NOTES

WATERSHED DEVELOPMENT AND MANAGEMENT - A MOVEMENT SEEKING INPUTS IN EARTH SCIENCES

Background

Land-use intensification in India has been very rapid especially over the last two decades or so. A significant fallout of this land-use intensification has been the increasing use of water for agriculture and related activities.

The increase in water-use has obviously affected both surface and groundwater supplies to a large extent and many areas of the country are clearly showing tell-tale signs of acute water crisis. Some apparent effects include small streams becoming seasonal, phreatic aquifers showing signs of water table decline and deeper aquifers showing reduced and uncertain yields. All these effects, in turn, have resulted in the users resorting to extreme measures like sinking deeper wells and drilling deeper bore wells and tube wells to catch falling water levels and augment uncertain water supplies thereby. The way out of this ever-increasing water crisis is simply to limit the extraction of water to a "sustainable" level first and to build in a buffer for this sustainable level through measures like watershed development and management which include the important component of augmenting groundwater recharge. Easier said than done, of course, but there ought to be a systematic beginning to this process right away. The implementation of limiting water-use itself is a multifaceted problem and has been discussed and dissected at various forums in the country. The solution that have emerged from such discussions have been restricted to attempting regulation and control over water-use (especially groundwater) through formal legislation - again rendering implementation of measures rather difficult.

Watershed Development and Management

Watershed projects offer ample opportunities to address some critical socio-economic issues pertaining to the rural scenario in the country today. However, the development, and more importantly, the management of a watershed as a physical system still leaves a lot to be desired. This problem essentially stems from an incomplete and often improper understanding of the physical system which hosts and carries water – surface or groundwater. The control parameters for a watershed as a physical system are geological, geomorphological, hydrological and hydrogeological which, on a scientific basis, are hardly considered during the planning and execution of most watershed projects.

It is a well-known fact that groundwater forms a very crucial source of water supply in the national scenario on water resources today. And yet, it is a resource that is grossly abused. Many watershed projects in the country still suffer from insufficient inputs (especially hydrogeological) to address the problem(s) of groundwater from within the watersheds. All watershed programmes must therefore include a study on groundwater balance and the changes occurring in this groundwater balance within each watershed so that within the next few years, there will be a good database on the hydrological and hydrogeological aspects from within watersheds. Such databases will not only enable a better understanding of the problems of groundwater in many areas but will make policy decisions on groundwater easier and practical. In other words, these databases can be used to streamline the watershed movement which will evolve into a platform to formulate better water management practices all over the country.

Mapping the hydrology and hydrogeology

Watershed maps in the country today carry many themes like land-use patterns, change in vegetation types, geometry of drainage courses, mapping surface water bodies etc. The one theme that is conspicuous by its absence from among such maps is the "hydrogeology of the watershed or catchment". A simple hydrogeological map can be prepared on the basis of remote sensing and other tools that are easily available today, backed strongly by detailed field inventories (which are rendered easier due to the relatively smaller areas covered by most watershed projects). Simple field exercises which include water-level monitoring, logging of existing and new wells, base-flow monitoring etc. can reveal many details such as recharge-discharge scenarios, short and long-term trends in water-level behaviour and, most significantly, help conceptualize the nature of groundwater systems within the watershed after integrating water-level data with other geological information collected during the course of the field inventories.

Characterising the groundwater regime

Groundwater is a very fragile resource in most areas of the country today. Thus, to establish the level of sustainability of groundwater resource from a watershed, it becomes imperative to realise the geometric framework within which groundwater accumulates and moves. Once the groundwater regime has been defined on the basis of watershed mapping, it is useful to characterise the groundwater system(s) from within the watershed. Pumping tests and their appropriate analyses can be used to characterise the aquifers and determine the yields or productivities of wells and well-groups.

Parameters established through the analyses of pumping test data can perhaps form a sound basis to plan well-use; in simple words, an understanding of the distribution of the storage and transmission attributes within the aquifers of the watershed can provide information on how best to use wells and schedule irrigation for areas within the watershed so as to achieve management of the available water resource. Therefore, "community sharing of groundwater as a common resource" through a group of wells tapping the same aquifer can constitute a unique experiment within all watershed programmes, bearing in mind that a detailed hydrogeological study forms a prerequisite for any such experiment.

One ought to be very careful in planning the development and deployment of groundwater resources in watershed programmes. A common paradox in many watershed programmes is the encouragement of further development of groundwater under the excuse of having executed recharge measures within the watershed. Without a proper understanding of the physical system, this development may actually result in overuse of the already fragile resource.

Impact assessment

Any watershed programme can be said to bring about some form of improvement or another to the catchment area. Having said that, it becomes imperative to judge for oneself whether watershed measures have proved "technically beneficial" in terms of the sustainability of water resources within the catchment. The benefits, vis-à-vis water, can be either in the form of an overall augmentation of water resources from within the watershed, increase in recharge to groundwater, additional scope for water resources development to support large agricultural land-use, improved water-use measures or an improvement in the water balance between the input to and output from the water resources systems.

A hydrological and/or hydrogeological validation or "technical audit" of the watershed can clearly answer queries on the benefits to the water resources systems (and particularly to groundwater). It is quite possible that a watershed may have immensely benefited from the socio-economic angle but might continue to be in a hydrogeological imbalance, watershed works may

have encouraged an indirect overdevelopment and consequently an overexploitation of the aquifers. To understand and mitigate such fallouts, "monitoring" becomes imperative in any watershed project. This monitoring can be planned to encompass three phases of any watershed programme:

- Pre-watershed development – to understand the status of water resources and water resources development
- Syn-watershed development – to establish a continuity between pre- and post-watershed time-frames
- Post-watershed development – to ascertain the changes in the water resources regime after watershed measures have been executed and arrive at some conclusions as to the benefits accrued through such measures.

Watershed monitoring will streamline the watershed movement further because such monitoring will provide "real-world" pointers on the extent of benefit which the measures have brought about. Sustainable development of water resources cannot be achieved through deployment of additional water within the catchment alone; sustainable development will be possible only after the total water resource available at any time is managed systematically within the framework of the watershed – both Natural and Socio-economic! Earth sciences form an important medium for such monitoring and must therefore constitute an integral part of every watershed programme.

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MAKE HYDROLOGY AN INTEGRAL PART OF EARTH SCIENCE STUDIES

Please refer to your editorial entitled "Dying Wisdom" and a note entitled "Make Hydrology an Integral part of Earth science studies" in the April, 1998 issue of your Journal. I have noticed that in recent years the Journal of Geological Society of India is publishing increased number of research papers on topics related to groundwater. I feel elated to note this as I happen to be a hydrogeologist/groundwater hydrologist. However, through your Journal, I wish to make it clear that lately there is a tendency amongst geologists to dilute the science of hydrology. Though the discipline of Hydrology is one of the principal activities of American Geophysical Union (USA) but we have to take note of the fact that groundwater hydrology is simply one branch of hydrology. So it would be almost impossible, technically, to incorporate 'Hydrology' as an integral part of Earth Science studies. Yet, groundwater hydrology can be imagined to form a part of Earth Science studies without much dilution.

As I have been involved in teaching of Groundwater Hydrology, Geohydrology and Hydrogeology to postgraduate students of Hydrology and Earth Sciences for over two decades, I genuinely feel that it would be feasible and logical to include only groundwater studies as a part of Earth Science Teaching Programmes. However, other branches of Hydrology like Water Resources Planning, Watershed Management, Surface Hydrology, Flood Forecasting and Water Conservation being equally important, may not be included in Earth Science studies due to their vastly different nature. Yet, these important subjects cannot be ignored.

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