A blueprint for sustainable groundwater management in Balochistan, Pakistan

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The challenge for groundwater-dependent countries is to ensure that the benefits derived from groundwater resources continue into the future. This requires a policy shift from groundwater development to long-term groundwater management. There follows a brief historical overview of groundwater development in Balochistan, Pakistan and a proposed blueprint for an improved groundwater management system in the region.

Pakistan has fertile alluvial floodplains but low and highly variable rainfall, and is among the most groundwater-dependent countries. Groundwater development is typically connected with the development of tube well (groundwater bore) irrigation systems, which have contributed enormously to increased food production, poverty reduction and improved sanitary conditions in recent decades.[1] Similar trends are evident across south Asia, where rapid increases in numbers of tube wells have driven significant growth in the agriculture sector.[2]

While groundwater polices in Pakistan have been highly successful in enabling increased agricultural production and prosperity, they have also resulted in massive groundwater drawdown.[3] A range of factors have contributed to groundwater resource decline, including insufficient legislation, poor planning and implementation, poor drought management, lack of institutional capacity and scientific knowledge, lack of groundwater entitlements, and a government subsidy for energy.[4] The historical record of policy implementation in Pakistan, particularly in Balochistan, is extremely poor. Prolonged political instability and lack of the required political will further aggravate the situation.[5]

The management of groundwater is complex due to the common-pool nature of the resource.[6] Furthermore, lack of knowledge about groundwater biophysical systems, poor understanding of the concept of sustainable yield, and a lack of monitoring infrastructure (which seldom exists in Pakistan) makes it hard to develop and implement effective groundwater allocation and licensing plans. The present circumstances need a solution.

Groundwater development and governance in Balochistan

Balochistan is one of four provinces of Pakistan and the biggest in terms of area (347,190 km^2). Upland Balochistan is classified as arid in terms of rainfall, receiving an average rainfall of 200-250 mm annually. The region is renowned for producing a range of high-value crops including fruits and vegetables.

Image: Syed Mohammad Khair

Tube well irrigation in Balochistan: (left) a newly installed tube well in a hilly area to irrigate downhill fields, and (right) a vineyard irrigated by traditional tube well

These are grown under irrigation with most of the agricultural water (over 50 per cent and increasing) obtained from groundwater resources.

In the absence of reliable surface-water resources, the Government's groundwater polices aimed to provide an alternative resource for irrigation to boost agriculture production — thus reducing poverty — and provide water for domestic purposes. The philosophy of policymakers was to provide the farmers with a more reliable water source for irrigation and to replace the traditional karezes (manmade sub-surface horizontal tunnels and galleries)[7] and natural springs which flowed all year round and were seen as causing water wastage.[8] The electrification of many rural areas of the province, along with improved communication networks and promising returns for fruits and vegetables, contributed to strong growth in tube well and dug well irrigation. A government subsidy on electricity use for tube wells, in place since the 1980s, further expanded tube well irrigation and improved rural income; however, this has had an adverse impact on water tables.[9] Without any restriction or mechanism for allocating groundwater rights and regulating groundwater use or access to the electricity subsidy, irrigators have extracted as much as they wanted without considering the detrimental effects on others.[10]

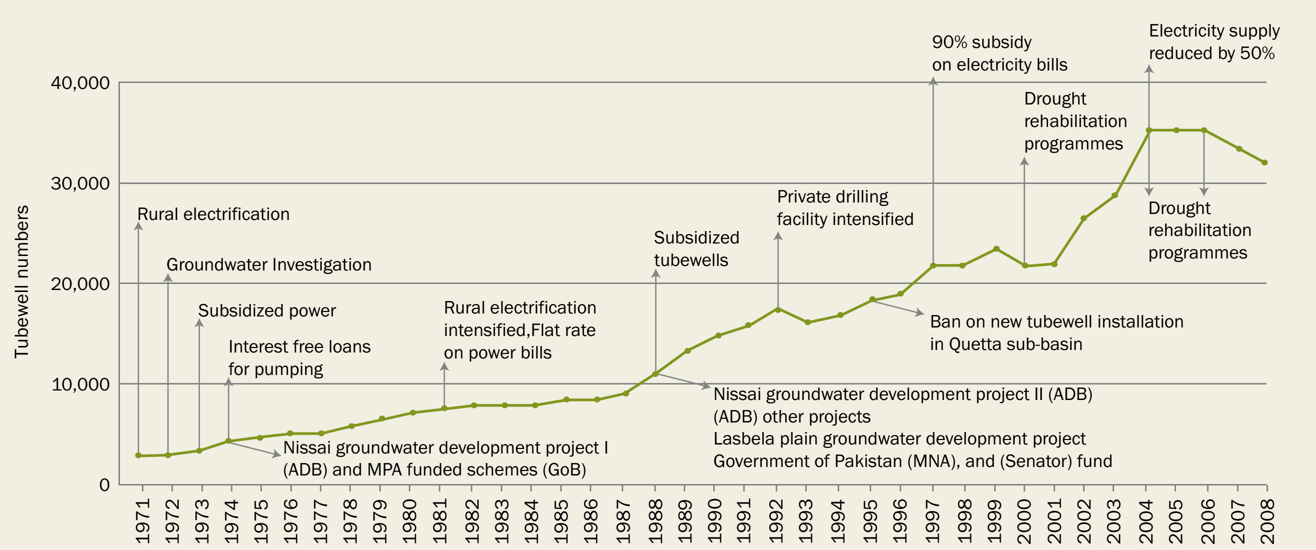
Until the early-to-mid twentieth century, karezes and springs were the major source of irrigation (60 per cent) in the upland areas of the province.[11] Because of the shallow water table (7-10 metres), animal-driven water-lifting devices such as the Persian wheel were used to access and pump water. However, in the early 1970s, following electrification in some rural areas, tube wells began to be installed in parts of the province. This period saw animal-driven and diesel pumps being replaced by electric pumps on existing open surface wells. As a result, farmers were able to convert more area to irrigation, leading to a substantial increase in cropping area. There was also a shift from subsistence to more commercialized cropping patterns. High-value crops such as such as apple, apricot and cherry replaced low-value crops such as wheat.

Between 1980 and 1990, the Government initiated a number of major groundwater development projects with the assistance of donor agencies such as the Kuwait Fund, the Asian Development Bank and the World Bank. These aid projects provided additional strong incentives to further increase the number of tube wells and groundwater extraction, to meet increasing demand. From 1990 to 2000, the increase in tube wells continued as a result of rural electrification and subsidized power supply to electric tube wells. The electricity subsidy initially required tube well owners to pay around 50 per cent of the bill; however, during the late 1990s, the subsidy was increased to 90 per cent in response to demands from farmers in the province. This fuelled further increases in water abstraction. The production of high water-demanding horticulture crops continued to expand in line with the increasing numbers of tube wells, resulting in overexploitation of groundwater resources and groundwater aquifer overdraft.

Since 2000, drought (1998-2004) and overdraft of some aquifers has caused the failure of large numbers of tube wells, with many farmers dispossessed of their source of irrigation and hence their livelihoods. In addition, the discharge flow of existing tube wells in many areas has decreased due to the continuous decline in water tables. Drought rehabilitation programmes were initiated by the Government and the installation of replacement tube wells, both privately and under the drought rehabilitation programme, has continued along with the subsidy on electricity.

The historical record suggests poor policy development and implementation owing to a lack of institutional capacity and scientific knowledge, prolonged political instability in the country and a lack of political will. Furthermore, legislation pertain-

Groundwater governance, tube well development projects and policies timeline



Source: Khair (2013)

The five fundamental elements of the proposed blueprint for sustainable groundwater management in Balochistan, Pakistan

ing to the governance and sustainable management of groundwater is largely inadequate. In addition, a key challenge for integrated groundwater planning is sectoral division, with the traditionally vertical, compartmentalized structures of government tending to limit information flows among agencies, thereby impeding coordinated action. Integrated water resource management (IWRM) also needs to be conducted at a range of spatial scales. Without coordination and collaboration, there is a real danger of losing effectiveness and efficiency.[12]

Blueprint for sustainable groundwater management

The proposed blueprint for groundwater management is based on five fundamental elements:

- improved governance and effectiveness of institutions
- demand-side groundwater management
- supply-side groundwater management options
- social adoption by the community
- effective coordination and cooperation.

Improved governance and effectiveness of institutions includes increased focus on strengthening and enforcing groundwater laws, including establishing clear and tradable property rights for water; better quantification of groundwater yield followed by appropriate groundwater licensing and enforcement to prevent over-extraction of groundwater; establishing appropriate systems for resource monitoring on a regular basis at the basin and sub-basin levels; and rigorous collaboration between various departments (such as the Irrigation Department, the Agricultural Department, the Balochistan Development Authority, the Public Health Engineering Department and the Water and Power Development Authority) to improve decision-making.

Demand-side groundwater management should include a rational pricing system for efficient water use; replacement of water demanding crops with water-use efficient crops; and the adoption of modern water-saving irrigation technologies and practice.

Supply-side groundwater management options should include rainwater harvesting and surface-water use for increasing groundwater recharge; promoting conjunctive water use where possible; and groundwater markets with suitable institutional mechanisms to augment water supply.

Social adoption by the community includes providing a sense of ownership of the regional groundwater resources and developing basin-wide groundwater users' associations with responsibilities to conserve, protect, develop and manage groundwater resources to increase community welfare. It entails the strengthening of coordination among various stakeholders (including government departments), developing a community vision of groundwater management through better information, knowledge-sharing and communications for social adoption and efficient water use. Social norms and rules must be developed (some already exist) to prevent any illegal water extraction for agriculture and other purposes.

Development of sustainable groundwater plans will require the cooperation and coordination of a number of government agencies and key stakeholder groups. The blueprint for sustainable groundwater management would require the community to provide significant input into the management planning process, particularly advising on appropriate uses and values of the local groundwater systems. In order to enhance cooperation and coordination, as suggested by Pahl-Wostl and Kranz,[13] some degree of decentralization combined with effective vertical integration of different levels of government (provincial and local) that share responsibility for a resource, and horizontal integration within government levels, would be required.

Social adoption and changing groundwater cultures offer considerable potential to internalize externalities (factors which received inadequate attention in previous IWRM plans) and are key elements of this blueprint for sustainable groundwater management in Balochistan. However, it is worth noting that without firm political commitment and effective coordination of different elements of the blueprint, it would be extremely difficult to achieve sustainable management of groundwater resources.

Moving from development to management

Groundwater is the subject of growing social concern around the globe, and this is especially so in Pakistan. While they are successful in enhancing agricultural production, groundwater policies in Pakistan and, most particularly, in the province of Balochistan are not well designed to handle groundwater sustainability issues. They are based on a lack of geophysical knowledge and are also poorly implemented due to poor governance, inadequate institutional arrangements and lack of political determination. With groundwater systems seriously degrading in the region, there is a critical need for a shift from groundwater development policies to groundwater management policies accompanied by sound hydrological planning. The five fundamental components proposed above should be part of any IWRM approach proposed and developed in Pakistan.