). The project also called for developing a water-quality monitoring network, conducting studies to determine water demand and for carrying out water cost analysis (Puyoo 2007).

An evaluation of the project was conducted in March 2007 and included interviews, site visits and a document review (Puyoo 2007). According to the evaluators, there were significant delays in getting the project started and it encountered difficulties in achieving planned outcomes. The planned water-quality monitoring network was not established, and a water-costing analysis was not done. More successfully, a synthesis of environmental impacts connected with exploitation of the

aquifer was carried out and an action plan was proposed. Further, the project inventoried wetlands and developed reports on the causes and distribution of salty-soil zones. A permanent consultation mechanism was successfully put in place, signed by the three country ministers of water.

A follow up project was carried out for the North West Sahara Aquifer System, entitled: Reducing Risks to the Sustainable Management of the North West Sahara Aquifer System (NWSAS). The project was approved in 2009 and closed in 2018. It sought to address risks associated with unsustainable exploitation and management of groundwater resources in the NWSAS, to formulate and initially implement a set of actions, focusing on sustainable agricultural practices and environmental management. The project was structured around five linked components: (1) Socio-economic surveys; (2) Pilot demonstration projects; (3) Development of databases and GIS; (4) Support for a regional consultation mechanism; and (5) Project management. A terminal evaluation of the project in 2015, indicating that the planned socioeconomic surveys, databases and pilot demonstration projects were carried out as intended, with one pilot moved from Libya to Tunisia due to political instability. The Regional Consultation Mechanism expectations were less successful, with weaknesses in the set up and support provided to this mechanism. The evaluation notes that the likelihood of long-term impact achievement is not very high, due to the political climate in Algeria, Tunisia and Libya, with water resource management issues not high on the ledger of national priorities.

Guaraní aquifer

The Guaraní Aquifer underlies Argentina, Brazil, Paraguay and Uruguay. One of the world's largest aquifer systems; its current water storage is estimated at 37,000 cubic kilometres, and it has an estimated natural recharge rate of 166 cubic kilometres per year. 24 million persons live within the aquifer boundary area and another 70 million access it through water diversions (Erickson & Rogers 2006).

In 2000, the countries sharing the Guaraní aquifer launched the Environmental Protection and Sustainable Development of the Guaraní Aquifer Systems Project. The overall focus of the project was to support the partnering countries to elaborate and implement a common institutional and technical framework for the management and preservation of the aquifer. GEF contributed \$13.4 million and the partner countries equally contributed an additional \$12 million, with small contributions from other donors. More than 80 percent of the project's \$26.8 million budget was allocated to research, analysis, dissemination and management. The project was implemented by the World Bank; the Organization of American States handled day-to-day management as executing agency (Erickson & Rogers 2006).

An evaluation of the Project was carried out in 2006. The evaluation notes that the participating countries made progress on a number of sub-objectives, yet were far from achieving their overall goals. In particular, the evaluation noted significant delays in developing a transboundary diagnostic analysis and a strategic action plan for the aquifer, serious delays in launching technical studies on the chemical, physical

and dynamic aspects of the aquifer system, and delays in establishing a monitoring and information system. The project was extended by 22 months and came in 20% over budget (Erickson & Rogers 2006).

A new GEF project for the Guarani has been approved in concept, entitled: Implementation of the Guarani Aquifer Strategic Action Program: Enabling Regional Actions.

Dinaric Karst aquifer system

The Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System Project (DIKTAS) was a cooperative effort by the countries of Albania, Bosnia and Herzegovina, Serbia and Montenegro, executed by UNESCO, with UNDP as the implementing agency, and the International Groundwater Resource Assessment Centre (IGRAC) as another involved partner. The project began in May 2010 and operational closure was in May 2015. The \$5.6 million project included a \$2.16 million GEF grant, plus \$3.4 million in co-financing from the involved governments and other sources. The Dinaric Karst aquifer system is one of the largest karstic geological aquifers in the world, and underlies the Dinaric mountain range.

DIKTAS was designed to help the cooperating countries establish and implement sustainable development models, including harmonized land use policies and physical planning, conceptual frameworks for balancing water resource demand, avoiding over-extraction and coping with strong seasonal variability of water resource usage; and accounting for the impact of wider systemic issues such as population growth and climate change. The project utilized the TDA-SAP process that typifies GEF international waters programming, moving from a transboundary diagnostic analysis to a strategic action plan for addressing risks and pressures to the water body.

The evaluation of DIKTAS indicated an overall moderately satisfactory assessment of project outcomes, noting high relevance, satisfactory efficiency and moderately satisfactory effectiveness and likelihood of sustainability. As can be seen in many of the GEF IW projects, and in particular for transboundary aquifers, the first step of the process – to diagnose the uses and threats to water systems – tends to move slowly yet successfully, but the projects then have serious difficulties in achieving binding agreement across the countries on actions they will take to protect the resource (Komitina 2016).

In the case of DIKTAS, a Strategic Action Plan was not signed by the countries by project end, and the envisioned consultation and information exchange body (CIE) was not created. A follow on study was recommended by the evaluation, in order to continue working towards an approved SAP and CIE. Other recommendations were to establish a joint monitoring programme, improve awareness raising and capacity building and consider enlarging the cooperation to include also Serbia and North Macedonia. This recommendation has led to the approval, in concept, of a \$5.145 million GEF grant for a follow on project entitled: Implementation of the SAP of the Dinaric Karst Aquifer System: Improving Groundwater Governance and Sustainability of Related Ecosystems.

Southern African development community groundwater and drought management project

The SADC Groundwater and Drought Management Project covered 15 countries of southern Africa with 14 major transboundary groundwater aquifer systems.² The aim of the project was to develop a consensus on a SADC strategic approach to support and enhance the capacity of its member states in defining drought management policies, specifically in relation to the role, availability and supply of potential groundwater resources. The project provided a \$7 million grant to SADC for a project implemented by the World Bank and executed by the SADC Secretariat Water Division, with support from United Nations Office for Project Services. The project had four components:

- 1) Development and testing of a groundwater drought and management plan for the Limpopo River Basin pilot areas;
- 2) Support for regional groundwater drought management;
- 3) Establishment of the groundwater institute of Southern Africa; and
- 4) Project management and administration.

The Implementation Completion and Results Report on the project, dated 31 October 2011 (World Bank 2011), generally noted success in raising awareness on the value of protecting groundwater resources in southern Africa. The Report also noted that the project succeeded in providing 'increased access to groundwater information to facilitate sound technical decisions by policy makers' (World Bank 2011: 27).

The project had a measure of success in strengthening regional coordination through the regional monitoring network, although efforts to more fully engage SADC countries who were not part of the pilot effort would have been useful, as many need assistance to upgrade their data on groundwater resources. Poor data had an impact on the quality of the regional drought and management maps created through the project. The authors of the Completion and Results Report concluded that the project was too ambitious given the complexity of the issue and region and should have had fewer project components. Results were weighed down by the long delay – 18 months – in getting the project started. The project ended prior to achieving discernible impacts in terms of reduced stress on groundwater resources and better capacity of the SADC countries to manage future droughts (World Bank 2011).

A follow-on project, using \$8.2 million in GEF grant funding, has been approved, entitled: Sustainable Groundwater Management in SADC Member States. The project was approved for funding in March 2014 and is under implementation by the World Bank.

Future considerations for transboundary aquifer projects

The transboundary aquifer project evaluations discussed here provide evidence of an evolving international support effort spearheaded by the GEF and its implementing agencies. It is not an exhaustive study of the results of international support

to transboundary aquifer management, yet the findings from the evaluations of these projects raise important issues and lessons for future effort to protect these critical water resources.

The five transboundary aquifers considered have all demonstrated success building greater awareness of groundwater system boundaries, extraction rates and pollution risks. The projects have also helped raise international awareness of the presence and importance of transboundary aquifers and have helped to enhance governments' capacities to determine risks to groundwater systems. Over an extended period of time, and including follow on projects, the transboundary aquifer projects have also achieved legally binding agreements (Northwest Sahara and Nubian) or are close to achieving agreement (Guarani, Iullemeden) on strategies and action plans aimed at reducing pollution and excessive drawdown risks.

There is a clear progression in the sequencing of these aquifer projects, with medium size projects (under \$2 million in grant funding), used to establish the transboundary diagnostic analysis and draft Strategic Action Plan, being followed by a larger SAP-approval and implementation project. This progression has become a hallmark of the GEF International Waters programme, including also for fresh surface waters and coastal marine systems. This recognizes the tendency for the portion of the project focused on transboundary diagnostic analysis to dominate most of the initial project period. Most of the projects have required a year or more extension to complete, and the use of 'no-cost' extensions is common. This suggests the need for more realistic project outcome expectations, longer timeframes for project implementation and a push for greater commitment from participating governments to start earlier on the difficult negotiations to achieve SAP agreements.

GEF transboundary aquifer projects typically call for the creation of joint committees among the countries involved. This mirrors the approach taken in GEF transboundary surface-water projects. The formation of self-standing transboundary aquifer commissions is a slow and difficult process, and those that do form tend to lack the power and capacity to influence national land and water use laws. Many remain viable only so long as international financial support continues.

While technical training in groundwater assessment and awareness-raising initiatives are helpful, many developing countries face significant practical operational difficulties that limit their ability to carry out conservation and protection measures for aquifers at the national and local levels. Many need to improve use and efficiency and reduce pumping in transboundary aquifers through regulatory and fiscal policy changes and through improved water resource management. Although some attention has been paid to resource substitution and augmentation, this area needs increased support. Ultimately, water-scarce nations will need to greatly expand the use of grey water and brackish water for non-potable uses and expand their access to resources through desalination, artificial recharge,³ conjunctive use of groundwater and surface water and the use of aquifers for surface water storage (Galloway et al. 2003).

These projects have yet to achieve systemic changes in water and land use policies and, ultimately, reductions in environmental stresses and pollution risks. There

is an assumption that participating countries will act on policy and management recommendations from the project and agreed to in strategic action programmes. Conflicting use demands among actors within each country often stand in the way of such actions. Results from the aquifer projects highlight the difficulty in forging political agreements on complex resource sharing arrangements, where it may take decades before positive environmental impacts can be discerned.

This review of the results of GEF transboundary aquifer projects also points to the need for greater attention to the equitable use of groundwater resources. It is the poor and disenfranchised who suffer the most when water is scarce, yet few of the transboundary aquifer projects focused attention on access rights and equitable allocations. Of the five evaluated projects, only the SADC Groundwater and Drought Management Project focused specific attention on communities at risk (female-led households, landless labourers, pastoralists and displaced persons; World Bank 2011). Each of the seven pilot drought and groundwater management studies in the SADC project focused on communities at risk as the prime beneficiaries. As water scarcity becomes more acute in many regions, due to increasing consumption coupled with climate change-impacted variability, it will be important for transboundary aquifer projects to pay greater attention to the equity aspects of groundwater access.

Notes

- 1 'Water scarcity is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully' (UN Water and FAO 2007: 4).
- 2 The SADC countries are Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.
- 3 Artificial recharge involves enhancing natural infiltration into ground-water systems by using spreading basins, recharge wells and induced infiltration of surface water.

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