Development of Conceptual Framework for Water Quality Trading

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Abstract — Water resources in our world: Scarce and Precious. Preservation of these resources in their pristine form is of utmost significance for the whole of humanity. The industrial sector consumes a huge amount of water and also pollutes it, further alleviating the problem of water scarcity. In order to incentivize the industries for effluent treatment and environmental issues as a whole, several 'Trading Schemes' have come up. Water Quality trading and Effluent trading are some of its forms. This study is focused on Water Quality Trading (WQT). It is an innovative and cost-effective approach to achieve water quality goals more efficiently. The intent of trading is to achieve an expected reduction of a particular pollutant at a lower cost by allowing sources with high abatement costs to purchase pollution discharge reductions from sources that have lower abatement costs. The challenge with trading is to allow for innovative, market-based reforms without compromising the existing safeguards in environmental protection. All the possible elements required for the successful implementation of WQT program to work with full efficacy have been discussed in the paper. It shall serve as a guideline to the researchers and developers to design more effective programs. Water-quality trading is an area of active development in environmental markets.
Keywords: Water Quality Trading (WQT), Abatement, Effluent, Environmental markets.

I. INTRODUCTION

Water quality is one of the most pressing environmental concerns facing many parts of the world. India, itself has a huge number of rivers, lakes, ponds and sea. All these water bodies play a simultaneous role of Source and Sink. They act as source by providing Water on regular basis in order to fulfill all the necessities. After a long journey of this water through various processes, it turns into Wastewater, which requires treatment. This wastewater is then treated at the Treatment Plants and the treated effluent is disposed into the sink. This whole cycle degrades the water quality to an extent where a need has arisen to bring into action the concept of Water Quality Trading (WQT).

Sources of water quality impairment are generally divided into two categories: Point sources and Nonpoint sources. Point sources are those sources that discharge pollutants into a water body via a discrete conveyance such as a pipe. Examples of point sources include sewage treatment plants and industrial facilities. Whereas, pollution from nonpoint sources is diffuse in nature, such as agricultural or urban runoff. [6] To address the increasing occurrence of water quality related problems, an innovative and cost-effective approach of WQT has been introduced. WQT is an area of active development in environmental markets.

United States of America (U.S.A) has undergone trading several years ago and is still practicing it. They usually deal with management of rivers and lakes irrespective of the Indian scenario.

Aim and Objectives: The main aim of this study is to develop a conceptual model for Water Quality Trading. The objectives of the paper is to share some knowledge in the field of water quality trading, to improve the water reuse efficiency, to understand market feasibility, to study the benefits and pitfalls of trading environment and compare the existing WQT schemes of the world.

II. BASICS OF WATER QUALITY TRADING

A. Need of water quality trading:

WQT, evolved due to the alarming ecological concerns. The highly polluted water bodies and the in-efficiently working/running CETP's led to the development of such schemes. Pollution abatement is costly; firms do not voluntarily reduce emissions to the efficient level. Therefore, the government needs to develop environmental regulation. This thought led to the formation of such trading systems and schemes. Firstly emission trading scheme commonly called ETS came up. It was brought into action in order to cope up with the air pollutants. Later WQT followed. WQT is a market based instrumental and an innovative approach to cost effectively achieve water goals.

B. Water quality trading:

Water quality trading is a market based instrument that is gaining popularity as a mechanism to cost effectively meet water quality goals. WQT is most commonly applied to nutrients such as N & P but has also been applied to Temperature, COD and Sediment. Trading allows the sources with high abatement cost to purchase pollution discharge reductions from sources that have lower abatement costs. WQT involves parties, stakeholders, who trade with each other either directly or by creating a market of credits that represent a specific amount of pollutant reductions. The intent of trading is to achieve an expected reduction of a particular pollutant at a lower cost. [6]

C. Water Quality Trading Formulations:

Trading between regulated point sources- i.e. two ETP's trading to meet permitted discharge levels.[6] Water Quality Trading programs can also allow trading between regulated point sources and unregulated nonpoint sources, such as agriculture. Trading between point and non-point sources enables point sources with high compliance costs to purchase pollution reduction credits (offsets) from non-point

sources with lower pollution reduction costs.
Point sources- Followed by regulatory discharge permits for e.g. U.S. EPA usually beyond.
Non-Point source- Not controlled by regulatory sellers of pollution reduction credits.

D. Success elements for Water Quality Trading Program:

1) T (TRANSPARENT):
Keep the public informed at every step of the process.
2) R (REAL):
Show pollutant reductions and water quality improvement.
3) A (ACCOUNTABLE):
Manage the program effectively.
4) D (DEFENSIBLE):
Base the program on sound and science protocol.
5) E (ENFORCEABLE):
Establish responsibility for meeting or exceeding water quality standards.

E. Working of Water Quality Trading:

Procedure for a Water Quality Trading program is mentioned below:

1) Decide which pollutants are eligible for trading.
2) Decide the units of trade and whether a minimum traded quantity is necessary to allow trading.
3) Find out parties eligible for trading
4) Fix the trading area.

F. Benefits of Water Quality Trading:

Highlights of the benefits of WQT are mentioned below:

1) Economic benefits: Reduces costs for individual sources and reduces overall costs of addressing water- quality problems in a watershed; allows dischargers to take advantage of economies of scale and treatment efficiencies; and provides incentives for innovations in pollution-reduction technology since investments in pollution control can lead to increased profits.
2) Environmental benefits: Achieves equal or greater reduction of pollution at equal or lower cost; creates an economic incentive for dischargers to go beyond minimum pollution reduction; can reduce cumulative pollutant loading; improves water quality and prevents future environmental degradation; may lower political resistance to higher water-quality goals over time; and if credits generated by nonpoint abatement can be sold, this creates an economic incentive for nonpoint source dischargers to reduce pollution even in the complete absence of regulatory standards.
3) Social benefits: Encourages dialogue among stakeholders; fosters concerted and holistic solutions for watersheds with multiple sources of water-quality impairment; and facilitates construction of social capital and trust.

III. VARIOUS WATER QUALITY TRADING PROGRAMS

The following chapter explains the various water quality trading programs. Basically it comprises of the programs that were established to carry out water quality trading. Out of which, some have reached a successful level while others are still under operating conditions. The present chapter is dedicated to all those programs which have been successful up to some extent. The below mentioned programs give the Basic details of the actual working of water quality trading.

A. Long Island Sound Trading Program:

In 1990, Connecticut, the State of New York, and EPA adopted a Comprehensive Conservation and Management Plan (CCMP) for the Long Island Sound. The CCMP calls for the reduction of nitrogen to increase dissolved oxygen in Long Island Sound and mitigate hypoxia damaging the Sound's ecosystem. A TMDL, approved in April 2001, includes wasteload allocations for point sources and load allocations for non-point sources in the watershed. Connecticut chose to develop a trading program for contributing point sources within its borders to lower the cost of implementing the CCMP and the TMDL. The trading program is stipulated in state law. Connecticut's program uses both its general state authority and its NPDES permitting authority to issue a single general permit for the total nitrogen loads of all 79 wastewater treatment plants (WWTPs) that discharge to the Sound. Sources discharging less than their annual limit receive credits for over-control; the State is obligated by law to purchase all nitrogen credits from these sources. Facilities that exceed their limit must purchase credits from the State at a price set by the Nitrogen Credit Exchange.

B. Middle-Snake River Demonstration Project:

After a five-year development process, the Upper Snake Rock TMDL was finalized in 2005 and called for significant reductions in phosphorous discharges to meet water quality goals. The Middle-Snake River stakeholders, including aquaculture and fish-processing facilities, municipalities, the State of Idaho, and EPA, have developed a trading program for buying and selling total phosphorus credits among dischargers. Under the trading arrangement, the City of Twin Falls' WWTP, fish-processing facilities, and aquaculture may generate phosphorus reduction credits that can be purchased by other aquaculture facilities in that same section of the Middle Snake River. The permit allowing for trading under the TMDL was recently finalized, and stakeholders predict that trading may commence shortly depending on final wasteload allocations.

C. Neuse River Basin Total Nitrogen Trading:

North Carolina established a Nutrient Management Strategy for the Neuse River Basin to reduce the total nitrogen load to the Neuse estuary from all sources. The Strategy sets annual nitrogen allocations for existing point source dischargers under a TMDL and allows dischargers a group compliance option to collectively meet their permit limit for

mass loading of nitrogen. Currently, 22 point sources are members of the Neuse River Compliance Association, which is issued a single, collective NPDES permit for nitrogen based on the sum of the members' individual nitrogen allocations. If new or expanding dischargers cannot secure nitrogen allocations from other point sources, they can purchase non-point source nitrogen offsets by paying into the North Carolina Wetlands Restoration Fund. The Compliance Association must pay into the fund at a fixed, per-pound price if it exceeds its annual nitrogen allocation, making the Association more like an exceedance tax than a traditional trading program.

D. Wayland Center:

When the Wayland Business Center, LLC (WBC) redeveloped an abandoned commercial property in Wayland, MA, it sought to reactivate the previous owner's NPDES permit for the small, on-site wastewater treatment plant. EPA and the Massachusetts Department of Environmental Protection denied WBC the permit renewal, interpreting the discharge as a new source to the Sudbury River. In developing a new NPDES permit for WBC, the USEPA initially set a 0.2 mg/L phosphorus limit, but the final permit allowed a 0.5 mg/L phosphorus limit in exchange for non-point source offsets. The non-point source phosphorus reductions came from sewering over two dozen properties in downtown Wayland that have failing septic systems. IEc originally selected two additional initiatives for inclusion in the evaluation– Charlotte Mecklenberg and Las Vegas Wash—but the interviews for these initiatives did not generate sufficient data. IEc selected two replacement initiatives that also meet program selection criteria.

E. Great Miami River Watershed Trading Pilot:

The Great Miami River Watershed Water Quality Credit Trading Pilot Program is a ten-year project to reduce phosphorus and nitrogen loadings into the Great Miami River. Despite pollutant reductions by point sources, over 40 percent of the rivers and streams in the Great Miami River watershed do not meet Ohio's water quality standards. Non-point sources, especially agriculture, are the major remaining causes of impairment. The pilot was established to increase funding for agricultural BMPs in the Great Miami River watershed, provide regulated dischargers with a cost-effective regulatory compliance option, and improve water quality in the Great Miami River watershed. Under the trading program, farmers will implement BMPs to generate credits that WWTPs can use to meet regulatory requirements. Funding for the projects will come from the WWTPs, combined with a grant from the USDA that provides more than $1 million for agricultural projects during the program's first three years. The pilot commenced in 2006; evaluation of project success is premature.

IV. COMPARATIVE ANALYSIS OF DIFFERENT WATER QUALITY TRADING PROGRAMS

Comparative Analysis of Different Water Quality Trading Programs across the World are tabulated below. The Table 1 briefly explains the details of the programs that existed or are even under existence.

Parameters for comparison	Chatfield	Middle-Snake River Demonstra-tion Project	Long Island Sound Trading Program	Total Nitrogen Trading in the Neuse River Basin	Wayland Center
Establishment year	1999	2001	2002	1998	1998
Location (U.S.A)	Colorado	Idaho	Connecticut	North Carolina	Massachussets
Program Type	Case by Case PS-PS/NPS	Cap and trade PS-PS	Cap and trade PS-PS	Cap and Trade PS-PS/NPS	Case by Case PS-PS
Scheme Developer / Organization	Chatfield Watershed Authority	Idaho Department of Environment-al Quality	Connecticut Department of Environmental Protection	North Carolina Department of Environment and Natural Resources	Wayland Wastewater Management District Commission
Pollutant Traded	Phosphorous	Phosphorous	Nitrogen	Nitrogen	Phosphorous
Project Categories	Chatfield Reservoir	Middle-Snake river	Long Island Sound	Neuse River	Sudbury River
Market Structure	Clearing House or Bilateral Negotiation	Bilateral Negotiations	Exchange	Clearing House (NPS) Bilateral negotiations (PS)	Bilateral Negotiations

Table 1: Comparative Analysis of Different Existed Water Quality Trading Programs across the World

V. CONCEPTUAL FRAMEWORK OF WATER QUALITY TRADING

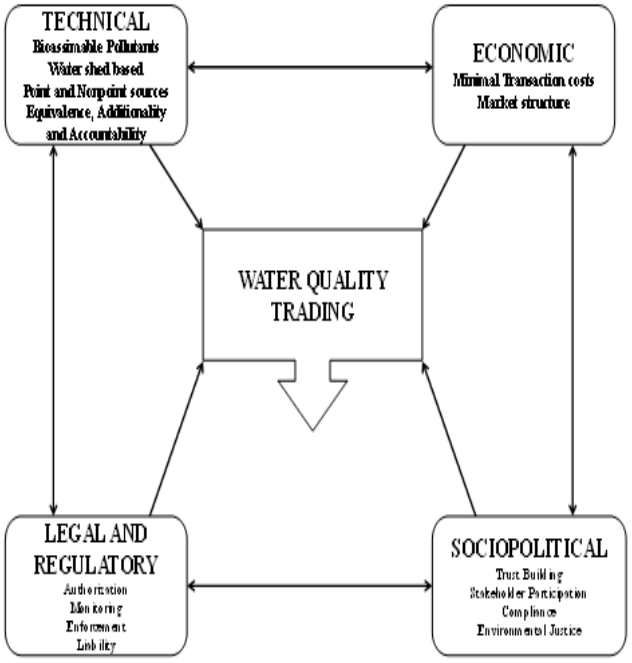

Fig. 1: Conceptual Framework for Effluent Trading

In recent years, the use of market based approaches to devise pollution control policies has become an increasingly

important topic for discussion among economists, environmentalists and policy makers. However, the idea of market based incentives has been since decades. Economists have substantially contributed to literature on market based approaches to achieve effective and efficient environmental policymaking. There are several elements, agents and entities that contribute to the development and implementation of water quality trading aimed at pollution control. This paper outlines some of the major Technical, Economic, Legal and Regulatory and Socio-political issues which play an important role in the Water Quality Trading program.

A successful WQT program must incorporate certain Technical, Economic, Legal and Regulatory and Socio-political elements into its design and implementation.

1) Technical Elements:

A major goal of any WQT program is to improve the water quality. Hence, such a program must take into account a number of technical factors and limitations. Trading should typically be enclosed to those classes of pollutants that are biologically degradable and assimilable. Pollutants that degrade slowly within the system are usually inappropriate to trade.

2) Economic Elements:

Any credit sold in a Water Quality trading program must satisfy the criteria of Equivalence, Additionality, and Accountability. Equivalence refers to the requirement that a credit purchased must at least offset the pollution load for which it is substituting. This requirement gives rise to trading ratios, which indicate the number of units of reduction by one source that is necessary to offset a single unit of pollution by another source. Additionality refers to the requirement that credits available for sale must represent real improvements in water quality. Accountability refers to the requirement that credits generated be subject to independent verification.

Once a program is set up that satisfies these criteria, other major concerns in Water Quality trading programs are transaction costs, market power, market structure, externalities, and moral hazards. These issues can determine the relative success or failure of the program. Water Quality trading is most likely to succeed where the economic benefits are greatest, i.e., where there is a significant difference in unit costs of abatement between sources.

If all sources in a watershed face roughly the same cost to reduce their pollutant load, then there will be little incentive to trade and a program will likely fail. Even if cost differentials exist, transaction costs may be an obstacle to trading. Hence, every possible step should be taken to reduce these costs.

With transaction costs in mind, a trading program must seek to strike a balance between efficiency, efficacy, and equity. Efforts to closely monitor trading can result in substantial transaction costs, potentially crippling the market. Hence, policy makers must seek to strike a balance between the efficiency of the market on the one side, and the governmental oversight, management, and monitoring of the efficacy and equity of the resulting allocation on the other.

3) Legal and Regulatory Elements:

Trading and other market-based incentive programs must be consistent with the statutory requirements and water quality standards outlined in the federal Clean Water Act and other federal laws.

Trading and market-based transactions may be developed within any authorizing framework. The total maximum daily load (TMDL) process appears to be the preferred method of U.S. EPA for addressing non-attainment watersheds, and it may offer the greatest opportunities for effluent trading. The regulatory agency must actively encourage Water Quality trading through information and education programs. Eligibility and enforcement mechanisms must exist to ensure trading party performance.

4) Socio-political Elements:

Designing successful Water Quality trading programs requires the support and cooperation of diverse stakeholders including federal, state, and local agencies; regulated parties; interest groups; and the public at large. Stakeholder education, input, and participation should be encouraged at all stages in the implementation and evaluation of trading programs. Trading should take place under an effective oversight and review process that assures that the impact of trades is consistent with U.S. EPA guidelines on environmental equity/justice. The distribution of baseline abatement responsibilities must be fair to all market participants.

VI. CONCLUDING REMARKS

Water quality issues have arisen since 1997, there has been a four-fold increase in the problems related to water quality. This has compelled Government to look for ways to deal such problems. Consequently, a number of WQT programs have increased and are continually doing so as to decrease such problems. Trading complements regulation, providing flexibility for sources to meet the regulatory obligations at lower costs, thereby making trading an attractive option for government to handle water quality problems. The paper easily communicates the readers and developers the basics of WQT. WQT is emerging within this context as a mechanism that can reduce the cost of achieving increasingly stringent water-quality goals.

While some successes were reported, the studies main findings were that there was limited participation by potential traders and a lack of trading activity. Lack of trading partners, lack of adequate regulatory drivers, uncertainty about the trading rules, legal and regulatory obstacles to trading, high transaction costs, cheaper alternatives, etc. are some of the limiting factors of a WQT program. Such obstacles can be solved by designing an appropriate market design. As the concept moves from pages of books and journals to the menu of instruments available to policymakers, however, realized outcomes will depend on how the market programs are designed and implemented and the contexts in which they occur. [4]

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