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Application of Economic Instruments for Control of Water Pollution- A Case Study of Industrial Water Pollution

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Abstract

Water is essential exhaustible natural resources that is now fast depleting due rapid population growth and climate change. Water is not just important for survival of humans but also for all other forms of life such as plants, mammals and aquatic species. It is an integral part of the ecosystem which enables both economic and non economic activities to flourish. Since Industrial revolution several major water bodies across the globe are highly being polluted with industrial effluents being the major source of point source pollution. Hence as much as the quantity, the quality of water has become an important environmental policy concern. To address this growing issue, in contrast to the traditional Command and Control (C&C) policy, several countries across the globe have made various attempts with Market Based Instruments (MBIs). This paper provides a review of literature and case study on the successful implementation of economic instruments in controlling industrial water pollution across selected developed and developing countries. The paper finally concludes with some policy suggestions as to how effectively MBIs can be implemented in India to address water pollution.

Keywords*: - Water scarcity, Water pollution, Industrial effluents, Water management, Market Based Economic Instruments.*

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INTRODUCTION

Water is a special type of renewable natural resources that is often considered to be Elixir of life. Water is not just important for survival of humans but also for all other forms of life such as plants, mammals and aquatic species. It is an integral part of the ecosystem which enables both economic and non economic activities to flourish. Hence water has long held a notion that it is abundantly available and should be made freely accessible to all without any discrimination and restrictions. This notion of water might have been considered reasonable and fair enough several decades back say till 1950s before the industrial revolution when water actually was available in plenty to meet the various purposes. But now water needs a shift in thinking in its use as the resources has become scarce in many parts of the world.Some emerging nations and under developed countries are already reeling under severe water scarcity. According to aWRI report most of the developing countries are ranked as highly water stressed nations. The report ranked India at 41 among 181 countries as high risk with respect to water scarcity.

The problem is not only with the resources becoming fast depleting due to population growth and climate change but also the existing water bodies across the globe are highly polluted with toxic chemicals. Seventy percent of the earth's surface is covered with freshwater but only 2 percent of it is actually utilizable (Hinrichsen and Tacio, 2012). With the advent of Industrial revolution several water bodies was getting polluted which has seriously eroded the quality of water resources (United Nations, 2011). Over the last two decades water pollution is becoming one of the important and serious environmental challenges of the developing countries. Countries in these regions like India and China are fast emerging nations and as a result of their higher growth aspirations, water use in these countries are highly inefficient with most of the major water bodies in these regions being highly polluted.

A majority of rivers in these countries are being polluted with industrial effluents and untreated domestic sewage. It is also expected that by 2030 the amount of available global per capita freshwater might fall significantly to as low as 5000 cubic meter (Gardner Outlaw and Engel man, 1997).

A limited availability of quality water severely affects the health of people particularly children. Globally, around 1.8 billion people use a source of contaminated

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drinking water putting them at a risk of various health issues. More than 3 million children under five die annually from diarrhoael diseases by use of unsafe drinking water (WHO, 2015). It is also estimated that the loss of productivity because of water related diseases may cost many countries upto 5 percent of the GDP (WHO, 2012). According to a report by WaterAid, a water and sanitation nonprofit, about 140,000 children in India die because of lack of access to clean drinking water. This is an alarming statistic for a country that is worth 3 trillion US dollars and third biggest economy in the world next to USA and China. Increasing population growth and climate change further exacerbates the problem as supply will fall short of the increasing demand for water resulting in a huge demand supply gap (Mekonnen and Hoekstra, 2016). So as much as the quantity of water, the quality of water has also now become a major concern for the policy makers across the globe.

A majority of poor live in countries where water is becoming increasingly scarce and is also of bad quality. Providing access to sustainable water over the long term is one of the important developmental challenges of the century next to global climate change. Water is a finite exhaustible resource that has competing uses and thus apparently needs to be safeguarded. Since this finite resource is now becoming scarce there is an urgent need and consensus among the international development community to conserve and manage water for sustainable future. In this regard both economists and the scientific community are continuously exploring options for a sustainable water future.

THE ROLE OF MARKET BASED INSTRUMENTS AND THE COMPLEXITIES OF ECONOMICS OF WATER DEMAND MANAGEMENT

Over the last two decades researchers and policymakers across the world have increasingly started to focus on environmental issues. Water pollution is one of the serious environmental challenges facing mankind. About a decade back researchers have been primarily focusing on water supply management but with rapid urbanization and industrialization accompanied by a growing population and changing climate water is increasingly becoming scarce and polluted affecting both the quality and quantity aspects. Hence of late there has been increasing attention and focus on water demand side management so as to address the problem more efficiently. (Nielsen, 2002)

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Countries across the world have introduced various regulatory and other policy measures to address the problem but there are relatively few successful cases of controlling water pollution through the traditional Command and Control (C&C) policy. Considering the limitations of C&C certain developed and few emerging countries have adopted Market Based Instruments (MBIs) to address water pollution and various other environmental quality issues. Though MBIs have been widely used in the field of climate change and energy policy, its applications in water is seriously limited by certain inherent difficulties. Being cognizant of these limitations is very much essential in order to successfully implement and make the best use of economic instruments to address water pollution and water scarcity.

In essence Market-based instruments can be described as regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution controls or methods. Unlike C&C, market based instruments allow firms the flexibility to control pollution with the least cost (ADB, 2011). It encourages the firms to innovate and adopt pollution abatement technologies that can achieve in reducing the pollution with least cost combination. In order to successfully implement MBIs there are certain prerequisites which have to be in place and be ensured. For example a decentralized regulatory authority, an efficient market and establishment of well defined property rights are some of the factors required for the success of economic instruments. The following session briefly highlights certain challenges to establish economic instruments in the water sector primarily because of difficulties in establishing such prerequisites mentioned above. Water presents special challenges for economic analysis including measuring benefits and costs and establishing appropriate institutional arrangements. Water has some unique physical, economic, social, political and cultural characteristics which make it challenging to establish economic instruments.

Determining the economic value of water is often difficult as people are generally against the notion of valuing or pricing water resources. This was also pointed by Adam Smith in his famous diamond water paradox. Water is often considered as low valued commodity. Moreover, estimating optimal price for water is challenging and a complex task as there are varied opinions on treating water as public good or as a private good. Moreover, unlike other natural resources such as coal, gas and oil,

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water does not have a unique market. Absence of specialized market for water serves as an obstacle to establish economic instruments to control pollution and conserve water (Hanemann, 2005). Since water is mobile it is difficult to establish well defined property rights which is one of the essential characteristics to manage resources in a market based economy. Unfortunately, the transaction cost and the cost of transporting and storage of water is extremely high in comparison with the economic value of water at the end use as compared to that of other resources. It is essentially because of these unique characteristics of water, establishing economic instruments to manage water becomes challenging.

THE RATIONALE FOR ECONOMIC INSTRUMENTS IN CONTROLLING INDUSTRIAL WATER POLLUTION:

In most countries industries are major consumers of water next to agriculture. There are several ways in which Industries can be penalized in polluting point source water but MBIs are one of the best ways to control water pollution. Several industries across both the developed and developing countries release huge amount of effluents that are highly toxic which contaminate local water bodies. This is becoming a severe problem across fast emerging nations like India and China with growth triggered by rapid industrialization. There is an increasing scope to charge a higher fee to industries using upstream water at least for two reasons. Firstly, those industries use clean water and second, it can avoid polluting the water significantly which can also be further used at downstream for other purposes. Though water is being used inefficiently and polluted to produce a product, more often than not the price of the final good does not capture the true cost of the virtual water being used during the production process.

This is one more reason in favor of application of economic instruments such as pricing and charging industries that cause pollution and use water inefficiently. On average high income countries treat about 70 percent of the industrial wastewater. It drops to 38 percent in upper middle income countries and to 28 percent in lower middle income countries. Low income countries just treat about 8 percent of the wastewater. About 70 percent of untreated industrial wastes in the developing countries are discharged into major local water bodies. This supports the fact that globally, over 80 percent of all the wastewater is discharged without any treatment. **(UN World Water Development Report, 2017)**

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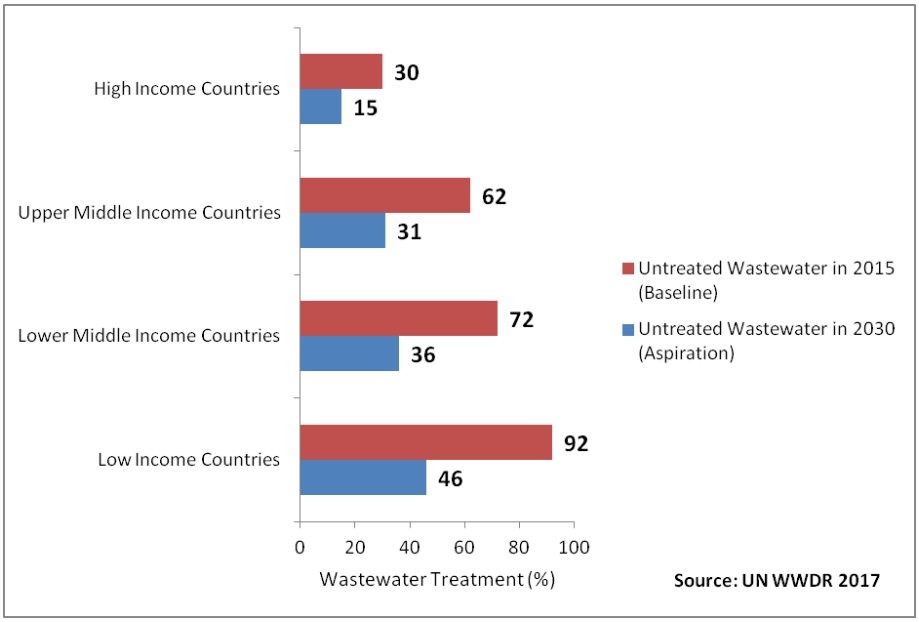


Figure 1: Percentage of Waste Water Treatment across the Globe

CASE STUDY ON APPLICATIONS OF ECONOMIC INSTRUMENTS: EXPERIENCES ACROSS DEVELOPED COUNTRIES

There are some of successful applications of MBIs in water management in spite of the challenges mentioned above in the preceding session. Though several countries across the world have adopted MBIs to improve water use efficiency there are relatively few instances of its application to address water pollution goal.

Germany*:* The effluent charge of German for industries on general Emissions Limit Value (ELV). The ELV depend on the Best Available Technology (BAT). Effluent charges are deliberately set at high rate such that it provides strong incentive for pollution abatement. Such high charges have made considerable motivations to industries to invest in efficient pollution abatement measures. Importantly, industrial plants of all sizes irrespective of the amount of discharges are subjected to the effluent charge system. The system also allows for charge reductions so as to encourage firms to seriously think about reducing pollution. If effluents meet the BAT-derived ELV, the charge is reduced by 50 percent, which creates strong incentives to invest in abatement technologies. The charge of €35.79 per unit of pollution was set in 1998 which was uniform across the country. The revenue generated was quite high to the tune of €365 million in 1999. Revenue from the effluent charge is used for range water

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management activities such as subsidies for investments in water pollution control measures. The revenue is thus used to improve water quality.(Kraemer et. al, 2003)

France: The effluent charging system implemented serves as financing measure to improve water quality management. The charges are set as incentives to adopt BAT to aggressively reduce water pollution. The charges are applicable to direct as well indirect discharges from industries and domestic sector into surface water and public sewer system. The Regional Directorates for Industry and Environment (DRIRE) issues permits for industrial effluents. The charges are based on sector specific ELV and the water utilities provide incentives to use BAT through bonuses. Charges vary across sector and regions and are based upon the quantity and quality of the discharges. The total revenue generated was €1260 million in 1999 and is used to improve water supply infrastructure. The effluent discharge system offers rebates and premiums for good environmental performance which acts as an additional incentive for pollution abatement.(Kraemer et. al, 2003)

Denmark*:* Denmark is one of the pioneers of water management and has adopted economic instruments since early 1970s. The effluent charge system in Danish serves as a fiscal instrument i.e. the revenue raised is added to the general government budget. The regional administration issue permits and collects charges for industrial discharges. Unlike France, the charges are only levied on direct discharges into surface water. The Danish effluent charge is calculated according to the following equation:

EC = €2.67 * x kg N tot + €13.35 * y kg Ptot+ €1.47 * z kg BOD5

where x, y and z equal to the total amount of Nitrogen (Ntot), Phosphorus (Ptot) and biochemical oxygen demand (BOD5) discharged per year. The high charges for nitrogen and phosphorous imply a greater reduction of nutrient in natural waters. The charges for major dischargers are collected on quarterly basis while that for minor dischargers are collected once in a year. Total revenue generated through the effluent charges were €37 million and was added to the government budget.(Kraemer et. al, 2003)

Australia: Marketable Emissions Permits (MEPs) are not as effective as compared to other instruments in controlling water pollution. Hence it is less desirable but

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however, MEP applied in Australia Murray Darling Basin has been a success. Australia is one of the major exporters of coal and is biggest mining industry. The rivers across the basin are polluted by salt from these industries. The Interstate Salinity Trading Scheme was introduced in 1992 and it is based on salt credits and debits. Ever since the permits were established the salt pollution rights are not freely traded by industries or individuals, but are exchanged between the governments of the participating states which include New South Wales, Victoria and South Australia. The MEP operates by creating a salinity bank account. States that undertake activities which increase salinity attract debit while states that reduce salinity earn credit. (Brunton, 2013)

Netherlands*:* The country introduced effluent charges in early 1970s and the main objective of charge was to raise revenue to improve the water quality. The charges are based on ELV and are set at flat rate €37 per unit for discharges into state waters while the charges varies for effluents released into regional waters. The revenue generated was € 900 million was used for improving water quality. Despite lower charges both the quality and number of treatment plants increased substantially over the period.(Kraemer et. al, 2003)

CASE STUDY ON APPLICATIONS OF ECONOMIC INSTRUMENTS: EXPERIENCES ACROSS DEVELOPING COUNTRIES:

Colombia*:* The water tax in Columbia is considered to be a successful model that can be replicated across most of the developing nations; it is notable for its clean production agreements with polluting firms and efficient capacity of tax collection. Industries contribute 5000 tones of TSS. To manage such high pollutant levels there was first a complete revamp of regulatory and institutional structure to effectively implement tax and monitor pollution reductions. The effluent tax initially faced several challenges and hiccups but later was showing significant reduction in pollution levels. For instance, after two years of implementation in Rio Claro Cocorna watershed TSS pollution level fell by 85 percent and BOD5 pollution dropped by 40 percent. In Rio Negra, TSS and BOD5 reduced by 33 and 34 percent respectively. (Blackman, 2007)

China: Emissions from industrial and municipal sources are the major contributors for water pollution. China adopted economic instruments way back in 1970s but since then is accompanied by C&C policy. The country has introduced various economic instruments but only few

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were successful and achieved the desired goal. This point out to the fact that not all MBIs are good and effective in controlling water pollution and careful analysis of the problem is essential for successful implementation. Effluent discharge system encourages firms to reduce pollution and serves as source of revenue for water quality management. The total volume of revenue collected increased from CNY1.2 billion in 1986 to CNY17.8 billion in 2007 (ADB, 2011). But the system was affected by low levies and low collection capacity. Low levies and inadequate management is common across most of the emerging nations. Such low levy induces firms to pay the fine than to reduce pollution. A tradable water discharge system implemented by China in 1992 has resulted in significant reduction in water pollution levels in upper Nanpan river. There was also significant cost saving to the tune of 2.4 million CNY annually as compared to that of 1.6 million CNY in the presence of non tradable permits. Despite the regional success China is facing certain institutional difficulties to expand the use of tradable water pollution rights to other polluted water bodies. (Tao et.al, 1998)

Malaysia: Palm oil is one of the major industries which started to expand since 1960s. With the expansion of the industries the output of Crude Palm Oil (CPO) grew significantly leading more use of water resulting in inefficiency and increase in pollution. For every ton of CPO produced the mills generate 2.5 tonnes of effluent. By the mid 1970s the pollution level reached alarming level resulting in around 42 rivers were severely polluted affecting the aquatic ecosystem. The government introduced a combination of three instruments viz; pollution tax, effluent standards and R&D subsidies. These measures were implanted along with the traditional C&C policy. In order for successful implementation and monitoring the government made certain restructuring in institutional arrangements. The firms were directed to reduce BOD concentration from 5000 ppm to 500 ppm between 1978 and 1981. But the fee enabled further reductions in BOD level that fell 100 ppm in 1984. The fee is consisted of two parts a flat fee of 100$ and a variable effluent. The Malaysian experience show that a well designed MBIs can be effective in reducing water pollution in other developing countries. Most importantly, pollution reduction is possible with simultaneous industrial expansion. (Kathuria, 2005)

Sri Lanka*:* The country has a significant number of rubber processing industry but most of the firm in the rubber industry do

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not abide by the water pollution control standards. C&C is the dominating regulatory measure that is in place and failed to reduce the water pollution. Jagath (2014) in his study estimates a pollution tax that could motivate the firms in rubber industry control pollution and meet the national emissions standards. The tax rate necessary for environmental compliance is 26 Sri Lankan rupees per 100 grams (in 2005 values) of Chemical Oxygen Demand (COD) per year. The burden of the tax would be approximately equivalent to 8.6 percent of the annual turnover but it varies with the size of the firm where small firms are worst affected by the pollution tax(Jagath, 2014).Apart from the revenue, the implementation of the tax is also said to affect the employment of small and medium firms. Though the implementation of tax have some influence and affects firm level factors such as profits and employment, these costs are expected outweigh benefits by significant reduction in water pollution.

CONCLUSION

Status of Environmental Regulations in India: Lessons and Policy Suggestions for India

India is one of the fast emerging nations and it is expected to become one of the super model economies by mid century. Much of the growth of India is triggered by industrial and service sector. Environmental quality in India has been seriously deteriorating over the last two decade with industrial expansion. Water pollution in India is a serious environmental policy concern and the government has given very little attention to the problem and has implemented various schemes such as Ganga Action Plan to clean the polluted rivers. The focus has been on cleaning up rivers rather than reducing the pollution. The environmental regulation has mostly been the traditional C&C policy providing very little flexibility and incentive for the firms to reduce pollution.

Almost 70 percent of the surface water and a growing percentage of groundwater resources are highly polluted with various toxic organic and inorganic chemicals. According to CPCB assessment a majority of polluted rivers were found near urban areas and this highlights the fact that the industrial and domestic sewage are the major contributors to the water contamination. Almost all of the rivers in India are polluted mostly with domestic and industrial effluents. Ganga, Damaodar, Yamuna, Bagmathi and Mahi are the major polluted rivers of India. Yamuna tops the list of polluted rivers of India and is also

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one of the top 10 dirtiest rivers in the world. More than 60 percent of the untreated domestic sewage and industrial effluents have chocked the sacred river. It is estimated that 68 major industries release about 100 cu.m. of untreated wastewater in the river. The Mahi river is facing an intrusion of saline water from sea and the accumulation of effluents from industries are poisoning the river water.(Murthy and Kumar, 2011)

The Water (Prevention and Control of Pollution) Act, 1974 prohibits the discharges of pollutants into water beyond a given standard and charges penalties for non compliance. There are two kinds of standards namely Industry specific standards, which stipulate maximum limits on specific pollutants from selected industries and general standard. One of the major limitations of these standards is that it is concentration based and not load based. In this case the standards can be met by diluting the concentration.(ADB, 2001)
So the Act reflects the C&C legislation with uniform mandates. Thus it does not take into account differences in Marginal Abatement Cost both within and across firms and industries. If the MBI are implemented the same water quality target would be achieved at low cost as firms consider and the differences MAC. Finally, there is no attempt by the government or the regulator to link the source specific discharge standards set under the act with the ambient water quality standards. Even if all the sources comply with the discharge standards there is no guarantee that overall ambient water quality will be met.(ADB, 2001)

The Water (Prevention and Control of Pollution) Cess Act, 1977 was introduced to meet the cost and expenditure of the state and central water utilities. The cess actually combines features of both a user charge and effluent fee. However, the cess did not meet intended role and has been less effective in reducing pollution or consumption. This is because the cess is not levied based on effluent discharge per se but instead is purely motivated as a source of revenue generation. As a starting point it would be better to amend the current water cess legislation and convert it as a genuine effluent tax which can be frequently raised upwards to reduce water pollution. (ADB, 2001)

Of late the Government of India (GoI) have been considering to introduce and experiment with MBIs to address various environmental quality issues including water pollution. But before embarking on the rapid transformation it is important to

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learn lessons from other countries and understand the local barriers and challenges to successfully implement MBIs to the deal with the problem. Lack of political interest and institutional barriers are posing as major challenges to shift to MBIs. Lack of proper monitoring and environmental compliance is another major factor that limits the success of MBIs. Moreover, there is also greater degree of lobbying by stakeholders in favor of the status quo(Murthy and Kumar, 2011). Despite these limitations India has huge potential to implement MBIs to address water pollution and other environmental quality issues provided it undertakes a focused and dedicated approach to revamp its regulatory and institutional structure. A decentralized institution enables close monitoring and stricter compliance so as to effectively reduce pollution. Finally, India can learn lessons from other developing nations such as China and Malaysia to gradually introduce MBIs working in parallel with traditional C&C for a smooth transition in the environmental policy framework.(ADB, 2001)

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