



# Intensively exploited aquifers

Main concepts,  
relevant facts  
and  
some suggestions

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In this paper the authors present what they consider are the main results obtained in the Madrid Workshop on Intensively Exploited Aquifers (Madrid, 13–15 December 2001), which included comments and ideas to improve water management in regions where there is an intensive use of groundwater. These results and suggestions only represent the personal viewpoint of the authors. The different contributions are published in the book *Intensive Use of Groundwater: Challenges and Opportunities* (Balkema, The Netherlands; ISBN 90-5809-390-5). During the International Symposium on Intensive Use of Groundwater (Valencia, Spain, 10–14 December 2002) these issues will be the subject of further discussion. The relevant results will then be included in a later publication, in the IAH Selected Papers Series.



There is intensive development of groundwater when a significant proportion of the interannual renewable resource is withdrawn from the aquifers, which in turn, noticeably modifies their hydrogeological functioning, or causes significant ecological, political or socio-economic impacts, or important changes are produced to river-aquifer relationships.

The concept of intensive development of groundwater points to clear facts, and thus it seems preferable to the poorly defined concept of overexploitation and other similar terms, which may involve either unjustified or unrealistic derogatory and pessimistic meanings. Consequently the editors propose their abandonment as a useful hydrogeological concept.

Intensive use of groundwater is becoming a common situation in many areas of the world, especially in semiarid and arid areas, and in small islands and coastal zones.

Many different and opposed viewpoints exist on the issues related to the intensive development of groundwater, and these are often partly true. This reflects the diverse situations different regions face because of their varied climatic,

hydrogeological, economic, social and political conditions, as well as the different interests and objectives. For example, groundwater developers, water suppliers, farmers, Nature conservationists, water managers and administrators, and policy-makers have very diverse positions in relation to groundwater use.

The facts and concepts that follow are based on diversity of situations and viewpoints, and rely on the different papers presented and the discussions held during the Seminar of Madrid. These may be presumably accepted by a majority of the participants in the Seminar, although they have not been formally consulted. Therefore what is quoted is the sole responsibility of the authors. Facts and concepts are given as short sentences, but some explanation may be added to comment on their consequences or applications. Therefore, some repetitions are unavoidable for the sake of clarity.

## Facts and consequences

» In most circumstances, aquifers may be developed in order to supply local people with freshwater, with clear benefits towards fostering regional development. Aquifers are a reliable water resource for water supply and for the irrigation of crops, at a reasonable cost and using affordable technology. Groundwater is a key water resource to alleviate poverty, to fight malnutrition and famines and to improve population health conditions.

Yet:

- Groundwater will not solve all situations nor should be promoted as unlimited resource leading to the uncontrolled growth of groundwater use.
  - Local problems and circumstances may appear to need special consideration or additional investment, like in the case of some fractured aquifers in arid lands, or when hazardous dissolved constituents appear, like arsenic or fluoride.
  - Groundwater-related environmental issues may be important, especially when the area becomes more developed in economical and educational terms.
- » Intensive groundwater development may induce some negative side-effects, like for any other utilised natural resource. These negative effects refer mostly to groundwater level drawdown, groundwater storage depletion, interference with springs, surface water and groundwater-dependent

ecosystems, and sometimes the deterioration of water quality. These are all externalities to be considered.

It should also be taken into account that:

- The consequences of intensive use of aquifers can be reasonably known and evaluated. This needs monitoring, inventories, and adequate studies by experts.
- Externalities should be bearable socially, and corrected, now or in the future, by channelling part of the benefits from groundwater abstraction. Solutions use to be technically easy although they may be socially complex.
- The existence of externalities should not deter the consideration of groundwater development as a reliable and effective source of water.
- Negative effects may appear some time after the beginning of the groundwater development, from months to many years.

>> Groundwater development is progressive and becomes more complex as it intensifies, when benefits should increase and knowledge should improve.

Yet:

- The emphasis should move from restricted, local situations to a wider-scope, since particular problems can be solved and should not impede benefits to a large community.

>> Intensive use of the aquifer finds its optimum when framed into integrated water resources development schemes, which include Nature protection.

# Economic issues

- » The benefits and costs from groundwater development are not static. These may vary through time. For example, what may be an acceptable practice or valuable asset today, was probably not so in the past, and this may not hold in the future.

Then:

- Cost and benefit analyses should be carried out within dynamic frameworks.
- » In the early stages of economic and social development of a particular area, groundwater may play an essential role, since it allows for smooth economic growth without the need for large previous investments.
- » In most cases groundwater development produces clear social benefits.

Yet:

- A follow up of groundwater development is needed to make it sustainable by imposing limits, correcting deviations and compensating externalities.
- Local circumstances may show negative shades. However these often disappear when benefits to a larger area are considered.

When the negative effects of groundwater development are emphasized without at the same time considering the benefits, planners and decision-

makers may neglect groundwater as a reliable water resource. Then at large the benefits posed by this resource may be lost while other less suitable, more expansive and less environmentally friendly alternatives become accepted.

It may happen that:

- Such alternatives become a serious burden for developing regions since more public funds are needed; therefore external debt is increased and there may also an increased dependency on external technology.

>> A main case of unsustainable groundwater management is mispricing.

But:

- This does not imply that pricing water properly is either applicable, possible or advisable.
- In many regions groundwater developers are in fact applying the 'full cost recovery' principle since they pay, without – or with only small – subsidies from public funds, the capital, operation and maintenance costs, which explain why water efficiency use is higher than in surface water developments.

>> Neither surface water nor groundwater users pay the indirect costs (externalities).



# Sustainability and social issues

- The sustainable use of aquifers should be considered in a wide context of space, time, scientific status, available technology, and social development.

It happens that:

- Most aquifers may be sustainably developed when they are part of schemes of integrated water resource development.

- The most serious obstacle to sustainable development of groundwater may be poverty.

It happens that:

- Intensive use of groundwater may effectively help to alleviate this poverty.
- Well-documented cases in which intensive development of groundwater has been the cause of a return to poverty, or has generated serious social problems, are rare.
- Serious problems frequently quoted from groundwater development mostly refer to extremely poor areas, in which real problems are of other nature, like often illiteracy, authoritarian rule, social inequality or corruption.

- Catastrophic consequences from intensive aquifer development described in some papers usually lack reliable data and serious analyses, and often present unreliable predictions of future situations as if they were a reality. Actually, in many cases, economic and social improvements due to groundwater development have permitted coping with some negative effects, and even aquifer and environmental restoration have been made possible.

>> A major threat to sustainable aquifer use is the deterioration of groundwater quality.

Yet:

- This deterioration may be – and is often – unrelated or only weakly related to intensive use of groundwater.

>> Intensive use of groundwater is a relatively new phenomenon, not much older than half a century, and often only a couple of decades old. Therefore, it is hardly surprising there is such a prevalence of current misinformation, pervasive 'hydromyths', and even the absence of opposed realistic viewpoints.

- This is a useful stage towards maturity, following a path that tends to sustainable development.
- The way forward to this maturity may be speeded up if technology transfer is improved.

# Management and institutions

- Intensive use of groundwater needs adequate management as a necessary step to sustainability. This means:
  - An institution or coordinated institutions to deal with management issues, technically sound, and with the human, economic and legal means to carry out their job.
  - Effective participation of all aquifer stakeholders in management - including non-landed parties- under clearly defined rules and with some shared powers for control and monitoring.
  - A clear definition on who are the stakeholders.
  - Adequate legislation and norms, and means to enforce them.
  - A sufficient public awareness and education on existing issues.
  - Data and monitoring, with results that are publicly available.
  - Specific research and technological activities directed to local issues.
  - The means to fight vested interests, abusive privileges, hidden monopolies and illegal actions.
- Management should include social, cultural, economic and environmental concerns besides hydrological ones, in a balanced form. This means:
  - Both quantity and quality aspects should be considered with adequate emphasis.

- Over-stressing or neglecting some aspects will prove in the long term disfunctional to social and economic stability.
- Management may include transfers of water, rights or land between competing users.
- Management should be accomplished to ensure the survival of the flow of services aquifers provide.

➤ Water regulations have been the primary tool used for surface water allocation in most countries, and often their ambit have been extended to groundwater.

Public participation in water management is not a new concept, although in many cases it is often limited to certain interest groups or to certain stages of the management process. So participation is not truly effective. In general, it is possible to distinguish three phases in the evolution in public participation programmes.

- i. Public participation is understood in a very limited sense, as a need to educate and inform the public on management decisions. This is not true participation, but rather an unilateral communication. Therefore the public has no possibility to influence the decision-making process.
- ii. Communication between management agencies and the public is bi-directional. Public opinion can, to a certain extent, influence management decisions. While the process is more participatory it is still the public sector that controls the decision-making process.
- iii. True participation occurs: management agencies move from informing the public and receiving their opinions to actually deciding with the public. The effort required from management agencies is significant, as are the possible resulting risks. It is at this stage that it becomes necessary to design conflict resolution mechanisms with the goal of reaching solutions that are acceptable to all. This process requires more effort and is time consuming, but the implementation of the mutually agreed-upon plans will be significantly easier.



>> Stakeholder participation and involvement cannot be effectively improved top-down, but it has to grow from the roots.

This means that:

- Water stakeholders should be convinced that there is an individual benefit to participating in the management of a common groundwater resource.
- Information must be shared and open to any one.
- Management should be transparent.

>> Groundwater management should be carried out within a medium and long-term water plan framework.

However this water plan should be:

- Flexible to consider uncertainty and adapting and evolving with changing circumstances.
- Transitional to allow time to adapt to major changes.
- Democratically agreed on by water stakeholders.
- Appropriate to local circumstances.
- Based on realistic water rights that fit what is needed to get groundwater use efficiency and promote confidence in its use.

>> Groundwater management should apply the subsidiarity principle: activities that can be adequately carried out at a lower administrative and territorial level should not be done at a higher level.

# Information and education

- » Information and basic knowledge have to be presented in a form that is both easily understood and easily accessible to all interested people.

This should be done by means of adequate means such as printed documents – posters, brochures – videos, seminars, conferences, interpretative centers, and any other means that helps in the understanding and the diffusion of information and knowledge. This should also include nowadays the use of Internet, co-existing with more conventional means.

It should be taken into account that:

- experts in communication should advise;
  - primary and secondary school students are preferential targets;
  - teachers should have adequate teaching materials.
  - the media, which play a crucial role, have to be provided with the educational means.
- » Groundwater hydrologists should make an effort to convey essential hydrogeological concepts and facts to the public in a palatable and easily understandable way.
  - » Information and education is mainly the responsibility of water management agencies, which have to provide means and resources.

- >> Non governmental organizations (NGO's) have an important role in diffusion.
- >> Special attention should be given to explain to managers, policy makers and stakeholders the special characteristics of groundwater that explain its advantages, but also why and how groundwater responds slowly and the long-delay to external influences and contamination.

This means:

- Giving examples in which the long time scale is shown.
- Convincing on the need for monitoring, looking for early warning signals, and long term planning.
- >> Effective stakeholders' participation can only take place if there is a concerted effort to inform and educate the public.
- >> The media should receive realistic information on the benefits and problems of intensive use of aquifers and not only on the negative aspects.
- >> To increase the knowledge about intensively developed aquifers and fill the existing gaps, it is suggested that:
  - A compilation of documented case histories is prepared, covering the most frequent scenarios, which besides conventional hydrogeological contents should include analyses on the ecological, economic, institutional, social, legal and political factors related to groundwater development.
  - An inventory of intensively exploited aquifers is prepared, with a summary on socio-economic impacts, an economic analysis, and an evaluation on sustainability.



- Periodical reports are elaborated (for instance every three years) on advances on the understanding and evolution of intensively exploited aquifers.
- An exchange of information takes place among a network of interested institutions.

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## **Groundwater in the UNESCO International Hydrological Programme (IHP)**

The UNESCO engagement on Water Resources started as the International Hydrological Decade (IHD, 1965–1974) and was followed by the International Hydrological Programme (IHP) in 1975. Since its inception particular focus was given to Groundwater Resources. Much progress has been achieved regarding methodologies for hydrogeological studies and training and education in groundwater resources.

In the development of its various phases, IHP has gone through a profound transformation from a single discipline to a multi-disciplinary programme. Recently, with the increased presence of the social science component, IHP has become a truly interdisciplinary programme, capitalizing on the recognition that the solution of the world water problems is not just a technical issue.

The sixth phase of IHP, covering the period 2002–2007, is planned to be devoted to 'Water Interactions: Systems at Risk and Social Challenges'. The IHP VI Groundwater Component will centre on 'Groundwater Resources Sustainability and Conservation'.

UNESCO through its Division of Water Sciences provides the Secretariat for the IHP Intergovernmental Council/Programme.

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