Institutional intervention in River Water Management: the Study of Yamuna river sub-basin in India[1]

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Abstract

Water is a primary resource for several human activities, and rivers are a major source of water in several parts of India. Unfortunately, rivers also becoming a major sink of wastes that flow into them. River water management is an important area of natural resource management that crosses several disciplines, and, in order to be more effective, it requires public intervention through appropriate institution and an action plan approach. River water authority is normally set up for assuming the managerial function of river water administration (mostly at regional/ basin level), particularly with regard to the sharing/allocation of river water. The allocation of river water in itself is a contentious subject, especially when it flows through several states; a similar problem arises now with regard to its pollution across them.

This paper makes an attempt to highlight the status of water of an inter-state river (river Yamuna), and discusses the need for establishing an exclusive administering agency for ensuring better river water quality and quantity. It first analyses the critical state of Yamuna river water resource in the past and the impending need for public intervention; the use of economic values of water as one of the guiding principles of prioritization and allocation of water to uses and jurisdictions is also discussed. It also takes stock of the performance of the implementation of Yamuna Action Plan (YAP) as an institutional approach towards river water management, and attempts to identify the alternate institutional arrangements and appropriate policy instruments for achieving the objectives within a broad management framework.

Key Words: River water management, water pollution, public intervention, economic valuation, institutional mechanism

1. INTRODUCTION

Environmental problems have been emerging across the world at various levels, to different extents and in different forms. Often, this is generally attributed to the rising human population, urbanization and economic activities. These exert pressure on environmental resources as well as result in the damages to ecosystems, upon both of which future human sustenance rests. Water resource is one such natural resource that has been coming under severe pressure, thanks to human population growth and economic activities, which prompts some social scientists to warn that in the coming years we may experience more wars on water at local to global levels. Riverine water resources, in particular, are becoming vulnerable to quantity decline (with shrinking influent water) and quality degradation (with rising wastewater discharges) due to

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human activities, more so in a country like India, which has as many as fourteen rivers and several cities alongside them. River water sources are increasingly coming under the threat of getting reduced to carriers of water of extremely poor quality in several stretches, particularly along the major cities wherein domestic and industrial wastewater enters them to a great degree.

Water is a primary resource for several human activities, and rivers are a major source of water in several parts of India. Unfortunately, rivers also becoming a major sink of wastes that flow into them. River water management is an important area of natural resource management that crosses several disciplines, and, in order to be more effective, it requires public intervention through appropriate institution and an action plan approach. River water authority is normally set up for assuming the managerial function of river water administration (mostly at regional/ basin level), particularly with regard to the sharing/allocation of river water. In India, they are set up in the form of Boards to undertake this function. The allocation of river water in itself is a contentious subject, especially when it flows through several states, as each State has its own criteria of arguing for better allocation to itself. Fixing water allocation among different areas and people itself has been a contentious issue with large political agenda attached to it. A similar problem arises now with regard to river water pollution across the States. Here, the challenge is not that of water distribution but burden-sharing of pollution treatment and river water quality maintenance, which also involve coordinated and co-operative action in order to be effective.

1.1 Rationale for Public Intervention

River water management therefore involves balancing of water quantity and quality through appropriate policy instruments. Although independent actions of individuals can make some difference, public intervention through appropriate institution and policy mix is more effective than individual level action towards river water management for various reasons:

- First, most of the resource management problems are due to the public goods nature of environmental resources and the associated externality problems i.e., resources are shared by several and their consumption leads to some unintended effects. In the case of common property resources, in particular, externality, free ridership, and disincentives all lead to misuse of resources rather than their optimal use. Under such conditions, no incentives exist for individuals to organize their actions to avoid or minimize the externality effects of their actions. The lack of incentives may arise from institutional constraints or economic rationality.
- Second, the regulation of use and maintenance as a trustee of planet earth and its ecosystems is desirable and lack of it leads to, quite often, non-compliant or free-riding behaviour, which in turn exacerbates the resource degradation and decline, resulting in what is popularly known as *Tragedy of Commons*. Therefore, sustainable resource use requires their management through policy making for conservation, monitoring of resources and ensuring the compliance from the behavioural changes brought-in. An exception is when monitoring and compliance are either costly or not practical, in which case getting a correct regime of property rights of environmental resource use has theoretical possibility of delivering better given the risk of high establishment costs of monitoring.
- Finally, the conflicts among various user groups with regard to their rights of use (over abstractive and in-stream water uses), especially when river water flow changes over space and time, calls for an agency that balances these interests in setting the allocative criteria of water to various uses. This is so when the consumptive uses e.g., drinking and irrigation, tend to prevail on non-consumptive uses e.g., recreation, navigation and environmental, and when there is uneven balance of river water quantity and quality in upstream and downstream areas.

2. PUBLIC INTERVENTION STRATEGIES

When it comes to the formulation of policy in case of river water, a multitude of factors comes in to picture. Often, policy maker is confronted by the various operational aspects of water management, complementing and conflicting, to be covered by the policy. Here, instead of allowing such confusion to prevail, the policy maker needs to understand the body of policy making in order to formulate appropriate strategies to implement policy. For formulating such strategies, policy maker needs to pose few questions first pertaining to effectiveness, goals, monitoring, evaluation, and review of policy, which are discussed hereunder. Here, public participation of various forms is essential at all levels. The body of policy making consists of:

- Formulation of goals and objectives
- Analysis and Design of strategies
- Monitoring and Review of outcomes

2.1 Goals

Goals are possible questions that the policy maker is concerned about in the policy. Water resources management has physico-chemical, engineering, biological, socio-economic, and even psychological dimensions. Often, professionals in these disciplines pose questions. However, given the constraints of resource scarcity, only few of these questions could be stated as goals of the policy. While setting goals, it is important to give attention to whether some questions have already been covered by other policies in order to avoid confusion that the policy may bring out. Further, a goal that transcends more than one discipline will be more effective than the one which is narrowed to a discipline. However, it has to be taken with caution that the goal is not too generic, as it becomes more difficult to assess its effectiveness at a later stage. Hence, the goal needs to transcend one discipline, but shall remain focused in structure. When there are multiple goals, they need to be prioritized to identify the key goal (s) that should be addressed first. Such prioritization can be done using various operations research methods. Finally, goals should not overlap or counteract each other, if so, some conflict resolution mechanism or goal priority setting needs to be resorted. *In the case of water resources policy, often improvement in water quality or quantity with improvement in net social payoffs is the common goal.*

2.2 Effectiveness

The effectiveness of policy will be more when it is made with little or no ambiguity i.e., when it is well specified and clearly stated. Besides statement, the effectiveness of policy is also determined by the understanding of the operational system (monitoring, evaluation, implementation, and taskforce), and there might be some inherent problems that necessitate very different approach. For example, the control of point Vs non-point source pollution (2). When controlling of one or a few pollutants based on specific and identifiable sources of pollution, mostly based on the regulatory policy instruments and supplemented by litigation and penalties, is the policy objective, it is effective in case of point source pollution; and it is more difficult to do so in case of non-point source pollution[2]. River water is confronted by both point and non-point source pollutants. Hence, the policy shall target only one of them first in order to make it effective to control water pollution. Further, the policy effectiveness can also be judged based upon how well the net social payoffs are maximized. This entails inclusion of any onsite (or private) benefits and costs, as well as offsite (or public) benefits and costs, of abatement policies.

Moreover, in addition to increasing net payoffs, policy goals may be set to include attainment of social equity, societal acceptability, and administrative feasibility.

2.3 Monitoring

The issue of monitoring relates to the capacity to enforce and measure the effectiveness of the policy, which renders to a more pragmatic dimension to policy making. The choice of policy making also depends on the strength of monitoring. Policies involving monitoring of pollutant in trace amounts requires considerable equipment and effort, and thus, increase the cost, whereas, measurement of a more common representative pollutant avoids it. A typical example is reducing trace metal pollutants in water. Policy to control them will require monitoring on a large scale across the river water and its analysis, whereas policy that aims at reduction in a parameter like BOD requires measurement at regular intervals and thus can be monitored effectively.

2.4 Evaluation

Evaluation refers to the assessment of policy intervention in tangible/deducible terms, so as to decide whether the policy is efficient and economically sound. Evaluation is necessary because, public policy renders public investments made in monitoring and execution. Benefit-cost analysis is widely used for evaluation of projects, plans, and recently policies (3). Thus, measurement of benefits and costs (both, onsite and offsite) becomes crucial in identifying whether the policy is effective in attainment of stated goal. Targeting conservation or abatement situations that provide best use of scarce funds (resources) also requires public benefits be carefully identified and measured for each situation. This, in turn, entails evaluation of a number of different physico-chemical, engineering and socio-economic variables using a comprehensive methodology with multidisciplinary approaches.

3. RIVER YAMUNA

River Yamuna is one of the major rivers in India and also a major tributary to river Ganges, the largest river in India. Both of these rivers cater to the vital human needs of the states in North India. River Yamuna originates from Yamunotri in Himalayas and traverses through Himachal Pradesh and Uttaranchal in the upper stretch of 200 Km drawing water from several major streams. It enters the plains at Dak Pathar in Uttranchal, where the river water is regulated through weir and diverted into canal for power generation. It then reaches Hathnikund/Tajewala in Yamuna Nagar district of Haryana state, where the river water is diverted into Western Yamuna canal and Eastern Yamuna canal for irrigation. During dry season, no water is allowed to flow in the river downstream to Tajewala barrage and the river remains dry in some stretches between Tajewala and Delhi. The river regains water because of ground water accrual and contributions of feeding canal through Som nadi (seasonal stream) upstream of Kalanaur. Figure 1 shows the river Yamuna and its course until it meets river Ganges at Allahabad.

River Yamuna enters Delhi near Palla village after traversing a route of about 224 Km. The river is again tapped at Wazirabad through a barrage for drinking water supply to Delhi. Generally, no water is allowed to flow beyond Wazirabad barrage in dry season, as the available water is not adequate to fulfill the demand of water supply of Delhi. Whatever water flows in the downstream of Wazirabad barrage is the untreated or partially treated domestic and industrial wastewater contributed through several drains along with the water transported by Haryana Irrigation Department from Western Yamuna Canal (WYC) to Agra Canal via Nazafgarh Drain and the

Yamuna. After 22 Km downstream of Wazirabad barrage there is another barrage, Okhla barrage, through which Yamuna water is diverted into Agra Canal for irrigation. No water is allowed to flow through barrage during dry season. Whatever water flows in the river beyond Okhla barrage is contributed through domestic and industrial wastewater generated from East Delhi, Noida and Sahibabad and joins the river through Shahdara drain. The Yamuna after receiving water through other important tributaries joins the river Ganga and the underground Saraswati at Prayag (Allahabad) after traversing about 950 Km.

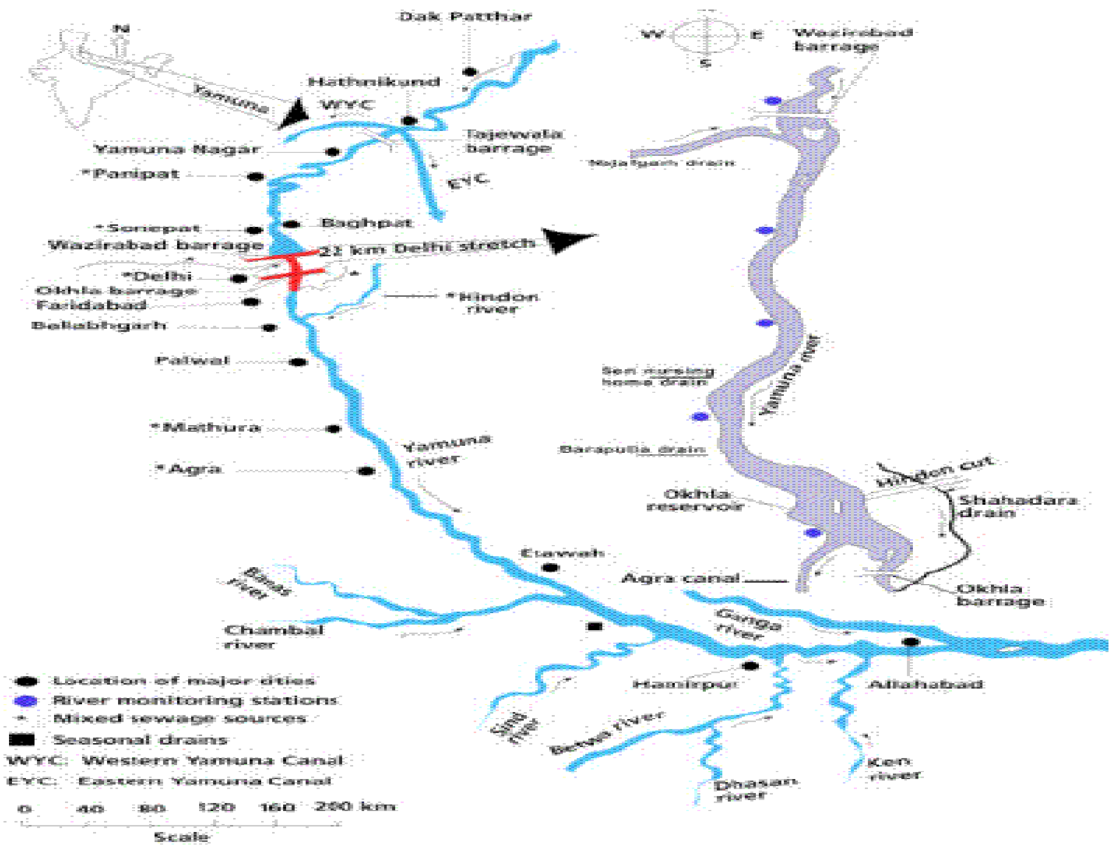


Figure 1 Location and traverse of river Yamuna

Yamuna river can not be designated as perennial river, as it flows very low in dry season (almost 9 months), but can be segmented into five distinguished independent segments due to characteristic hydrological and ecological conditions. The catchment of Yamuna river system covers parts of Uttar Pradesh, Uttranchal, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh & Delhi states. The tributaries contribute 70.9% of catchment area and balance 29.1% accounted for direct drainage into the Yamuna river or to the smaller tributaries. On the basis of area, the catchment basin of Yamuna amounts to 40.2% of the Ganga Basin and 10.7% of total land mass of the country. River Yamuna water has some key functional uses identified as:

- Irrigation
- Drinking water
- Bathing water
- Livestock use
- Navigation
- Aesthetics and Recreation
- Religion and Culture

Irrigation is the major use with the net irrigated area in the basin has gone up from 47,000 sq km to 110,000 sq km during 1950-90, although there has been a shift from traditional canal irrigation to ground water irrigation (which is replenished by river Yamuna and rains) (Narula *et al* 2001). While extractive uses like irrigation have major share of water use in upstream States of Haryana and Himachal Pradesh, water for drinking and other domestic uses dominates in the middle stream States of Delhi and Uttar Pradesh. Further downstream, the stream uses like navigation, religious and aesthetic uses The population of the basin has grown from 51 million to 131 million at 2.4 per cent during 1950-1990 and Delhi, in particular, has grown at 4 per cent, while level of economic development in the basin is high and diverse (Narula et al 2001). Water use has risen from 1000 MCM to 4000 MCM during this period. Drinking water is the next most important use and the rising population discussed above reflects the rapid rise in domestic and drinking uses. Likewise, industrial use has also risen as a result of rapid rise in number of large and medium scale industries, which numbered to almost 10,000 by 1990s (Narula *et al* 2001). These uses are representatives of several functions that the river renders as a continuum of water. Besides acting as a supportive resource for use, river Yamuna also renders service as a sink by assimilating wastes originating from domestic, agriculture and industrial activities.

4. WATER QUALITY DEGRADATION IN RIVER YAMUNA

4.1 Water quality changes

Most of the water in the region is drawn from river Yamuna for various uses, predominantly for agriculture and drinking purposes, through various diverging canals in the upstream parts of the river basin. These uses draw good amount of water from river Yamuna. For example, the total water use in the capital, where drinking is the predominant use, was 1,027.84 mcm in 1992, which increased by almost 30% in three years to 1,330.04 mcm in 1995 (NEERI 1997). At the same time, the total water use in the basin, where agriculture uses a majority of water, was 44,926 mcm in 1992, which rose to by 10% to 50,437 mcm in 1995 (NEERI 1997). Such rapid rise in use by increasing drawal from river over years resulted in drastic reduction of river water to a level that the river cannot offer any services/ functions.

An important observation to be made is the reduction in annual river water flow from 10 mcm/y to 5 mcm/y (CPCB 1978). The low self-purification capacity of the river Yamuna is due to the want of minimum flow in the river and discharge of heavy municipal and industrial pollution load emanating from Delhi. Even though Delhi constitutes only 2% of the catchment of the Yamuna basin, yet it contributes to about 80% of the pollution load. There are 16 drains which discharge treated and untreated waste water/sewage of Delhi into the Yamuna. The municipal sector is the main source of water pollution in terms of volume. Approximately 1,900 mld of waste water is discharged from the municipal sector and 320 mld from the industrial sector. The installed capacity for treatment is 1,270 mld. At the same time, the existing capacity for treatment is not up to the desired secondary treatment level. Thus, substantial quantity of untreated sewage and partially treated sewage is discharged into Yamuna every day. The Najafgarh drain contributes 60% of total waste water and 45% of the total BOD load being discharged from Delhi into the Yamuna. The municipal waste water increased from 960 to 1,900 mld and treatment capacity enhanced from 450 to 1,270 mld during 1977-97 (NEERI 1997).

4.2 Water quality status

The effluents flowing into river Yamuna comprise municipal and industrial wastes. The Central Pollution Control Board (CPCB) monitors the water quality of Yamuna at the upstream of Wazirabad and at Okhla. Upstream of Wazirabad, the dissolved oxygen (DO) level is 7.5 mg/l and biochemical oxygen demand (BOD) level is 2.3 mg/l, whereas, downstream at Okhla, the DO level declines to 1.3 mg/l with the BOD at 16 mg/l, indicating considerable deterioration in water quality in the stretch due to discharge of sewage and industrial effluents (MoEF 2003). The stretch between Wazirabad and Okhla is designated as bathing quality standard in terms of its water use. The coliform count at Wazirabad is 8,506/100 ml whereas at Okhla, it increases to 3,29,312/100 ml, as against prescribed standard of 500/100 ml (MoEF 2003).

A healthy river should contain at least 5mg/l of Dissolved Oxygen (DO) and a maximum of 3mg/l of Biochemical Oxygen Demand (BOD) in its water. Pathogens or the disease causing bacterias indicated by faecal coliforms counts should not exceed 500 per 100 ml of water. When sewage or industrial effluents containing pollutants (organic matters) are dischaged into river, these draw oxygen from the river water for oxidation of organic matters. Continuous discharge of pollutants results in depletion of DO in river water adversely effect the flora and fauna of eco-system. Untreated sewage also contains pathogenic or faecal matters gives rise to disease causing bacterias in the river water. When people take bath in the river pathogenic bacteria get transmitted to the human body impacting on their health.

4.4 Water quality status

Accompanied by this, there is an increase in the wastewater flows into river Yamuna. Industry is the largest polluter; strong effluents of high pollutant concentration are discharged into it, while also, agricultural farm return flows and livestock use constitute yet another major source of pollution. Wastewater discharges in the capital alone have increased from 745.03 mcm in 1992 to 835.34 mcm in 1995 (NEERI 1997). The result is that the river no longer serves as a stream of water. The river clearly shows a declining trend of water quality measured on several parameters soon after it enters Delhi as shown in Table 1. The decline in river water flow and degradation of water quality of river flowing have effects varying from the loss of various services (including ecological services) rendered by the river in the stretch of NCT-Delhi to the negative effects on the public health due to contamination and spread of vector borne diseases.

Table 1: Water Quality in Polluted Stretch of River Yamuna
(Average values of three successive years 1995-97)

Location / Parameter	Talla (u/s Delhi)	Nizamuddin (Delhi)	Agra canal (d/s Delhi)
pH	8.2	7.6	7.6
DO	8.6	1.9	1.5
BOD	2.7	12.2	16.4
COD	25.6	50.2	60.9
TC	5878.0	319573.7	251568.0
FC	2529.3	220245.7	178326.0
TKN	1.1	919.0	13.4
WT	25.2	26.4	25.8
AMM	0.4	8.0	9.8

Source: Calculated from MoEF (2003)
DO = Dissolved Oxygen, mg/l
FC = Fecal Foliform,no./100 ml
BOD = Biochemical Oxygen Demand, mg/l

TKN = Total Kjeldahal Nitrogen, mg/l
COD = Chemical Oxygen Demand mg/l
WT = Water Temperature, °C
TC = Total Coliform, no./100 ml
AMM = Ammonia, mg/l

River Yamuna, over time, lost good use of several of its functions and reduced itself to almost a drain flowing through capital, thereby causing severe public health problems. In the Fifth State of India's Environment report of the Centre for Science and Environment, it was observed that the river has become more filthy, and it is a drain of waste water which chokes and dries up in summer. The major causes of river water pollution are urbanization, industrialization, withdrawal of water, agricultural runoff, and improper religious and social practices (CSE 1999). Likewise, the Central Pollution Control Board (CPCB) has also identified that the river flowing through capital has very low river flows and associated by it the water quality in the stretch is very poor for any direct use as evident in table 2 by the class of existing water quality vis-à-vis desired water quality. Table 3 shows the designated best use classes.

Table 2: Water Quality in Polluted Stretch of River Yamuna (1998)

Location	Desired class	Existing class	Critical parameters
Hathnikund, Haryana	A	B	E-Coli
Panipat, Haryana	C	C	
Wazirabad, Delhi, CPCB	C	C	
Okhla Bridge (Inlet of Agra Canal)	C	E	DO, BOD, E-Coli
Delhi			Ammonia
Mathura U/S, U.P.	B	D	BOD, E-Coli
Agra U/S, U.P.	C	D	BOD, E-Coli
Agra D/S, U.P.	C	D	BOD, E-Coli
Etawah, U.P.	C	D	BOD, E-Coli
Allahabad D/S, (Balua Ghat) U.P.	B	D	E-Coli
Hindon			
Saharanpur D/S, U.P.		E	

Source: Central Pollution Control Board

Table 3: Primary Water Quality Criteria For Designated-Best-Use-Classes

Designated-Best-Use	***Class of Water***	***Criteria***
Drinking water source without conventional treatment but after disinfections	A	1. Faecal Coliforms organism MPN/ 100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved oxygen 6mg/l or more 4. Biochemical oxygen demand 5 days 20°C 2mg/l or less
Outdoor Bathing (Organized)	B	1. Faecal Coliforms organism MPN/ 100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved oxygen 5mg/l or more 4. Biochemical oxygen demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and	C	1. Faecal Coliforms organism MPN/ 100ml shall be 5000 or less 2. pH between 6 to 9

disinfections		3. Dissolved oxygen 4mg/l or more 4. Biochemical oxygen demand 5 days 20°C 3mg/l or less
Propagation of wild life and fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2mg/l or less
Irrigation, Industrial cooling, controlled waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical conductivity at 25°C micro mhos/cm max. 2250 3. Sodium absorption ratio max. 26 4. Boron Max. 2mg/l

Source: Central Pollution Control Board

5. YAMUNA ACTION PLAN – A REVIEW

The CPCB Study (1978) indicated that a major cause of pollution was discharge of domestic wastewater into the river from nearby towns and habitations which contribute about two-thirds of the pollution load, the remaining one-third being contributed by industries and agriculture activities. Organic pollutants can be removed or minimised by proper treatment of sewage and treated sewage is required to be disinfected to kill the pathogenic bacteria before it is finally discharged into a water body. Based on the CPCB study and the subsequent studies of NEERI, the Government of India decided to take up pollution control measures for Yamuna river and requested the Government of Japan in December-1990 for a loan assistance for implementation of an Action Plan. It was proposed that the Yamuna Action Plan (YAP) would be on the lines of ambitious project Ganga Action Plan (GAP).

The Government of Japan sent a fact finding mission in 1991 to assess the contents of the YAP proposal and its suitability vis-à-vis actual site conditions. Based on the suggestions of the mission, the Japan Bank for International Cooperation (JBIC) decided to arrange for a feasibility study to be conducted through consultants appointed by it before agreeing to the loan. The feasibility study was conducted by the consultants in 1992. Yamuna Action Plan was launched in 1993 with the objective of improving the Water Quality of River and restoring it to the Desired Bathing Class. It was implemented in two phases:

- Yamuna Action Plan-I (YAP-I) was implemented by the National River Conservation Directorate (NRCD) of the Ministry of Environment and Forests in 21 toons since 1993. The JBIC provided soft loan assistance of about Rs. 700 crore for implementation in 15 of the 21 towns and GoI provided the funds for the remaining 6 towns. It focused on reducing the discharge of untreated domestic wastewater and other wastes into the river from the towns located along its banks.
- At the request of GOI, Government of Japan agreed to extend the loan for another two years from 2000 to 2002 and the project was termed as Yamuna Action Plan II (YAP – II). During the extended period, ongoing works would be completed along with some remedial works to enhance the effectiveness of the project.

Yamuna Action Plan was framed to prevent pollution of river Yamuna. Its main objective was to improve the water quality of river and restore it to the desired bathing class. It envisaged pollution abatement schemes in 21 towns of 3 states. Pollution from domestic sewage is tackled under Yamuna Action Plan, whereas pollution of industries is monitored and controlled under the existing environmental laws. The main focus under YAP is on:

- Laying of trunk & Intercepting sewers, for diversion of sewage outfall into the river

- Construction of Sewage Treatment Plants to treat the captured sewage
- Non point sources of pollution to be addressed by:
  - (i) Providing electric/improved wood based crematoria to minimize the river pollution on account of disposal of unburnt dead bodies
  - (ii) Constructing low cost toilets so that public resist from resorting to open defecation.

In addition, activities such as river front development, plantation along the river and public participation and awareness works have been taken up under the programme. The action plan had a strong focus on actions rather than activities that achieve the objectives in long term. Yamuna Action Plan is an intervention but it is executed as a project and with a focus, once again, was given to control of pollution by treatment of water, rather than, prevention of river water pollution. A dedicated institution that takes holistic approach to river water management is required here, which is a river water authority that takes stock of all activities that lead to improved river water management.

6. INSTITUTIONAL APPROACH TO RIVER WATER MANAGEMENT

River water authority (RWA), modeled on the lines of river basin authority, needs to be set up by Central government under the Central Water Commission to function independently but in coordination with State and Central government agencies in terms of ensuring the undertaking of the activities and monitoring the progress. The Yamuna river water authority shall take care of the river water quality and quantity by taking a regional approach and use economic approaches to policy making with wider stakeholder participation based on the scheme outlined and discussed later. The authority shall, thus, formulate goals, and set objectives, evaluate various options for water management, and evaluate them and their alternatives in a benefit-cost analysis framework using economic valuation as a major tool to measure, implement action plan using various policy instruments to bring in effective action.

6.1 Water quality improvement

Water quality is an important aspect of resource value and conservation of it needs to be justified through benefit-cost analysis. While measuring benefits and costs, public benefits appear as formidable to identify and measure, more so, when public policies are aimed at improving status of water resources - qualitatively or quantitatively. This is because of many biophysical, engineering, and socio-economic attributes that affect public benefits form such improvement. The attributes include (Stonehouse *et al* 1997):

a. existing water quality, according to a well defined criteria prior to implementing abatement policy
b. actual or planned uses of the water together with any standards or levels of quality associated with each use
c. the actual or potential number of users of water identified for each use
d. the extent of improvements in water quality made by the abatement policy
e. the value placed on the water quality improvements by the water using public, otherwise known as willingness of public to pay for water quality improvements

6.2 Water quantity allocation

The dry weather flow in the river Yamuna along Delhi is nearly zero, which resulted in almost total depletion of the self cleansing capacity of the river of Wazirabad (MoEF 2003). Pollution in river Yamuna cannot be controlled fully unless a minimum flow is maintained in the river. It is mentionworthy that sewage treatment plants are designed for reducing the pollution in sewage to a certain economically achievable level only. The rest of the pollution is controlled by the dilution available in a water body. To maintain the water quality of the river within the bathing class standard, nearly 10 times the discharge of the fully treated municipal waste water is required. The principal activities for controlling water pollution in Delhi include (MoEF 2003):

- Designing a strategy for augmentation of water resources in the upper stretches of Yamuna and for conserving water both in domestic and irrigation use (by Ministry of Environment & Forests/Governments of Uttar Pradesh/Haryana/Delhi).
- Maintaining minimum flow in the river Yamuna (by Central Water Commission/Upper Yamuna Board).
- Controlling pollution discharges in the upper stretches of the river Yamuna and the western Yamuna Canal (by Government of Haryana/Haryana State Pollution Control Board).
- Construction of sewage treatment plants upstream of Delhi at Yamuna Nagar, Karnal, Panipat, & Sonepat, etc. (by Ministry of Environment & Forests/Government of Haryana).
- Pumping of sewage to the full capacity of existing sewage treatment plants and regular maintenance of sewers and pumps (by Delhi Water Supply & Sewage Disposal Undertaking).
- Construction of sewage treatment plants to meet effluent treatment requirements (by Delhi Water Supply & Sewage Disposal Undertaking).
- Statutory regulation of ground water (by Ministry of Water Resources/Ground Water Board).

6.3 Economic valuation of water

The river water authority could explore several options for improvement of river water, which are not only economically efficient in terms of pooling resources and using them optimally in meeting the objectives. This process can be implemented with the help of various stakeholder groups. The setting up of such authority in an integrated framework shall be a first step towards improving river water quality and quantity on part of government, while effective functioning of the board shall be brought in by various mechanisms. The present classification of river stretches based on use quality can be a first method of choice that could be expanded later on to include several other parameters. Moreover, the authority needs to consider economic as well as technical/ engineering parameters in making appropriate choice, which brings forth importance of economic valuation. Economic Valuation takes a careful approach towards the resource and the question of measurement in money terms; first, it undertakes a careful study of the services/functions of rendered by the resource, and next the value of such services are assessed by various methods in literature (Figure 2 illustrates Taxonomy of values).

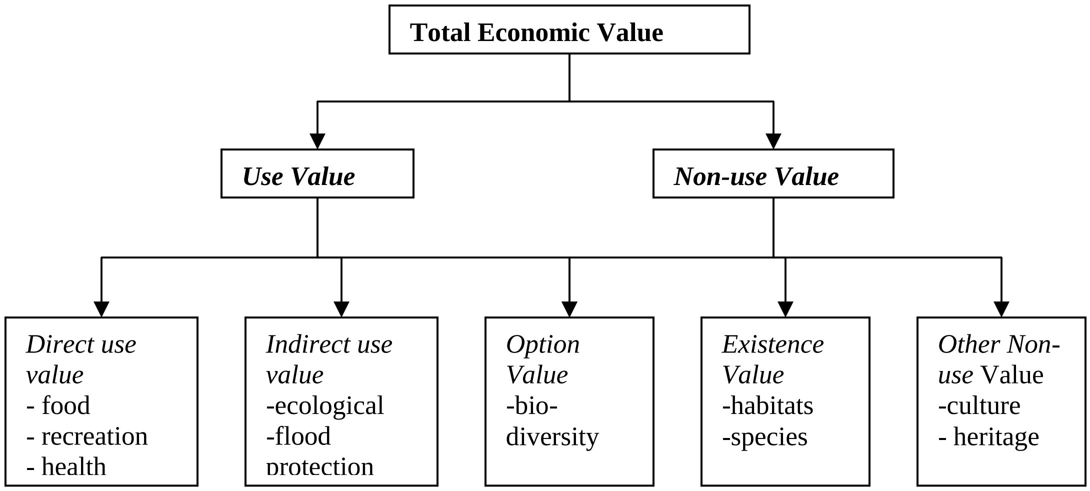
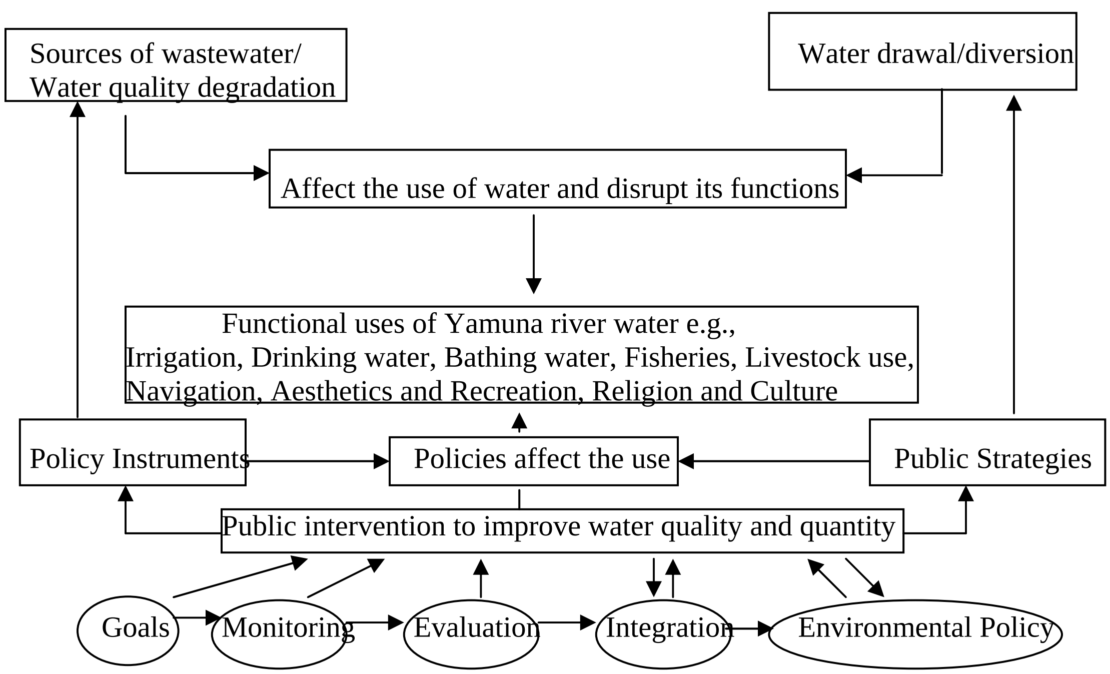


Figure 2 Taxonomy of values Source: Munasinghe (1993)

6.4 Framework for river water management

The key tasks for the river authority shall be regular monitoring of water resources and review of implementation, and ensuring key stakeholder participation i.e., industry, non-governmental organization, local community and other representative groups, into the decision making at all levels. The public intervention will become true and meaningful with such action. Water resources management in Yamuna river basin within the above framework is shown in Figure 3. The policy instruments identified above shall be used appropriately to distinguish the varying approach in case of point sources (e.g., industry) vis-à-vis non-point sources (e.g., agriculture), different taxation principles (e.g., pollution taxes or permits in case of industrial waste water, and pricing or taxation in case of domestic water consumption).

Figure 3 Framework for public intervention toward improving river water



6.5 Policy Instruments

Taxation of public goods or bads is most resorted policy option in case of environmental resource management. An alternative policy instrument commonly referred to in literature is permits/quotas. This is an alternative approach to the riddle due to non-marketed nature of environmental goods, which tries to establish market for these goods through institutions. This approach, takes into consideration of thresholds of resources quality and quantity, beyond which damages will take place and which may be irreversible in both technology and cost or reversible either after substantial amount of damage has taken place or involve huge costs. Thus, thresholds serve as upper limits set based on eco-toxicological or carrying capacity methods, or standards reflecting it can be set based upon several criteria identified. Once the standards are laid down, it is easy for a policy maker to fix pollution permits or quotas, which equal to the set limits to comply with standards. Subsequently, the quotas/permits can be made tradable in a market among polluters. This tradable permits mechanism fulfils the objective of environmental conservation in two ways: on one hand, it creates market for public bads such as pollution through the permits/quotas, on other hand it brings in incentives for rational behaviour on part of polluters to tradeoff the costs of pollution permits with abatement costs. An increasing demand for permits makes them costly in long run and thus abatement becomes more acceptable option to firms. This leads to the economically efficient method of achieving the objective (improved river water quality and quantity).

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Ramakrishna Nallathiga, India
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Brussels, 8 June 2011

Dear Ramakrishna Nallathiga,

2011 International Congress of IIAS
4-8 July
Lausanne, Switzerland

We are pleased to inform you that your paper proposal *"Institutional intervention in River Water Management: the Study of Yamuna river sub-basin in India"* has been accepted and selected for presentation during the congress under sub-theme "*Water Use and International Management* " on Tuesday 5 July 2011 from 14.30 to 16.30.

The following documents are attached for your information:

- Draft timetable of the congress
- Guidelines for paper presenters

If you have no done it yet, please remember to register to the congress. Information on how to register can be found via the following link: www.conftool.net/iias2011.

We thank you very much in advance for your kind cooperation and we look forward to meeting you in Lausanne.

Yours sincerely,

Anne De Boeck
IIAS Executive Secretary