WATER MANAGEMENT IN POLICY PERSPECTIVE FOR RESOURCE USE IMPROVEMENT

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ABSTRACT

The world's fresh water resources are unequally distributed both in time and in space. Until recently water resource management is focused on reallocating water to when and where it was required, a supply-side or fragmented approach. Nowadays, there are provened signs that water resource availability is dwindling due to both population growth and increased per capita water use which in turn result into the ecosystems damage. To face this challenge a new holistic approach is needed.

This paper describes a holistic approach which includes the *'Integrated or Conjunctive Use of Surface and Groundwater Resources'* and takes account of social, economic and environmental factors. The approach also recognizes the importance of water quality issues as health is a direct related concern. Moreover, in this context, the paper further examines in brief the aspects and problems concerning with the planning, design, construction and management of conjunctive use of water resources so as to achieve the ultimate target of sustainable development. The importance and role of research and development in technology transfer, institutional strengthening, effective partnerships between governments and stakeholders, and sound financial frameworks are examined to improve the enforcement mechanism. Finally, the challenges and benchmarks for future actions that the scientific community and planners have to face and deal with are briefly outlined.

Key Words: Groundwater management, Sustainable development, Resource planning, R&D institute, Enforcement mechanism.

1.0 INTRODUCTION

The growing needs of the population world over and improper use of water resources increases, environmental vulnerability too. In this context, mismanagement of water resources, paying only lip service to the environment, has led to water scarcity and water pollution which has threatened security and the quality of human life in recent decades. Giving disregard to this unsustainable trend, various water management forums acknowledged the pivotal role that “integrated water resource management” plays in the process of sustainable development. The term “integrated” embraces the planning and management of water resources, both conventional and non-conventional, and of land. It takes account of social, economic and environmental factors and comprehends surface water, groundwater and the ecosystems through which they flow. Moreover, it recognizes the importance of water quality issues too.

2.0 CONJUNCTIVE USE OF SURFACE AND GROUNDWATER

The Concept

A critical problem that mankind has to face and cope with is how to manage the intensifying competition for water among the expanding urban centers, the agricultural sector and instream water uses dictated by environmental concerns. Confronted with the prospect of heightened competition for available water and the increased difficulties in constructing new large-scale water plants, water planners must depend more and more on better management of existing projects through basin-wide strategies that include integrated utilization of surface and groundwater. Todd (1959) defined this process as “conjunctive use”. Lettenmaier and Burges (1982) distinguished conjunctive use, which deals with short-term use, from the long-term discharging and recharging process known as cycle storage. Until the late nineties, planning for management and development of surface and groundwater were dealt with separately, as if they were unrelated systems. Although the adverse effects have long been evident, it is only in recent years that conjunctive use is being considered as an important water management practice.

In general terms, conjunctive use implies the planned and coordinated management of surface water and ground water, so as to maximize the efficient use of total water resources. Because of the interrelationship existing between surface and sub-surface water, it is possible to store it during critical periods the surplus of one to tide over the deficit of the other. Thus, groundwater may be used to supplement surface water supplies, to cope with peak demands for municipal and irrigation purposes, or to meet deficits in years of low rainfall. On the other hand, surplus surface water may be used in overdraft areas to increase the groundwater storage by artificial recharge. Moreover, surface water, groundwater or both, depending on the surplus available, can be moved from water-plentiful to water-deficit areas through canals and other distribution systems. Conjunctive use allows the utilization of saline or brackish ground or surface water resources, either by mixing them with freshwater, or by using alternate water resources for irrigation events. On the whole an integrated system, correctly managed, will yield more water at more economic rates than separately managed surface and groundwater systems.

In conjunctive use, the two most important issues that planners have to face concern is the storage of surplus water and the optimal allocation of water withdrawals. With regard to the first problem, a question that needs to be answered is where to store water and which reservoirs to develop: surface or subsurface? Sub-surface water storage offer several advantages over surface storages but has some constraints too. More research is also needed on optimum management of **storage systems.**

Related to the surface water storage is the **"reservoir management"**. The critical elements considered in this context, is the *storage losses due to sedimentation* which can be managed easily by engineering management approach.

Linked to storage is the **optimal allocation of water withdrawals** / **releases**. Heightened competition for withdrawals, increasing in-stream flow regulations, compelling groundwater quality issues, along with environmental concerns, lead to the formulation of permitting programs and the establishment of regulatory agencies aimed at coordinating and controlling water resource allocations.

The current trend in **aquifer management** focuses on determining the maximum and minimum water levels, in order to regulate storage capacity. As a matter of fact, uncontrolled overexploitation causing progressive drawdown below the minimum permissible piezometric levels, will lead to increased pumping costs, land subsidence, infiltration of poor quality water, drying up of springs and shallow wells, decreased river flows.

Moreover, in **coastal aquifers management** the prolonged reduction of freshwater flow towards the sea reduces the equilibrium gradient, inducing saltwater intrusion and the inland movement of the freshwater – saltwater interface. Combining so many aspects requires methods of analysis that systematically integrate them in such a way that within the planning process alternative solutions can be defined, tested and chosen.

Normally **artificial groundwater recharge** is accomplished by means of infiltration basins or injection wells. Other techniques for augmenting subsurface supplies include vegetation management, runoff inducement and increasing seepage from streams by widening the wetted perimeter of channel sections or lowering the groundwater table in the flood plain.

Water quality aspects play a major role in this process. They mainly concern the quality of recharge water and its effects on groundwater quality e.g. "Water Factory 21" plant in Orange County (California), where wastewater undergoes an advanced treatment process before being injected into deep wells to create a barrier against seawater intrusion (Cline, 1983). Numerous issues need to be addressed before suitable recharge systems can be chosen, designed and managed for optimum environmental and economic performance. One problem is proper site selection, which requires field surveys and infiltration/soil hydraulic conductivity measurements to predict seepage rates etc.
To address the above-mentioned water management problems, the following should be considered and carried out:

- Detailed reliable and general groundwater surveys and in-depth studies to know the estimates of water quality and quantity and identification of the potential sites from ground water availability angle.
- Geo-hydrological investigations to establish aquifer conditions and behavior;
- Integration of the physical characteristics and conditions previously collected and analyzed, with economic and social parameters to formulate suitable strategies and policies for sub-surface water use, planning and management.

To face this challenge a new holistic, systemic approach, relying on conjunctive use of surface and ground water resources is needed. This system should be an integrated one to overcome the current fragmented management of water. Hence, the term "*Integrated water resource management" is evolved which* implies long-term planning and management strategies with respect to both water quantity and quality.

This new holistic approach entails system analysis and modeling, which requires the identification, analysis and evaluation of the interactions between all the components of water resource systems over space and time. These components should be integrated into a network or system involving relationships between humans and their institutions, nature and technology.

For such systems to be sustainable, they must interact smoothly with other social subsystems and adapt to changes and uncertainties in supply and demands. Multiple alternatives should be defined and evaluated with respect to overall system performance objectives. Managers and decision-makers have to consider a large number of often conflicting demands on the available water, and develop and operate water resource systems under numerous social, economic and legal, as well as physical constraints. In this context, the traditional approach whereby water resources development and management was a “government’s business” needs to be replaced by a participatory approach involving both governments and stakeholders at all levels.

Experience shows that **stakeholder participation must be genuine and not symbolic**, and that user associations must have a decisive role in the decision process as to what is done, how it is done and who pays for it. Experience also shows that partnerships between governments and stakeholders can be effective with governments playing a vital role in creating an enabling environment and in providing technical support and research thrust.

Economic constraints are equally important in water resource development. The cost of water system operation and improvement is normally tremendous, and governments, in this era of transition towards a market-oriented economy, will be unable to continue financing activities as they used to. The new philosophy is based on the principle that the services must be paid for by those who benefits from them. Sustainable development, as previously defined, requires a sound financial management framework in which the revenues from service provision cover the costs.

‘Conjunctive Use’ shall be promoted by institutional strengthening and proper financial assessment. This new philosophy is since based on the “user pays” principle an appropriate institutional and financial analysis in all phases of planning and water management is an essential pre-requisite.

3.0 INTEGRATED WATER RESOURCE MANAGEMENT

Integrated water resource management is a management that depends on co-operation and partnerships at all levels, from individual to governmental and non-governmental, national and international organizations sharing a common political, scientific and ethical commitment. To achieve this goal, there is a need for coherent national, regional or interregional policies to overcome fragmentation and for transparent and accountable institutions at all levels. Some focal policy points as regards with this are -

1. Water resources should be managed at both the river basin and aquifer levels.

2. The management framework should envisage a high level of autonomy for the body responsible for water use and planning, allow for stakeholder participation in decision-making and generate and disseminate information.

3. Where appropriate, specific river basin, catchment and groundwater authorities should be set up, and their capacities enhanced.

4. Where water is shared, actions should be taken to build confidence among riparian states, enabling them to accept some form of restricted sovereignty regarding their common resources, based on both equitable utilization and regional cooperation.

5. Besides institutional strengthening, sound and fair financial management, based on the "user pays" principle is needed to improve the efficiency of services, provide additional resources for investment, encourage demand management, and promote pollution control and prevention.

6. Water resource management should preserve or enhance the environment's buffering capacity to withstand unexpected stress or negative long-term trends.

Integrated water resource management is thus a management concerned with local conditions. It is an attempt to identify key issues deserving attention (O'Callaghan ,1996) and can be best addressed by policy initiatives. NGOs are the best tool for its implementation. The cumulative effect of *Integrated water resource management* is very positive and its effects are clearly visible soon upon implementation

4.0 RESEARCH AND DEVELOPMENT: ROLE AND THRUST

Research needs to be focused more effectively than in the past on planning and management problems of conjunctive use of surface and groundwater. This is the main way to provide planners and decision makers with suitable and well-tested technologies for targeted measures designed to enhance conjunctive use efficiency, while protecting the environment. The lack of research, application of research findings and access to new and advanced technology, is seen as one of the main reasons for the problems plaguing the sector. Successful research thrust on sustainable integrated water resource management should include the following actions:

- Data Base Improvement (Availability of reliable data)
- Decision Support Systems
- Modeling & Computer Use in Technology Improvement (simulation, optimization etc.)
- Sustainability Criteria (Devising various new approaches)
- Spatial Analysis Procedures [geo-statistic methods, remote sensing, geographic information Systems (GIS) and geo-informatics]

4.1 Role of R&D

Research must be directed towards solving water use and planning problems, gaining a better understanding of the hydro-dynamic and hydro-chemical processes involved. Action oriented research should cover field and laboratory evaluation, assessment and monitoring, development and implementation of suitable water management strategies. This process requires enhanced basic and applied research and a large variety of tools ranging from field techniques to advanced technology for water control and regulation such as models, Remote Sensing, Geographic Information Systems, Decision Support Systems and spatial analysis procedures. All these tools have to be considered under a broad and integrated approach for addressing the use, planning, conservation and protection of both surface and subsurface water resources, that takes proper account of the environmental impacts and socio-economic effects of development.

4.2 Thrust on Improvement in Enforcement Mechanism

In context to India low efficiency, lack of beneficiary responsiveness, inappropriate penalty procedures and vagueness of laws, slow judicial procedure and politics reduces water management productivity. This in turn leads to higher environmental degradation, high costs and ineffective enforcement. If these points are adequately addressed at multiple level of state and federal policy it helps in improving the state-of art of water management and use. To enhance or increase the "**Enforcement Mechanism",** better infrastructure at various institutional levels is needed. Since water management affects the common man directly or indirectly, honest attempts and positive mindset of people involved will fuel the attempt of improvement in enforcement mechanism, author feels. In policy perspective, the resource use improvement is a multilevel challenge. However, some key challenges for future, which have long term benefits, are listed in next sub-section.

4.3 Mining Industry and Water Management

Mining is an industrial activity which is capital intensive, large in size and generally studied in relation to environment. Surface mines, vital these days for raw material production are important because they changes the hydro-dynamics of both surface and groundwater system considerably. There is plenty of evidences world over and all across the mineral industry that active mines cause negative impacts. The effect of these changes is more noticeable in areas where the mine is located closer to the habitats. Unchecked mining can cause water contamination and other environmental problems e.g. water level decline or drawdown, drying of springs, water sources etc. Therefore, water management in mines and mine water issues are important from future perspective. A new concept of "Reliable Mine Water Technology" has emerged in recent years which needs policy attention with a view to prevent damage to water resources and also to minimize negative impacts on the environment (Brown, 2010). The role of the mine management to manage water properly becomes extremely important as gone were the days, when water was a free and easily available resource. Besides statutorily compliance more needs to be done in mining industry for water management to make effective and judicious use of water.

5.0 CHALLENGES FOR THE FUTURE

Future technology options are linked to the technical know-how available. Hence, infrastructure and research capabilities should be developed through research. Some important areas are as given below. They could be from the arena of R&D or infrastructure sectors.

- Groundwater management, monitoring and remediation (overexploitation, water table lowering, water deficit and pollution).
- Conflict resolution in water management.
- Water resource management under climate change.
- Rainfall / Runoff processes and modeling.
- Modernization of existing infrastructure capabilities.
- Computerization of water related databases.
- Steady and continuous implementation of plans for effective resource use

6.0 CONCLUSIONS

To ensure sustainability, water resource systems need to be planned, designed and managed is such a way as to fully meet the social objectives of both present and future generations, while maintaining their ecological, environmental, and hydrological integrity. This imposes constraints on every stage of development from project planning to final operation and management. In the strive for sustainable development in water resource use and management, the effectiveness of any instrument devised to realize a goal, depends ultimately on two factors namely the approach adopted and the quality.

Only the holistic and systematic **INTEGRATED APPROACH & CONJUNCTIVE USE** outlined herein seems to be capable of providing a deeper understanding of the behavior and evolution of surface and groundwater systems. This approach will also design strategies for maximizing the efficient use and management of available water resources, while preserving or enhancing the buffering capacity of the environment against unexpected stress or negative long-term trends.

It is essential, on the other hand, that engineers, economists, ecologists, planners, along with stakeholders, user associations and all sectors of society must be involved in the decision making process. Failure to do so will increase the risk of opposition to projects even once they have been designed or constructed. Successful collaboration with an informed and attentive public can lead to more socially compatible uses of water resources and to more creative, appropriate, and hence sustainable uses of technology for addressing community or regional water resource problems or needs.

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