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Water Rights Pricing in the Philippines:
Issues, Challenges and Way Forward

by

Maria Francesca Mercedes D. Grabador*

*Graduate Student, University of the Philippines (UP) School of Economics

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Abstract

Water is critical not only to economic progress and sustainable development but most importantly, to human survival. Yet, the way water is valued suggests an inexhaustible supply, when the opposite is true. This paper examines if water rights in the Philippines are underpriced and looks at how these can be valued at full economic cost. It finds that water resources in the Philippines are essentially given no value since the administrative cost-recovery approach is used to determine fees for water permits and water charges. Moreover, through the analysis of different pricing models used in other countries' water markets, this study also presents the core components of an economic pricing model for water rights. While the establishment of water markets may represent the first best solution to water scarcity, it is an ideal solution in an ideal setting; thus, second and third best solutions are also presented. The study concludes that while it is not possible to immediately price water rights at its full economic cost, it may be done gradually, starting with the adoption of volumetric pricing and strengthening the institutional capacity of the National Water Resources Board (NWRB).

Key words: water permits, water rights, water rights trading, water rights markets, economic pricing models for water rights, water resource management, volumetric pricing

JEL Codes: Q21, Q25, Q28, O53, O57

Water Rights Pricing in the Philippines: Issues, Challenges and Way Forward

Maria Francesca Mercedes D. Grabador[1]

I. Introduction

A. Background and Rationale

Water is critical not only to economic progress and sustainable development but most importantly, to human survival. Yet, the way water is valued suggests an inexhaustible supply, when the opposite is true. Water-stress indicators are rising as a combined effect of climate change, population growth, and increasing economic activity. Competing uses of water have been increasing within and across sectors of the economy over time. Water rights pricing, if done right, should reflect water's scarcity and true economic value, leading to its efficient allocation and use, more investments in much-needed water infrastructures as well as better protection of water sources and related ecosystems. As water grows scarcer, water rights should have been increasing in value. However, in the Philippines, fees and charges for water permits have not been updated since 2015, and the proposed increase in 2022 still cover only the administrative costs associated with processing applications for water permits and other services performed to manage water resources.[2,3] The use of the administrative cost-recovery approach effectively assigns no value to the underlying water resource, which in stark contrast, is a scarce economic good. Thus, reflecting water scarcity in the price of water rights is an important tool for effective water resource management and sustainable use of water in the country.

B. Statement of Purpose

"Water has an economic value in all its competing uses and should be recognized as an economic good."

\- Dublin Statement on Water and Sustainable Development, 1992

The main objective of this study is to determine if initial water rights in the Philippines are underpriced, and if so, provide a framework for the economic valuation of these water rights. These will be done through the following:

1. Explore water resource management practices in the Philippines, as well as those in other countries to identify issues and best practices;
2. Look at how transfers/sales of water rights in other countries are priced and carried out to see if there are aspects of the different transfer pricing methodologies we can adapt in the initial pricing of water rights in the Philippines;
3. Assess the feasibility of incorporating economic costs in the prices of water rights in the Philippines; and
4. Identify potential issues and challenges in implementing economic pricing of water rights. Policies or other measures which may address these challenges will be presented.

C. Research Questions and Sub-Questions

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[2] Holders of water rights in the Philippines pay a one-time water permit application fee of ₱7,200 and annual water charges based on water rights classification and water use. Source: Fees and Charges. (n.d.). National Water Resources Board. Retrieved March 26, 2023, from https://nwrb.gov.ph/fees-and-charges/

[3] Based on proposed increase of NWRB fees and charges in 2022: https://nwrb.gov.ph/wp-content/uploads/2023/01/Proposed_Fees_and_Charges2022.pdf

This study starts with the question: Are initial water rights in the Philippines underpriced? If these are indeed underpriced, how can the economic value of water be reflected in the price of initial water rights? Specific research questions would include:

1. What water rights pricing mechanism is currently used in the Philippines? How does this account for the true economic costs (i.e., financial, economic, social and environmental) of water?
2. What can we learn from water resources management and water rights pricing mechanisms in other countries? Are there any country experiences we can learn from and best practices we can adapt?
3. How should the economic pricing of water rights look like? How can we use the tradability of water rights to estimate economic value?
4. Are economic pricing mechanisms for water rights administratively and politically feasible in the Philippines? What challenges will likely be faced and what policies or measures are needed to overcome these?

D. Nature of Study

A mixed method approach was employed in this study, as follows:

1. Analysis of administrative data/information,
2. Comparative study approach using review and synthesis of existing literature in the Philippines and other countries; and
3. Interviews with regulators and other key participants in the Philippine water sector.

II. Overview of Water Resource Regulation in the Philippines

A. Government Agencies Mandated to Regulate Water Resources

1. National Water Resources Board (NWRB)

The NWRB is an attached agency of the Department of Environment and Natural Resources (DENR). The Board manages and regulates the use of all water resources in the Philippines and appropriates them among various uses. The NWRB is the sole government body mandated to perform water resource regulation.

The NWRB's mandates may be broadly categorized into the following:

i. Policy formulation and coordination,
ii. Resource regulation, and
iii. Economic regulation.[4]

In the most recent version of the Senate Bill proposing to create the Department of Water Resources (DWR) and the Water Regulatory Commission (WRC), the NWRB will be reconstituted as the National Water Resources Allocation Board (NWRAB), with its resource regulation mandate preserved entirely. A Resource Allocation Office will be created to serve as Secretariat and provide technical support to the NWRAB.[5]

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[4] Resource regulation refers to the issuance of water permits to different appropriators across the Philippines. Meanwhile, economic regulation refers to the determination of service standards and targets, as well as tariff levels and schemes.

[5] Senate Bill No. 2013, introduced on March 15, 2023 by Senator Joel Villanueva. As of writing, the bill was on First Reading and was referred to the Committees on Public Services; Civil Service, Government Reorganization and Professional Regulation and Finance on March 20, 2023.

In Executive Order No. 22 dated 27 April 2023, the NWRB was tasked to closely coordinate and collaborate with the newly created Water Resources Management Office.

2. Water Resources Management Office (WRMO)

Executive Order No. 22 also created the Water Resources Management Office (WRMO) under the DENR. The principal mandate of the WRMO is to immediately implement the principles of Integrated Water Resources Management (IWRM) in accordance with the United Nations Sustainable Development Goals and formulate a corresponding Integrated Water Resources Master Plan (IWMP).[6] The IWMP should integrate various water-sector plans including the Philippine Development Plan, the Philippine Water Supply and Sanitation Master Plan, and the NWRB Water Security Master Plan. The WRMO was also tasked to oversee the creation of an apex body, such as the proposed DWR, and the WRC.

3. River Basin Control Office (RBCO) - DENR

The River Basin Control Office (RBCO) of the DENR is mandated to rationalize and integrate all national plans, projects and programs involving the country's river catchment basins. It oversees all river basin initiatives, projects and programs, which include infrastructure development, environmental protection, and IWRM. The RBCO formulates river basin policies and manages the central funds for river basin appropriations provided under the DENR budget. Moreover, the RBCO manages the river basin database. All river basin organizations are required to submit to the RBCO their updated database for consolidation in the River Basin Integrated Information System (RBIIMS). Along with the DENR's Forest Management Bureau, the RBCO also oversees the different reforestation and conservation programs for the countries' watersheds.

B. Property Rights on Water

1. Water rights administration

In the Philippines, all water resources belong to the State. An explicit water licensing system is implemented by the government through the NWRB, wherein water rights, as evidenced by water permits, are issued to qualified applicants in exchange for the payment of a fixed filing/permit fee and annual water charges. [7]

2. Type of Water Rights

Water rights in the Philippines are of a hybrid type, being a combination of riparian and prior appropriation rights.[8] Landowners or beneficial users of a land may apply for a water permit to legally appropriate water from sources situated in their property. Subsequently, water rights may be transferred or sold separately from the legal rights to the land where the water source is situated.

3. Attributes of Water Rights in the Philippines

The basic attributes of water rights in the Philippines are provided in detail in Appendix 2.

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[6] IWRM aims to reconcile a country's water resource requirements with the limitations of available water resources. Principles of IWRM provide a holistic framework based on the following: 1) efficient water use, 2) equitable access, 3) balance between competing uses, 4) use of appropriate environmentally sound technology, and 5) collaboration between various government agencies and representatives of all stakeholder groups. (ADB, 2007)

[7] A permit should be secured from the NWRB prior to water appropriation except for "purely domestic purpose" defined in the Water Code as use of not more than 250 liters/capita/day of water by a single household.

[8] In times of shortage, water established first in time are given priority, except for emergency situations wherein domestic and municipal purposes are given priority (Bird & Von Custodio, 2009)

As to duration and conditions, water rights in the Philippines are granted on a permanent basis and will not be revoked for as long as holders remain compliant with conditions expressly provided in the water permit, the Water Code and other implementing regulations. Nevertheless, in Article 29 of the Philippine Water Code, as amended, water permits may be revoked on grounds of non-use for a period of three consecutive years reckoned from the date of issuance of the water permit or completion of diversion works and necessary structures. This will render the permit null and void, except when the NWRB deems the reason/s to be beyond the control of the water rights holder.

C. Current Water Rights Pricing Methodology in the Philippines

Water permit applicants are required to pay the NWRB a fixed filing fee of ₱7,200 per application and annual water charges which vary based on water rights classification and water abstraction.[9] It is important to note, however, that unlike other countries, annual water charges and water quotas in the Philippines are expressed in flow, i.e., liters per second (lps), instead of volume of abstraction. Fixed annual water charges are levied on water permittees depending on the purpose of water use and granted water allocation (in lps) as indicated in the approved water permits.

The effective application fees and annual water charges were approved in 2015. The proposed increase in fees and charges in 2022 have not yet been approved as of writing. The proposed rates are still based on the administrative costs incurred by the NWRB in the process of rendering its services to the public, including salaries of its personnel, supplies and materials. This suggests that the underlying value of water is zero, and its full economic cost is not priced into the NWRB's fees and charges. If indeed, the NWRB fees and charges reflect water's full economic cost, the price of water rights should be dynamic, varying according to, among others, demand and supply conditions. Likewise, the price of water rights should reflect the environmental, ecological and social costs of its use.

Nevertheless, the NWRB has legal basis to incorporate certain economic costs in water rights prices. The Amended Implementing Rules and Regulations (IRR) of the Water Code of the Philippines allows the NWRB to revise the water fees or impose special water rates as the need arises, taking into consideration, among others, the following:

a) Intended use of water,
b) Quantity/rate of water withdrawal vis-à-vis other users considering the water-bearing potential of the source,
c) Environmental effects,
d) Extent to which water withdrawal will affect the source, and
e) Development cost of bringing water from the source.

This section has provided a brief overview of water resource management and water rights in the Philippines. The rest of the paper proceeds as follows: Section 3 surveys the bases used for initial water rights prices in other countries, provides examples of economic pricing models used in three countries, namely China, Australia and United States of America (USA), and presents water markets in these countries as case studies. Section 4 identifies major issues and challenges in implementing economic pricing of water rights in the Philippines. Section 5 discusses and integrates the results of the analysis and presents general findings. Conclusions are provided in the last section.

III. Review of Related Literature

A. Initial Water Rights Pricing Across Countries

[9] Except for municipal Level 1 and 2 and communal/individual water rights, which are charged a permit application fee of only ₱550. Source: https://nwrb.gov.ph/fees-and-charges

The criteria used for setting the fees/charges for water rights vary across countries/states:

Country	Basis*
China	Volume of water abstracted (provincial level) and purpose of water use
Arizona	Volume of water abstracted, area of use, and source of abstraction
France	Volume of water abstracted (river basin level)
Australia	Volume of water abstracted
Germany	Purpose of water use and source of abstraction
Netherlands	Type of water source
Spain	Profit made by water user
England	Administrative costs of water rights administration and management
Italy and Mexico	Purpose of water use

Source: Bird & Von Custodio., 2009; Conca et al., 2020; OECD

*Unless otherwise stated, fees/charges for volume of water abstracted is determined at the national level

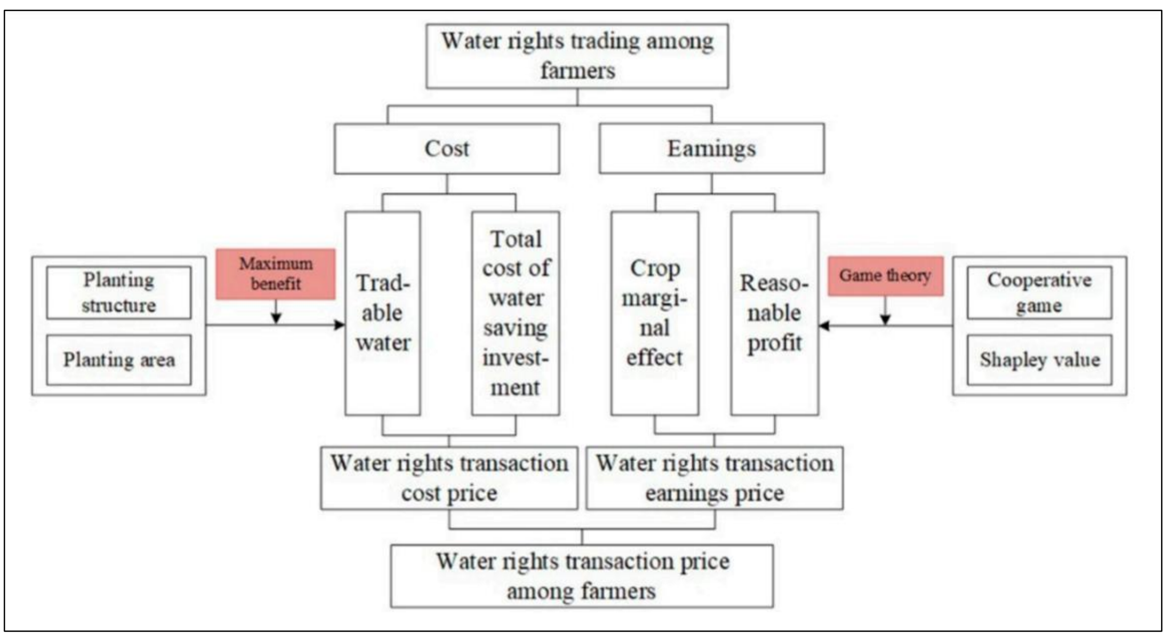
In Chile, no abstraction charges are imposed on holders of newly issued water rights. Chile relies mostly on its water markets for resource allocation (Bird & Von Custodio, 2009). Similarly, Austria and Sweden do not impose abstraction charges, but this may be explained by the relatively abundant water resources in these countries (OECD, 2021).

B. Examples of Economic Pricing Models for Water Rights

1. Water rights pricing between irrigation water users based on cooperative game in Hetao Irrigation District, Mongolia (Guan, et al. 2021)

   Many studies have shown that transfers of water rights within the agricultural sector incentivize water conservation in irrigated areas. Likewise, water rights transfers facilitate the movement of water from low to high-value use, enhancing the economic viability of irrigation districts. The pricing model for the Hetao Irrigation District assumes a transfer of water rights among three (3) farmers (i.e., one buyer-two sellers scenario), each planting a different crop and having initial water rights to specific amounts of irrigated water. The pricing model is depicted in Figure 1.

Figure 1. Hetao Irrigation District Price Model Diagram for Farmer to Farmer Water Rights Transfer



Source: Guan, et al. 2021

The water rights transaction price among farmers (in US$/$m^3$), is computed as the sum of cost and earnings price, with greater emphasis placed on the computation of the earnings price. The cost side is discussed first. The total cost of water saving investment refers to costs incurred for water conservation measures undertaken by the farmers. For simplicity, the authors of the Hetao study assumed that the only water saving measure implemented by the farmers was the adjustment of the planting structure at no cost.[10] In cases where conservation measures are undertaken at a certain cost, the cost price is computed as the total cost incurred to implement the measure divided by the tradable water volume.

Tradable water volume (in cubic meters) is computed as the difference between the optimal allocation of water resources and the initial allocation of irrigated water. The optimal allocation of water resources per crop is determined using supply and demand, with the supply side held fixed. The total crop revenue of the farmers is maximized subject to the constraint that the total water resources to be allocated to all farmers is equal to the sum of the farmers' initial irrigation quota (i.e., water demanded is equal to supply). In general, tradable water rights may come from water conservation measures implemented by the farmers or the amount of water saved after determining the optimal allocation of water resources for each farmer.

On the other hand, the earnings price refers to the difference of the marginal crop revenue of the buyer and sellers under different alliance decisions (using the cooperative game theory) and the marginal crop revenue after the optimal allocation of water resource, multiplied by a reasonable return coefficient.[11] The return coefficient was determined using the Shapely value method of Cooperative Game Theory to redistribute the income of farmers under different alliance scenarios.

To simplify, the per cubic meter transfer price computed under this model is the sum of the cost of water conservation and the marginal benefit/revenue of all farmers due to water trading. The main difference of this pricing model compared to the Ningxia pricing model (to be discussed next) is that the transfer price for water rights is a single amount, rather than a range of possible values. However, the transfer price computed under this model may vary depending on alliance decisions of the farmers. The transfer price may also be affected by initial allocation of water rights, water conservation costs, price of crops in the market, and changes in crop yield.

2. Water rights trading and pricing model between agriculture and energy development in Ningxia, China (Qin, et.al., 2022)

   Ningxia Hui Autonomous Region is a province in northwestern China. In 2014, a pilot project on water transfers between agricultural and industrial users was implemented in the province by the Chinese government due to Ningxia's significant water resource constraints. Agricultural demand accounts for 88% of water use in Ningxia, but more than half of the water in irrigation canals are wasted in the process of water transfer.

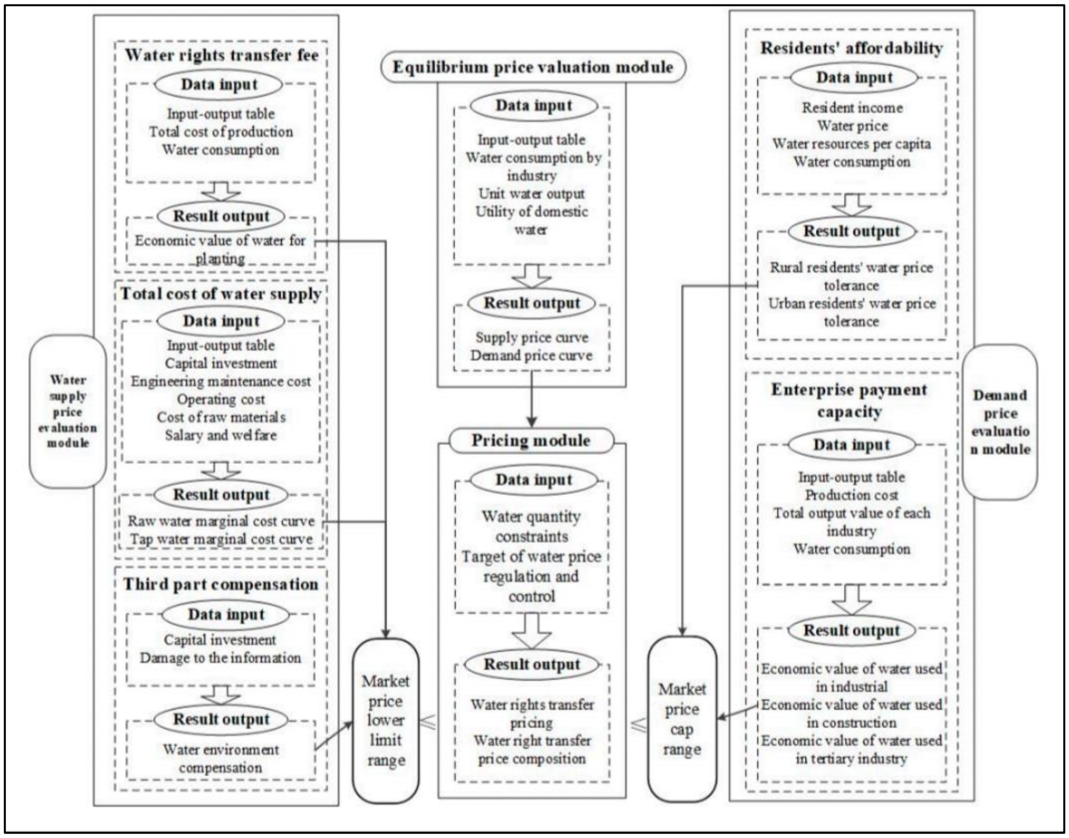
   The Ningxia water rights transfer price model may be used for transfer of water rights from agricultural use to industrial (e.g., energy development) or to residential use. The model considers the interests of the water rights assignor, compensation to affected third parties, the paying capacity of the water rights assignees, the overall economic condition of the country, as well as the level of available water supply.

   The model is composed of four modules: 1) supply price evaluation module, 2) demand price evaluation module, 3) equilibrium price evaluation module and 4) pricing module. The structure of the model is shown in Figure 2.

[10] Other water conservation measures include straw/plastic membrane mulching, field adjustment and land leveling. Adjustment of planting structure refers to choosing which crops to plant based on each crop's economic contribution and water footprint. At times, adjustment of planting structure may lead to reduction of irrigated lands.

[11] Under the cooperative game theory, players seek to maximize all the players' welfare and then divide the earnings among themselves according to all players' possible order of arrival and expected marginal contribution.

Figure 2. Ningxia Water Rights Transfer Pricing Model



Source: Qin, et.al., 2022

The supply price evaluation module is used to estimate the economic value of the water rights to the assignor. The supply price (CNY/m^3), is a sum of the following per-unit costs:

i. Water rights transfer fee which refers to the opportunity cost to the assignor/farmers of giving up water resources which could have been used in agricultural production; It is computed using data from the input-output model (i.e., production value and non-water costs) as well as data on water consumption (in m^3), and the specific water supply risks for the agricultural and industry sectors;

ii. Cost of water supply which is based on related capital investments (e.g., land, water infrastructure such as pipelines, canals, etc.) and other business costs incurred by the assignor to abstract water and transfer this to the assignee (e.g., transportation costs, labor, maintenance fees and materials); and

iii. Compensation price for third parties, which measures the actual impact of water rights transfers on other relevant stakeholders (e.g., damages for reduced flow to downstream user, increased groundwater usage, ecological and environmental degradation and decline in water quality, as well as other damages for any affected livelihood due to the water transfer).

On the other side of the model, the demand price evaluation module estimates the economic value of water to the assignee. The variables used to compute the demand price will vary depending on whether the assignee is an industrial or residential (urban/rural) user. For industrial assignees, the economic value of water is based on the gross value-added from water use, computed using the input-output table. For residents (urban or rural), the economic value is based on the residents' willingness to pay, computed using data on water prices, water supply and water consumption.[12]

The equilibrium price valuation and pricing modules use a general linear programming model with the objective function of maximizing national economic profit (i.e., gross value added) subject to water resource constraints and allowable values for the supply, demand, and equilibrium price.[13]

3. Water allocation prices for irrigation activity in the Southern Murray-Darling Basin, Australia (Gupta & Powell, 2018)

The Southern Murray-Darling Basin (sMDB) water allocation market is widely viewed as one of the most advanced water markets in the world due to its ability to facilitate large volumes of trade (approximately AUD 2 billion annually, which accounts for about 90% of water trading activity in the country) among water users in different river catchments. The sMDB facilitates both permanent and temporary trades, as well as interstate trades.[14]

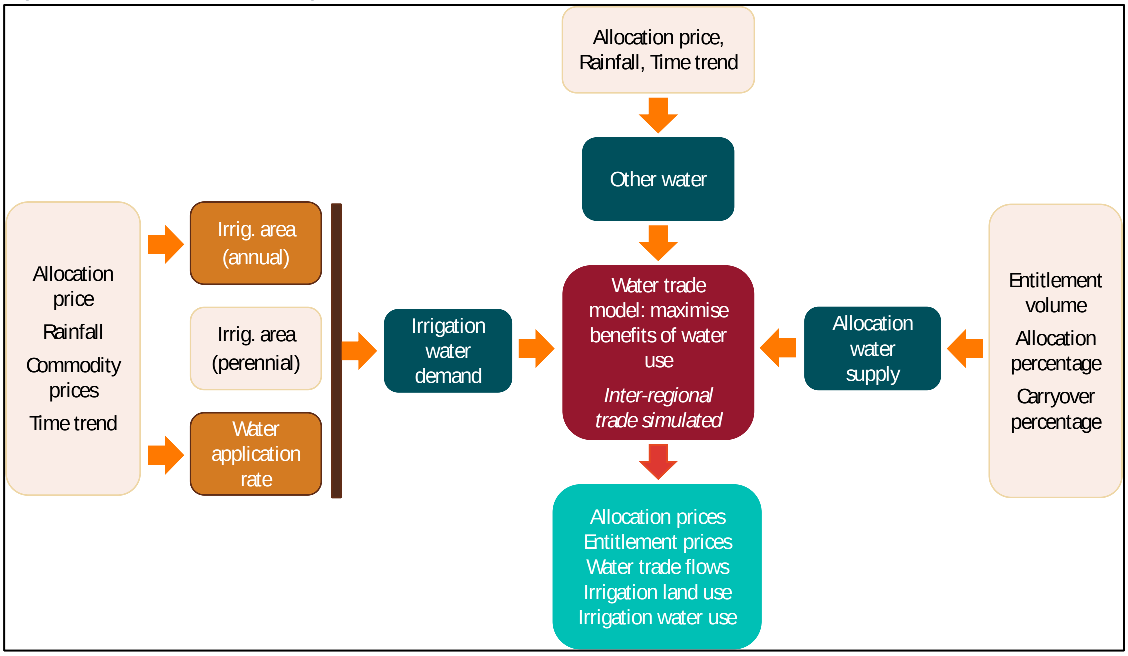
The model uses a spatial partial equilibrium framework and is focused on the short run.[15] Each region's allocation of water supply is based on water entitlement volumes, annual allocation percentages and carryovers.[16] This water can be traded between different irrigation activities and across regions subject to sMDB's trading rules. Meanwhile, water demand is estimated for each irrigation activity in each region based on the pricing model framework presented in Figure 3.

Demand for irrigation water (by region and irrigation activity) are based on estimates of irrigation land use and water application rates. Irrigation land use are simulated in each year given prevailing water availability, rainfall and commodity prices.[17] Water application rates, on the other hand, are defined for each irrigation activity as a function of water allocation, rainfall and commodity prices. In addition to these variables, estimates for irrigation land use and water application rates are also based on a parameter estimated by Ordinary Least Squares (OLS) regression. Parameters for irrigation land use are determined by irrigation activity and region based on water prices, average commodity prices and mean rainfall. Meanwhile, a dummy variable identifying the specific region is added to the above variables to estimate the parameter for water application rates.

Equilibrium water allocation prices are determined as those which maximizes the benefits of water use subject to constraints on trading.[18] Model results for water allocation prices are robust when compared to historical values.

[12] The term "water price tolerance" was used in the paper. Since the scenario presented in the paper was a transfer from agricultural assignors to industrial assignees, the authors did not provide further details on the application of the pricing model for residential users.
[13] The demand price should not be less than the supply price. If the demand price is less than the supply price, the water rights transfer will not be transacted through the market but may nevertheless be concluded through negotiation between the two parties.
[14] Permanent or entitlement trades in the sMDB refer to the trade of water rights which are measured as a constant volume of water per year. Temporary or allocation trades refer to the sale or transfer of a proportion of an entitlement. Meanwhile, interstate trading refers to water trade across state borders where river systems are connected. Source: Murray-Basin Darling Authority (MBDA)
[15] The spatial partial equilibrium model is a multi-region partial equilibrium model which links buyers and sellers from different locations. It solves the simultaneous equilibria of plural regional markets considering the existence of transportation costs between two regions.
[16] Water entitlement is the ongoing right to a share of the available water in the river system up to a maximum amount. It refers to a right holder's regular share of the water. In contrast, allocation refers to the amount of water an entitlement holder receives *in a given water year*. Meanwhile, carryover refers to the unused water allocation (or part of an allocation) that the entitlement holder saves for the next water year. Source: Common Water Management Terms, MBDA
[17] For some irrigation activities, irrigation land use is treated as exogenous and set to historical values. Perennial land areas (i.e., land used to grow plants that persists for several years) are only varied for purpose of scenario analysis.
[18] Inter-regional allocation trade constraints include regional import and export limits as well as other trade limits enforced by other regions during drought conditions.

Figure 3. sMDB Water Pricing Model Framework



Source: Gupta & Powell, 2018

The model may also be used to simulate water entitlement prices, which by definition, are much closer to the value of initial water rights than water allocation prices. Since water entitlements provide annual returns in the form of water allocations, the model determines water entitlement prices as the discounted values of future water allocations. The inherent assumption is that historical water availability and market conditions reflect future values. To make more robust predictions of water entitlement prices, current environmental water recovery levels are also used in the estimation.[19]

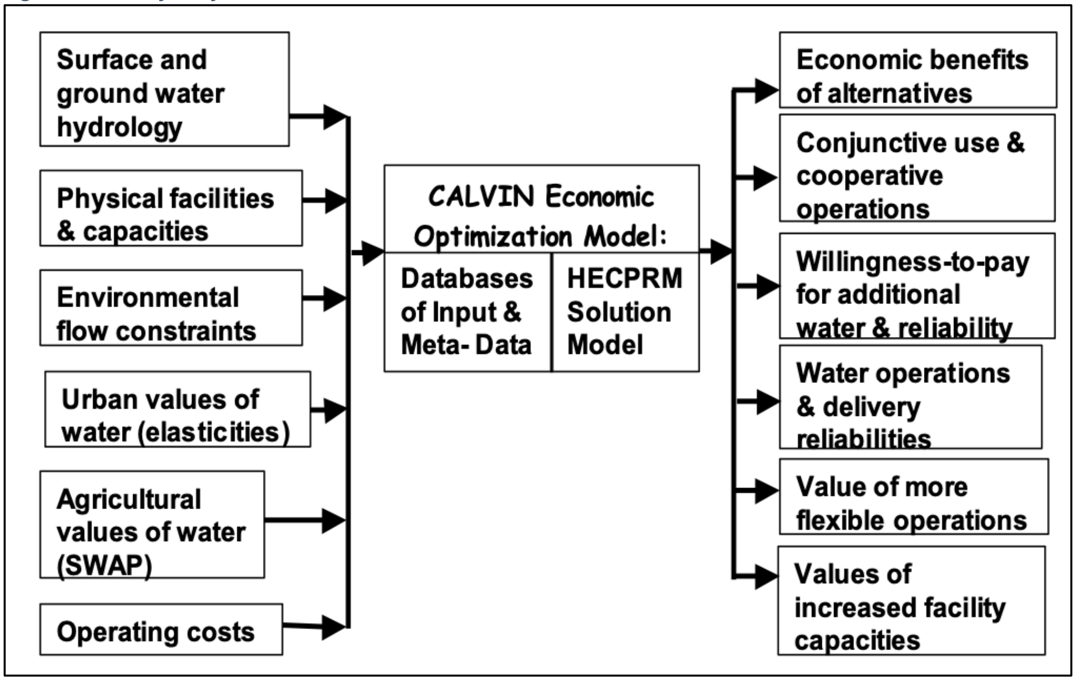
4. Economic-Engineering Optimization Model in California, USA (Howitt & Lund, 1999)

The complexity of the California Value Integrated Network (CALVIN) model is a reflection of the complex hydrological, technical, financial and economic issues surrounding California's water resources. The current and future (predicted) water scarcity in the State is characterized by interconnected problems related to both water supply availability and reliability.

In 1998, the State of California Resources Agency funded an 18-month study by a team of economists and engineers from the University of California - Davis, to analyze financing options for California's future water supply. As federal funding for water projects were no longer assured, it was necessary to assess whether private investment in new water infrastructures was an option. Thus, users' willingness-to-pay for additional water supply reliability became the basis for assessing the viability of building additional water infrastructures. Since then, the operational objectives of the project have continued to evolve. Among others, it was recognized that water markets and water transfers were feasible allocation mechanisms which may reduce or eliminate the gap between supply and demand. Specifically, an economic model would identify and measure the net benefits of water trading by exploiting spatial and temporal differences in the marginal valuation of water (Howitt & Lund, 1999).

[19] Water recovery affects water availability. Water recovery levels are determined as the difference between the maximum amount of water that can be sustainably diverted from the sMDB for consumptive use and the estimated average amount of water historically diverted from it.

Figure 4. Data flow for the CALVIN Model



Source: CALVIN Handbook, University of California, Davis

Despite the existence of other large-scale models for California's water system, none of these were able to perform simulations using a statewide hydrological period while using economic performance indicators as a criterion for operating the system. Thus, CALVIN was a new way of modeling the State's water system, abandoning previous simulation models in favor of an economic-engineering optimization model.[20] The particular technique used by the CALVIN model was network flow programming, a subset of linear programming. According to Howard and Lund (1999), the CALVIN model's specifications are as follows:

i. Economic objective function: Maximize statewide net economic benefits for agricultural and urban water use.[21]
ii. Decision variables: Time-series of reservoir storages and water allocations
iii. Constraints: Conservation of mass (change of storage = inflows – outflows), capacity limits of the water system (storage, conveyance systems and water treatment), and regulatory or policy requirements (e.g., minimum instream flows, restrictions on allocations and transfers)

The level of water in reservoir storages and water allocations estimated using CALVIN are driven by economic values for agricultural and urban water use across different parts of California. Demand for water is estimated using the Statewide Water and Agricultural Production Model (SWAP) and the Static Urban Demand Model (SUD) for agricultural and urban users, respectively.

The SWAP was developed alongside CALVIN to determine the economic value of water use as well as its variation across time and space. Like CALVIN, SWAP is an economic optimization model which maximizes farmers' returns from agricultural activity subject to production and resource constraints for both land and water. SWAP is still based on annual or seasonal planting decisions but is able to estimate monthly water use. The model captures how farmers adjust crop production when there are changes in

[20] Simulation models were used to estimate economic benefits from a given set of water allocations. On the other hand, optimization models determine optimal water allocations and operations given a certain set of economic values. Ideally, these two types of models should be used simultaneously (Howard and Lund, 1999).
[21] Net benefits are defined as economic benefits less operating costs.

the price or availability of water.[22] SWAP is run several times typically under eight levels of water constraints. The marginal value of irrigation water (per region, per month) is imputed using the shadow prices associated with the different levels of water availability. Maximizing the net marginal values of irrigation water for each water availability level yields the maximum demand for irrigation water, which is the final output of SWAP and is a data input to CALVIN.

On the other hand, for urban water users, marginal value functions are computed using SUD as an input to CALVIN. Urban regions are broken down into residential and industrial water users.[23] Residential water values are computed based on monthly residential water demand functions derived from published price elasticities of demand, observed retail prices and observed water usage. (Howitt & Lund, 1999). Commercial and public water usage are treated as having zero price elasticity of demand. Thus, the target demand for commercial entities and government is just added to the residential demand function. The integral of this composite residential function determines the reduction in consumer surplus (i.e., cost) associated with shortages in water supply. Meanwhile, the marginal value of water for industrial users are derived from survey data based on the opportunity cost of production due to hypothetical levels of water shortages. Industrial value functions are derived from these production values.

The CALVIN model is thus able to do the following:

i. Assess statewide economic value of water for agricultural and urban users,
ii. Quantify the economic value of new storage and conveyance facilities,
iii. Model water marketing and water transfers,
iv. Identify the viability of private investments for water infrastructures, and
v. Calculate the economic cost of increasing environment flow requirements.[24]

In summary, it can be seen from the above water rights pricing models that that there is no systematic, one-size-fits-all model for water rights pricing. Pricing of water rights transactions is a very complex task as prices typically vary according to many factors, which include the following:

1. Sectors involved in the transfer (e.g., agricultural-agricultural, agricultural-residential, etc.),
2. Number of parties involved in the transfer (e.g., single buyer-multiple sellers, multiple buyers and sellers)
3. Location-specific hydrological factors (e.g., water availability, supply risk for a specific water source, rainfall, climate conditions)
4. Environmental and ecological factors
5. Socio-economic factors (e.g., incremental loss due to water reallocation away from aggrieved parties, bargaining power of parties involved)
6. Other factors (e.g., heterogenous cropping patterns of farmers)

Nevertheless, while the different pricing models presented use diverse types of data, approaches, and methodologies, we are still able to glean fundamental economic principles from these models, which should form the basis for a theoretical water rights pricing model for the Philippines. While pricing models will vary depending on many factors with complex interactions, the underlying economic principles used in all these models may form the basis for a framework for valuing initial water rights, which should subsequently be adjusted or supplemented to account for specific attributes of each water rights transaction.

[22] Similar to the Hetao pricing model, farmers are assumed to adjust crop production depending on water availability and water supply. In the SWAP, farmers can make three adjustments: 1) reduction in irrigated crop area (i.e., land fallowing), 2) adjustment of cropping mix; and 3) deficit irrigation.

[23] The residential node includes residential, commercial and government water use.

[24] In the 2007 Brisbane Declaration, environment flow was defined as the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.

C. Country Case Studies on Market-Based Approaches to Water Resource Management: China Australia and California, USA

China

Water scarcity is an urgent and growing concern for China, particularly in its northern regions. Due to a combination of limited water supply, population growth and rapid economic development, urban and industrial demand for water has significantly increased and has exacerbated water shortages. Moreover, China's agricultural water-use efficiency is very low, with 55% of abstracted irrigation water being lost to leakage and evaporation.

In response to the existing water crisis, China has implemented market-based solutions to address water scarcity. Along with water price reforms, in 2014, the country's Ministry of Water Resources expanded seven existing pilot water market projects by establishing water rights trading systems in different provinces in Northern China.

However, the establishment of water rights trading in China was not without serious challenges. Moore (2014) grouped these challenges into three broad categories: 1) definition, enforcement, and participation; 2) integrated coordination and management; and 3) strategic policy integration.

The first category of challenges pertains to unclear property rights and lack of effective monitoring and enforcement of water rights. Unclear legal definitions and undefined attributes of water rights, such as duration and purpose, hampered market transfer of water rights. As a result, only a small percentage of water rights trades were verified, even as large discrepancies between actual and estimated water savings existed. Another main issue under this category was the implementation itself of the water rights trading system. Compliance with the water permit system was weak, which resulted into significant overconsumption of water. Wells were built without proper permits and even for those with permits, over abstraction was common. Adherence to quotas was not effectively monitored and enforcement was virtually non-existent.

The second category referred to unclear delineations of mandates and functions for trans-provincial water rights transfers, competition among different units of government, and a lack of appreciation of water rights trading as a strategic solution that involved extensive coordination. As a result, policies and regulations with respect to water rights trading were not integrated with other efforts such as water price reforms to resolve water scarcity issues. In addition, local governments decisions were sometimes biased against water rights trading in favor of more traditional water conservation measures.

The last category of challenges drove a wedge between market-based responses like water rights trading and regulatory reform, such as China's "Three Red Lines" policy and 20-year goals for water resource management implemented in 2011.[25] Apart from uneven implementation among the different provinces, the Three Red Lines required a scale of trading which has not yet been achieved by the water rights markets at that time. Similarly, water rights trading was not viewed as a major solution to water scarcity issues, but merely part of a package of policy responses.

Some of the challenges mentioned were merely operational, and thus were relatively easier to address. However, some involved legal reforms, institutional capacity building and coordination efforts across different jurisdictions and levels of government. A central strategy which integrates administrative regulation, market-based approaches and supply augmentation efforts needed to be formulated and communicated to the regulators and other stakeholders of the water rights markets (Moore, 2014).

At present, these issues have not yet been fully resolved, and water rights trading is still secondary to administrative regulation as a solution to water scarcity. Nevertheless, the seven pilot projects on water rights

[25] The Three Red Lines strategy correspond to the regulation of water supply, water use and pollution.

trading have established that transfers of water rights not only led to water conservation but also had a positive impact on reducing water scarcity. The variations in water rights trading in the pilot projects have provided water experts in China with a wide range of actual experience in water markets upon which they can build on in succeeding years (Jia, 2018).

<u>Australia</u>

Due to much variability in rainfall and water availability across the country, water resource management in Australia has been a challenge since the European settlement, well before the 1900s. As one would expect, early approaches to water resource management were mostly focused on augmentation of water supply. Up until the 1970s, the government invested heavily in water infrastructures such as dams, locks, weirs and water storages, establishing a steadier supply of water for municipalities and farmers. There was a significant tradeoff, however, as the state of the Murray River and its surrounding environment declined. In addition, population expanded along with irrigation demand, putting even more pressure on already scarce water resources. By the 1980s, water supply was rapidly dwindling and water rights in many river catchments have been fully allocated. Building more water infrastructures was no longer a viable option given its significant negative impact on the environment.

Extensive droughts in 1982 and 1983 spurred the development of early water rights markets, which functioned as a "cap and trade" market. Two important water reforms facilitated the water market's development: 1) caps on the amount of water in the Murray Basin which can be consumed, and 2) separation of water rights from land ownership. Between 1983 to 1989, trading of water allocations among private water rights holders began, but were still restricted and localized.

In the 1990s, water markets expanded, and trade in the Murray-Darling Basin (MDB) grew rapidly. Major government initiatives were implemented which gave way to interstate trading of water entitlements, an MDB-wide cap on water abstractions, entitlement reforms, and efforts to address overallocation of water rights in the MDB. In 1992, the National Strategy for Ecologically Sustainable Development identified water trading as one of the measures to deal with Australia's environmental problems.

As the market expanded, electronic platforms were introduced, which lowered transactions costs by making market information available and easily accessible. The National Water Initiative was implemented in 2004, through which the Australian government prioritized water market development as part of national competition policy reforms. By 2007, water markets have become the country's primary tool to combat water scarcity (DCCEEW, 2021).

Today, Australia is widely recognized as a world leader in water markets, with a turnover of AUD 1-3 billion per year. However, challenges remain, including the following:

1. Imperfect information – The lack of quality, timely and accessible information impairs decision-making by water market participants. Irrigators and traders would benefit from the availability and accessibility of information on key government policies and river operations.
2. Complexity of the water rights system – Differences in the trade processes and discrepancies in water registries between Basin states preclude market participants from getting timely and accurate supply and demand prices. Likewise, the complexities of the MDB water market are biased toward traders and businesses who are more equipped to participate in water rights markets.
3. Market manipulation and speculation – Inadequate rules govern market participants' conduct. Market manipulation, insider trading and other adverse trading behaviors can undermine the water market's integrity.
4. Changing conditions – Water use, trade restrictions and other key assumptions underlying market trades vary from time to time.

In response to these challenges, in 2022, the Australian Competition and Consumer Commission (ACCC) recommended a comprehensive reform package with broad categories as follows:

1. Better governance,
2. Stronger market integrity and conduct regulations,
3. Better trade processes and market information, and
4. Market architecture which better reflects the physical characteristics of the MDB system.

Moreover, the ACCC's proposed reforms include the establishment of a new and independent Basin-wide water markets agency, which will centralize the administration and regulation of water markets.

California, USA

California's water problems are characterized by interconnected issues on water supply availability and reliability, growing and competing demand for water among its agricultural, urban and environmental sectors, as well as water quality degradation and groundwater overdraft.[26] Rainfall and winter snowpack, which have been below normal levels in recent years, have further exacerbated water shortages in many regions across California. The State's water supply challenges were traditionally met with investments in water infrastructures. However, due to environmental barriers and the increasing cost of investing in new water infrastructures, the state government had to consider other ways to manage California's scarce water resources, including market-based approaches (e.g,, water trading, water markets and groundwater banking) and regulatory policies (e.g., imposing water restrictions for certain sectors).

Trades in California's water markets are made through short- and long-term leases, and permanent sales of water rights. Short-term leases allow for water to be used in activities and places where the costs of water shortages are higher. Meanwhile, long-term leases as well as permanent sales address geographic shifts in demand due to population growth and economic developments. (Hanak et al., 2021). Most trades in California's water markets are for surface water. While groundwater trades have been limited to certain managed river-basins, groundwater trades are expected to increase due to the Sustainable Groundwater Management Act (SGMA) of 2014, which aims to protect groundwater resources over the long-term.

California's water markets took off during the 1987-1992 drought. However, while there was an observed shift to long-term leases and permanent sales, trading volume has remained fairly stagnant since the 2000s. As of 2021, the water market in California covered only 4% of the water demand, and varied in extent and type of participants across regions. (Hanak et al., 2021). Moreover, while there is considerable optimism among water managers and other stakeholders of the markets' potential to improve water resource management, build resilience to climate change and support the environment, the State's water markets continue to face serious challenges, which include the following:[27]

1. Lack of transparency in market information

   Transparency is an essential feature of effective water markets. However, the system in place for trading of surface water in California has been criticized for its lack of transparency, especially with regard to market trends in quantities and prices of trades. Additionally, the transfer approval process is unclear, inconsistent and fragmented, with different rules for different participants and types of water rights. Market participants find it difficult to readily ascertain when, where and how much water is being traded. (Ayres et al., 2021).

2. High transactions costs

[26] Demand from the environmental sector refers to allocations for environmental flows.

[27] For instance, the Public Policy Institute of California (PPIC)'s Water Policy Center found that increased trading in water markets can reduce the costs of ending excessive groundwater use by about 60% in San Joaquin Valley, as well as protect jobs for low-income families (Hanak, 2021).

Transactions costs in California's water markets include both physical and administrative transactions costs. While not all trades are subject to physical transactions costs, proposed transactions are subject to a review process that will depend on the source and destination of the proposed water trade. Some trades may be subject to multiple levels of regulatory review by the California State Water Resources Control Board, California's Department of Water Resources and the U.S. Bureau of Reclamation. Meanwhile, some transactions are reviewed by counties (Hagerty, 2023). Administrative reviews by the state and federal government are lengthy processes, lasting months or even years, resulting to high regulatory transactions costs and increased uncertainty among market participants (Hanak, 2021).

3. Poorly defined groundwater rights

A fundamental requirement of a well-functioning water market is a legal system with well-defined and secure water rights. While surface water rights are in general, well-defined and tradable, the opposite is true for groundwater rights. In general, allocation of well-defined groundwater rights have only progressed for specially managed river basins. (Ayres et al., 2021).

IV. Major Issues and Challenges

The pricing models as well as the country case studies presented in the previous section suggest that implementing market-based approaches to resource water allocation, such as economic pricing of water rights, water trading and water markets, are complex multi-stakeholder initiatives that can be fraught with issues and challenges, even for countries with long-standing and advanced water markets. Thus, these are issues and challenges which must also be considered in assessing the feasibility of incorporating economic costs in water rights prices in the Philippines.

1. Legal framework for water rights

No market can operate without a legal framework underpinning it. Legal preconditions are necessary to promote water rights transfers and support water markets. Endo et. al (2018) prescribes a minimum set of three legal conditions that need to be met in order to institutionalize water markets, as follows:

i. Existence of a rule allowing water reallocation,
ii. Separation of water rights and landownership, and
iii. Modification of the cancellation rule for non-use.

The Philippine Water Code satisfies only the first two of the legal conditions provided above.[28] Water reallocation is allowed in Article 19 of the Water Code, either through lease or transfer of the water rights in whole or in part, with prior approval of the NWRB and after due notice and hearing. However, while this provision allows water transfers, the approval process would need to be changed in order to better facilitate water rights transfers. The existing legal provisions do not allow simultaneous or multiple levels of review (e.g., by river basin organizations and local government units) as well as the delegation of the review process depending on certain aspects of the trade (e.g., quantity, source, etc.).

As to the third condition, it was mentioned earlier that water permits may be revoked on grounds of non-use within a period of three years. The "use-it-or-lose-it" rule, while not strictly enforced in the Philippines, disincentivizes water conservation which generates the surplus water for transfer or sale to other users. Like the Philippines, California had a cancellation moratorium of only three years. However, to support its water markets, the state government extended the moratorium to five years and declared that conserved water is tradable.

[28] Presidential Decree 1067 Water Code (1976) dated December 31, 1976 and its Amended Implementing Rules and Regulations

On the other hand, an argument in favor of the "use-it-or-lose-it" rule is that it prevents dormant water as well as speculative behavior in water rights markets. In Chile, the absence of such a prohibition on non-use has resulted in hoarding of water rights and monopolistic behavior. To discourage such kinds of behavioral response, the Chilean government imposed an escalating fee against non-use.

Meanwhile, in the Philippines, the provision in Article 19 which reckons the start of the moratorium from the completion of diversion works and necessary structures has been used by some water permittees as a legal loophole to expand the period of non-use. Thus, to promote water conservation and better facilitate water rights transfers, the Philippine Water Code, which was signed into law nearly half a century ago on December 31, 1976, should be reviewed to reflect current legal and economic conditions.

2. Institutional capacity of the NWRB

Based on informant accounts, the NWRB appears to be severely understaffed. The processing and evaluation of water permit applications alone require significant manpower resources which the Board unfortunately does not have. To augment the limited number of personnel, the Water Rights Division of the NWRB relies heavily on staff from regional offices of the Department of Public Works and Highways (DPWH), National Irrigation Administration (NIA) and DENR to conduct on-site field inspections and investigations for water permit applications. Likewise, due in part to lack of manpower, the NWRB has been largely focused on and bogged down by its day-to-day/operational functions, leaving its policy formulation and coordination mandates on the sidelines. Based on the organizational chart of the NWRB, its Policy Formulation Section has only four staff, composed of three engineers and one economist. If water is to be managed as a scarce economic resource, the NWRB must be equipped with the right set of skills not only to effectively perform its regulatory functions but also its policy formulation, policy coordination and economic regulation functions.

Apart from being understaffed, the weak enforcement and implementation of water resource regulations appears to also be due to rent-seeking behavior within the NWRB. For instance, based on informant accounts, there are many ways to extend the cancellation moratorium period of three years, one of which is to bribe NWRB personnel to overlook the period of non-use. Thus, in general, water permits are only revoked for non-use when there are complaints by third parties. Likewise, hoarding and non-allowable transfers of water rights (e.g., transfer of water rights by a government agency to a private firm through a conduit private entity) escape scrutiny by the NWRB due to rent-seeking and regulatory capture.

3. Policy coordination

As evident in China's experience, policy coordination across different levels of government is key to establishing efficient and well-functioning water rights markets. Since water is a multi-faceted and complex good, there is a tendency for the legal framework and network of water-related agencies to get complicated over time as well. In the Philippines, the water sector is fragmented, with ambiguous and overlapping mandates and functions among water-related agencies (Velasco, 2020). While this may be a more pressing concern for the water supply and sanitation (WSS) sector, the recent establishment of the WRMO may have resulted in overlapping functions as well. As previously mentioned, the WRMO is mandated to ensure the sustainable management of water resources in the country and tasked to immediately implement the IWRM, both of which should have been part of the NWRB's main functions.

Aside from the overlapping institutional set-up, there also appears to be weak policy integration among different government agencies. The alignment and harmonization of policy actions by different levels and units of the government is crucial in achieving common goals and addressing interrelated challenges. Water resource management is a multifaceted and interconnected undertaking with social, economic and environmental dimensions. Ideally, it requires a holistic approach through collaboration and coordination among government actors. This lack of coordination may be best depicted using free irrigation as an example.

One of the main drivers of the establishment of water rights markets in other countries is the reallocation of water supply within the agricultural sector (Rosegrant & Gazmuri, 1995). This is true in both developed and developing countries. In the Philippines, irrigated agriculture account for about 76.2% of consumptive water use but with only 5.9% contribution to gross value added (GVA).[29] There is thus, much incentive to improve the efficiency of water use in the agricultural sector to free up water resources for other users.

However, in 2018, Republic Act No. 10969, or the Free Irrigation Service (FIS) Act was signed into law by then President Rodrigo Duterte, which granted free irrigation to farmers owning not more than eight hectares of land. Under this law, small-scale farmers are exempt from paying irrigation service fees imposed on water used from the national irrigation system (NIS) and communal irrigation system (CIS) managed by the NIA and other government agencies. The law likewise condoned unpaid irrigation fees and other penalties.

While the FIS Act was geared towards the promotion of comprehensive rural development and food self-sufficiency, in terms of water resource management, it was a step in the wrong direction. With free irrigation, farmers are no longer incentivized to conserve water and to shift from low- to high-value use. One can argue that there is a whole array of policies which can help farmers increase productivity without the risk of worsening water shortages (e.g., improving access to credit, providing crop insurance and other social protection programs, infrastructure development, investments in agri-processing, etc.). Even within the purview of irrigation, there are still other ways to improve agricultural productivity while promoting effective water resource management, such as replacing open irrigation canals with piped or drip irrigation systems.

4. High information and transactions costs

Transactions costs include the costs of defining, valuing and transferring water rights, as well as the costs of conducting and reviewing/verifying water rights transfers and trades. Given the uniqueness of each water rights transaction, information costs often account for a substantial portion of the high transaction costs in water trading. As may be seen from other countries' pricing models, a diverse and often extensive set of macro- and microeconomic data, hydrological data and forecasts, environmental and ecological statistics, and other information are required to estimate the transfer price of a single water right transaction at a certain point in time. The computational requirements of these pricing models are far from trivial. Thus, the substantial data requirements needed to price water rights is a key factor in driving up transactions costs.

By reducing gains from trade, transaction costs may hamper the development of water markets. For this reason, water trades are more limited than predicted by economic theory. Considering the large potential gains offered by water rights trading, thin trading volumes in most water markets across the world suggest that transactions costs are indeed high (Leonard, et. al., 2019).

Nevertheless, digitalization and other technologies, as well as developing new data sources can reduce transactions costs. For instance, under its New Water Initiative, Australia has been undertaking efforts to further minimize transactions costs on water transfers by improving information flows in its water markets (OECD 2021).

5. Political and equity issues

Water scarcity is becoming a bigger problem in the Philippines, along with other countries in the world. Its scarcity alongside growing and competing uses for water have extensive political and social implications. As demand for water grows with population, industrialization and urbanization, the competition for scarce water resources intensifies. Reallocations of water to various sectors due to water shortages has become a more frequent and more intense task for water managers and can often lead to conflicts among various water users and sectors. Unequal access to clean water, which is well-recognized as a basic human right, can exacerbate existing socioeconomic disparities.

[29] Average based on the Water Accounts of the Philippines, 2010 to 2021, from the Philippine Statistics Authority (PSA).

While it is well-recognized in existing literature and among water sector experts around the world that putting the right price on water will lead people towards more judicious use, increasing the price of water to reflect its true economic cost can be politically contentious, primarily on grounds of social equity. Pricing water at its scarcity value will likely increase its price many times over, especially in a country like the Philippines where water is currently valued at zero. Thus, it may be politically unfeasible to do so, especially since it will in fact, place a disproportionate burden on poor households and small enterprises. However, it is important to note that knowing the true cost of water is still necessary so that water managers know how far water prices are from the ideal value. Incorporating economic costs in the price of water can then be done little by little over time.

6. Externalities

Almost all forms of abstraction alter natural water flow regimes. Water extraction from its natural course through building infrastructure can substantially alter the hydrological cycle. Diversions such as dams and irrigation channels can disturb ecosystems which normally depend on steady water flows. Erratic and inadequate water flow impact the overall ecological balance by disrupting migration routes and breeding cycles. Certain uses of water rights may also increase harmful practices which contribute to water pollution. For instance, instream use for industrial purposes may result in the discharge of pollutants into the water source, leading to contamination. Even water use for agricultural purposes may lead to pollution and harm aquatic species as pesticides and fertilizers seep from the ground and into the water source. Saltwater intrusion may also result when net withdrawals from an aquifer are too high (Chong and Sunding, 2006).

Water rights determine who gets access to water and by what amount. Thus, in periods of water scarcity, water allocation decisions may be biased towards certain uses of water over others. In the Philippines, for example, domestic and municipal consumption are often prioritized over agricultural use. Yet, in these instances, farmers are often not adequately compensated for their income loss, if compensated at all.[30]

Moreover, even in the most basic sense, water use may affect flows for other water rights holder of a common water source. For instance, downstream flows may be adversely affected by water rights use of upstream permit holders. As seen in the China case study, this often results in water disputes among water rights holders, as compensation/damages for third-party impacts are not provided. The economic pricing of water rights should then take into account all of these environmental, ecological and social costs.

7. Hoarding of water rights for speculative purposes rather than beneficial use (NEDA, 2021)

Market regulators naturally expect some form of market manipulation and other adverse trading strategies to emerge in all types of asset markets in general, including water markets. However, even in the absence of water rights markets, manipulative practices already exist in the form of hoarding of water rights for speculative purposes. The NEDA, in its 2021 Philippine Water Supply and Sanitation Master Plan, identified this as a key issue in water supply and sanitation.

In the Philippines, water rights are essentially permanent in nature. While Article 29 of the Water Code allow for the revocation of water permits on the grounds of non-use for three years, as mentioned before, water permits are rarely revoked, except when a complaint is filed against the water rights holder with the NWRB. Likewise, documentary requirements for water permit applications are virtually the same between small-scale and larger permittees, such as deep well owners and bulk water suppliers, respectively. Ideally, past a certain threshold of water use, applicants should be required to prove that they have the financial and technological capacity, as well as the absolute intent to abstract water for large-scale use. More rigorous inquiry and investigation during the water permit application process will help detect potential hoarders and discourage them from acquiring water rights.

[30] As an informant recounted, in one instance of severe water shortage, water was reallocated by the NWRB from irrigation to domestic and municipal users of water. The affected farmers were not given any monetary compensation for their loss of income. Compensation was given by the government in the form of finding construction jobs for these farmers.

The most damaging effect of hoarding water rights is that it exacerbates water scarcity issues. Hoarders of water rights or those who hold them for speculative purposes, reduce the amount of water that would have been available to others, including farmers and communities. Thus, hoarding of water rights is also an equity issue. Depending on the level of water scarcity, this practice may drive up the price of water and disproportionately affect vulnerable segments of the population. Hoarders and speculators are mostly large-scale investors or well-capitalized firms. Therefore, concentrating control over water among this type of water rights holders may result to further socioeconomic inequities.

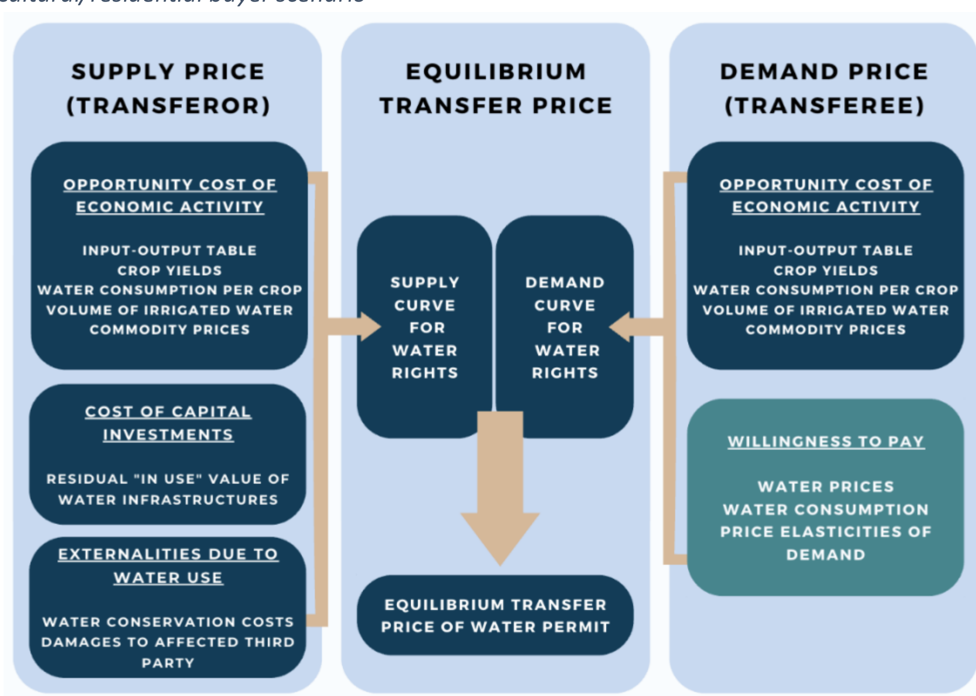
V. General Findings and Discussion

"Those who control how water is valued, control how it is used."
- UNESCO World Water Assessment Program, 2021

A. Core Components of an Economic Pricing Model for Water Rights

As mentioned earlier, fees and annual water charges for water permits in the Philippines are based on an administrative cost-recovery approach. Consequently, this pricing method does not reflect the economic value of water use. As may be seen across the pricing models examined in this paper, the economic prices of water rights should be based on the marginal value, or benefit, of water use. In the pricing model for Ningxia, China, the marginal value of water was determined through an input-output analysis which quantified the gross value added of a unit of water on agricultural commodities or residential use. While more complex in form, Australia's sMDB model and California's CALVIN model essentially adopt the same principle. The core components of an economic pricing model for the Philippines are summarized and depicted in Figure 5, which most closely resembles the Ningxia model, in view of its relative simplicity as well as the availability of input-output data for the Philippines.

Figure 5. Fundamental components of an optimal water rights pricing model – agricultural seller to agricultural/residential buyer scenario



Note: Box in teal green refers to the demand price for a residential buyer.

The simplest form of a water rights pricing model is that for an agricultural seller to an agricultural buyer, similar to the model used in Hetao, China. The supply price, or the minimum price an agricultural assignor would be willing to accept is determined by the opportunity cost or shadow price of the agricultural activity which would no longer be undertaken due to the transfer of water rights. The shadow price may be estimated using data from the input-output table, along with average data on crop yields, water consumption per crop, crop prices and volume of irrigated water available to the transferor.

The opportunity cost of capital investment includes the costs to the transferor of infrastructure built to abstract water. This may include intake devices such as pumps, valves, screens, as well as pipelines, storage and treatment facilities and control systems. The financial costs of these capital investments should be adjusted for market distortions such as tariffs, taxes and subsidies to reflect the true economic costs.

Spillover effects should be included in the water transfer price. For instance, if the transfer of water rights will cause reduced downstream flow below a certain threshold, the supply price should include damages or compensation to the downstream user. Water conservation costs include damages for ecological effects of the water rights transfer, costs to restore water quality to pre-transfer levels and other watershed protection costs. On the demand side, the benefit to the agricultural assignee is estimated in a similar way as the opportunity cost of the water rights transfer to the agricultural assignor. Using data from the input-output table, along with average data on crop yields, water consumption per crop, crop prices and volume of irrigated water available to the assignee, the shadow price of the agricultural activity which can now be undertaken due to the transfer of water rights may be estimated.

As can be seen from Figure 5, the equilibrium price will be at a level where the benefit to the assignee is equal to the total costs to the assignor, only a portion of which is the shadow price of the assignor's economic activity. This underscores the underlying principle that water rights transfers provide a mechanism to shift water from low-value to high-value use, whether trades are intra- or inter-sector.

B. First-Best, Second-Best and Third-Best Solutions

The first best solution to the economic pricing of water rights may well be the establishment of water rights markets where the true costs and benefits of water among market participants are revealed. Likewise, in water rights markets, transaction costs, while still high, will be spread across market participants and incorporated in the costs of trade. However, this represents an ideal solution in an ideal setting. Water is not like most commodities traded in asset markets, as it is a complex good and its allocation is a multifaceted and multistakeholder issue even when market-based approaches are applied. For this reason, countries that have established water markets several decades ago still contend with significant issues and challenges which hinder these markets from being truly efficient and competitive. The Australian water markets may be closest in semblance to a first best solution but is still not quite so because of market distortions such as imperfect information and externalities. Thus, while water rights markets may represent a first best solution, there is a need to look at second or even third best solutions to price water rights at its economic cost. The findings of this study may constitute the first, second and third best solutions to economic pricing of water rights. These are summarized in Figure 6 and discussed in detail below. The initiatives in the leftmost box constitute the third best solution. Adding the initiative in the middle box constitute the second best solution, while the first best solution is a composite of all these initiatives. Alternatively, Figure 6 may also be viewed as a roadmap to the first best solution, as all initiatives listed from left to right are also necessary preparatory steps towards the establishment of water rights markets.

1. Adoption of volumetric pricing along with initiatives to improve frequency of water meter reading

Volumetric pricing refers to a pricing method wherein water charges are proportional to the amount of water abstracted, i.e., a level or stock measure. It is a better resource allocation method than flow-based or flat-rate pricing as it ensures that those who use less pay less, and vice versa. Volumetric pricing encourages more efficient water use and directly links the cost of water to its use or consumption, thus providing financial incentives for water conservation.

Figure 6. Summary of solutions to the issue of economic pricing of water rights

As previously mentioned, however, annual water charges in the Philippines are indicated using flow measures (lps) and are based on administrative cost recovery. Likewise, these charges are generally fixed, except in cases of over-extraction (i.e., abstraction at a rate above the flow measure indicated in the water permit), for which a penalty of ₱3,000 for every excess of 1 lps is levied on water permittees. Moreover, water meters installed in diversion points are usually read only once a year.[31,32] Therefore, the current pricing method for water rights do not reflect the economic price of water due to the following reasons:

i. Administrative cost-recovery do not reflect the marginal benefit of water use to the water rights holders, as well as other social costs of water use.

As discussed in the previous section, economic prices of water rights should be based on marginal benefits of water use to the water rights holders, as well as include the cost of negative externalities (e.g., environmental effects and damages to third parties) which result from water use.

ii. Flow rates are a poor indicator of actual water abstraction compared to volume

Flow- or flat-rate pricing are at times, also called "unlimited" pricing. This method of pricing is often used when precise measurement of usage is difficult or when it is impractical to implement volumetric pricing. Clearly, this is not a pricing methodology which should be implemented on a scarce resource like water, as it charges users a fixed fee regardless of the quantity or frequency of usage. Under flow-based pricing, water rights users, particularly larger ones with water storage facilities, can

[31] Based on interview with the NWRB and informant accounts.
[32] Standard volumetric flow meters allow for measurement of flow rates as well as volume (i.e., volumetric flow rates), much like household electricity meters which can measure electricity usage at a certain point in time as well as total electricity consumption for a certain period (e.g., usually per month).

over-abstract as long as they do so within the approved flow rates in their water permits. Thus, flow-based pricing is inefficient in that conscientious water use is not incentivized, as well as inequitable since other users effectively pay higher annual charges than others. It is also important to note that while meter readings can and do reveal over-abstraction both based on flows and volume, only over-abstraction based on flows are penalized by the NWRB.

iii. Failure to capture incidences of over-abstraction due to infrequent meter reading.

As mentioned, water meters at diversion points are usually read only once a year; flow rates are thus averaged over this period. This presents a loophole in water resource regulation, as a water rights holder may average out extraction by diverting water at rates beyond that allowed by the NWRB, then subsequently abstract water at a lesser rate. The problem with this practice is that water extracted in this manner creates even more negative externalities, particularly by increasing water shortage risks for other users, as well as the adverse effects of over-abstraction, at any point in time, on the surrounding environment and ecosystem. These externalities are on top of those automatically created even by allowable levels of water extraction and are not priced into the annual water charges.

Shifting to volumetric pricing and increasing water reading frequency may be the most feasible and practical way to incorporate at least some economic costs to water rights prices. The standard water meters already being used by water permittees are able to measure the volume of water usage for a period of time and are read by the NWRB once a year. Thus, the shift to volumetric pricing (without changing the frequency of meter reading) can be done without any additional administrative cost to the NWRB.

Based on informant accounts, a previous proposal by the NWRB to shift from flow to volumetric pricing was not met favorably primarily due to equity grounds. A shift to volumetric pricing will surely increase water prices, making it more unaffordable for the poor. As a basic necessity, water is usually viewed not just as a commodity, but more as a basic human right. It has therefore been politically difficult to propose significant increases in water prices. Nonetheless, volumetric pricing is not an end in itself. Sound economic principles dictate that the economic viability of a project or policy does not require every stakeholder to perceive a net benefit. However, if volumetric pricing better reflects the economic cost of water than the current pricing methodology, it should still be undertaken since the net gains for the country imply that those who cannot afford to pay the higher prices can be cross-subsidized or compensated.

It is worth noting however, that even if the NWRB successfully shifts to volumetric pricing, tracking of water abstraction based on flow rates should still be undertaken to discourage and penalize withdrawal at rates above the water quotas currently being imposed by the NWRB, which are based on environmentally sustainable outflows. While frequent meter-reading used to be a labor-intensive and time-consuming activity, technologies such as automatic meter reading (AMR) and advanced meter infrastructures (AMI, or "smart meters") are now available, which more accurately measure usage and allow remote meter reading.[33] However, due to the additional costs of shifting from traditional meters to AMRs or smart meters, these devices may first be rolled out among larger water rights holders, such as bulk water suppliers and industrial users. In advanced economies, households are now starting to use smart meters.

2. Multi-disciplinary research

The water rights pricing models presented in this study provide an understanding of the computational complexities and data intensiveness of the task at hand. The data needed to estimate the economic price of water vary according to type and are not all readily available. At the minimum, to properly value water at its economic costs, macro- and microeconomic data, financial data, as well as hydrological and environmental data

[33] With both AMR and AMI/smart meters, water abstraction data can be transmitted from the device directly to the central information system of the NWRB through cellular or radio towers in the case of AMRs and through internet/satellite in the case of AMIs. In both cases, manual meter readings are generally no longer needed. Unlike AMRs however, smart meters are also equipped to detect and locate leakages in water connections, resulting in reduced water losses at the water rights holder level.

are needed. Therefore, the task will entail economists working with other disciplines and professions, including academics, engineers, hydrologists and other scientists, ecologists, river basin planners and the like.

Even in the absence of water markets, multi-disciplinary studies such as those conducted in pilot projects in Hetao and Ningxia will be a significant step towards estimating the economic value of water. At the very minimum, these studies should provide an environmental impact assessment of water abstraction, and therefore the conservation costs and value of other externalities which should be included in the economic price of water.

3. Promotion of good governance and strengthening of institutional capacity

As the government agency with the primary mandate of formulating policies on water resource management, it is a reasonable expectation that the dialogue on economic pricing of water would originate from, or at least significantly involve the NWRB. Unfortunately, this is not the case. Lack of manpower and an apparent mismatch of skills and competencies hinder the NWRB from actively engaging in policy discussions involving water resources. Likewise, informant interviews are ripe with accounts of rent-seeking behavior at the NWRB, which impede the effective discharge of their duties.

To enable the NWRB to better deliver its mandates, the promotion of good governance through strong leadership and strong governance structures are needed. Likewise, a comprehensive assessment of the agency's current capacity may help identify areas (e.g., skills, knowledge, resources, processes, etc.) that need improvement and provide a baseline for monitoring progress. Gaps in knowledge and skills identified in the comprehensive assessment may also form the basis of training and professional development interventions which will enable the NWRB to better perform its functions.

4. Improvement of policy coordination

Policies involving water use have extensive multidimensional impact (e.g., social, economic, political and environmental). Therefore, it is expected that water regulation policies will impact various sectors of the society. Conversely, other policies may also have unintended consequences in water resource regulation. A key example, as discussed in the previous section, is the disconnect between water resource regulation and the agricultural policy of making irrigation free. The FIS Act constitutes a huge setback in managing water resources as an economic good. However, repealing this Act would likely be a contentious political and equity issue.

Moving forward, incorporating economic costs in the price of water rights should entail horizontal and vertical coordination among different government actors. For instance, the impact of increases in water rights prices will likely be uneven across different groups in the population. Thus, it is necessary to coordinate with other government agencies and even local government units to cushion disproportionate impacts through the use of cross-subsidies and other methods of compensation. In any case, a collaborative approach to water resource management will enable policymakers to assess interdependencies and consider cross-cutting issues. This will break down silos among government units and promote integrated policy solutions.

The creation of a central coordinating body is an important step towards simplifying and harmonizing the currently fragmented set-up of the Philippine Water Sector as well as promoting policy coordination among government actors. However, the creation of such an apex body is not a simple task. This requires further study, which should include, among others, a thorough cost-benefit analysis of different organizational specifications and a careful examination of its integration with existing government structures and processes.

5. Improvement of legal framework

As may be recalled from the discussion of major issues in the previous section, one of the key challenges to the economic pricing of water is the absence of the legal preconditions necessary to promote water rights transfers and support water markets. In the Philippines, this pertains mostly to the provision on revocation for non-use of up to 3 years, as well as the review process for all water rights transfers. It is important to note that the

Philippine Water Code was signed into law in 1976, almost half a decade ago. While it was decreed in view of increasing water scarcity, it may be argued that the conditions then no longer reflect current conditions. Climate change, economic development, changing patterns of water consumption, advancements in technology and infrastructures, among others, must be considered in crafting an amended Water Code that is more responsive to the needs of the country.

6. Pilot projects on basin-level water markets using a multi-stakeholder approach

River basins are natural hydrologic units. Water markets operating at the river basin level face the same water availability levels, environmental profile, ecological needs and set of water users. Likewise, being the natural hydrological boundary, the river basin is the basic information unit for water sources. This is primarily the reason why the IWRM espoused by the United Nations also advocates that water resource management be rooted at the river basin level.

Similar to the approach taken by China, pilot projects across major river basins can be considered to test the behavioral response of water users to the economic pricing of water and assess the feasibility of other market-based approaches, such as water trading and water markets. Using pilot projects is a cost-effective way to better inform national policymakers of the viability of market-based solutions to water resource management. Likewise, pilot projects will allow for fine tuning the various aspects of the water rights trading process (e.g., definition, monitoring and enforcement of water rights) before rolling out to other places in the country. These pilot projects may also provide basin-specific volumetric prices which can be imposed in lieu of national volumetric prices, as this more aptly reflects the true economic price of water from a specific source.

Akin to the concept of IWRM, pilot projects at the basin level should bring together relevant stakeholders, such as government agencies, river basin organizations, water users, local communities and environmental organizations in building a basin-level management plan which include the economic pricing of water, and possibly water trading or water rights markets. This multi-stakeholder approach will ensure that the social, economic and environmental dimensions of the water resource management plan are adequately considered. Moreover, a more inclusive and participatory approach will foster cooperation, better dialogue, and information sharing among stakeholders in support of well-coordinated policy decisions.

7. Establishment of water rights markets in the long-term

It is no accident that in areas of the world where there is persistent and intense water scarcity, there is also a growing interest in water markets as a mechanism towards more sustainable water resource management. While water markets take a long time to fine tune and are by no means the panacea to the world's growing water problems, some water markets have been successful in some parts of the world, such as in Australia and Western USA (Hadjigeorgalis, 2009). Some water experts argue that water rights markets are here to stay. As climate change, growing population and increasing economic activity further worsen water scarcity problems, market-based approaches such as economic pricing of water and water rights markets will play an increasingly important role in water resource management. While there are currently limited applications to developing countries, except in the case of Chile, it may be prudent to consider that sometime in the future, water scarcity may indeed reach a level where establishing water rights markets will be a necessity.

In the Philippines, water markets seems to be a far-off idea. For one, water scarcity in the country may not yet be at a level at which water rights markets make sense. Likewise, the country seems to be ill-prepared for such an advanced market-based mechanism. As the United Nations Development Programme correctly pointed out in its 2006 Human Development Report, "For developing countries, with weaker institutional capacity, there are distinct limits to the market" (UNDP, 2006). Instead, the country would do well to focus on integrating more and more economic costs of water in its water rights prices over time in order to incentivize water conservation and address growing water scarcity problems.

VI. Conclusions

This study determined that indeed, water rights in the Philippines are undervalued. In fact, water is essentially given no value in the current pricing methodology. This is alarming given that the water scarcity problem in the country has been growing continuously in light of an increasing population, urbanization, greater economic activity and perhaps even climate change. Through the analysis of different pricing models used in other countries, this study determined the core components of the economic price of water rights. Likewise, the study looked at the feasibility of implementing economic pricing of water rights in the Philippines, as well as the issues and challenges associated with this market-based approach. A series of solutions, ranging from first-best to third-best was identified. The study concludes that while it is not possible to immediately price water rights at its full economic cost, it is possible do so little by little, starting off with volumetric pricing and strengthening the institutional capacity of the NWRB. This study may serve as a foundation or starting point for more extensive future research on economic pricing of water rights and water rights markets in the Philippines.

Appendices and References

Appendix 1. Definition of Terms

Hydrologic units – drainage areas that are delineated so as to nest into a multi-level hierarchical drainage system. Aside from the surface waters that are collected within the boundary of a hydrologic unit, it may also accept water from one or more points outside of the unit's boundary. (DCR, 2023)

Prior appropriation rights – a doctrine in property law that allocates water rights based on the place in history when a user first put the water to a continuous beneficial use. In case of a water shortage, priority access to the water is conferred to the holder of the oldest permit. Appropriative water rights allow water permit holders to sell their land separately from the land.

Riparian rights – a doctrine in property law that determines the right to use surface water based on land ownership. Property owners may make "reasonable use" of water, including for domestic needs, for as long as it does not obstruct the natural flow of water for other riparian owners.

River basins or drainage basins – a land depression drained by a river and its tributaries. A river basin or drainage basin includes the lowest point in a river.

Surface water – any waterbody found on the Earth's surface, including both saltwater in oceans and freshwater in rivers and streams.

Water conveyance systems – Infrastructures and networks which transport water from its source to other destinations. These may include canals, aqueducts, pipelines, conduits and other water supply networks.

Water reallocation – change in water allocation between agricultural, industrial, domestic, and environmental sectors, or within sectors. (Endo et. al, 2018)

Water market – an organization which implements water reallocation.

Water rights – legal rights to use water from a specific water source.

Watershed – an area of land and water defined by a boundary such that all surface drainage within the boundary converges to a single point. This point of convergence is usually the exit point or outlet, where the collected waters leave the watershed. Watersheds and hydrological units are almost interchangeable, except that there are watersheds out of which no water flows. (DCR, 2023)

Appendix 2. Basic Attributes of Water Rights

Attribute	Description	Philippine setting
Quantity	Amount of water (volume/flow) that a water rights holder may withdraw. It may also specify the amount of waste (volume/flow/ concentration or load) that the water rights holder is allowed to discharge	Not exceeding the stated liters per second (lps)
Quality	Quality of the water to be withdrawn or disposed	None
Source	Specific water resource for which the right was granted and its location and diversion point	Specific water source applied for, with address based on point of diversion as indicated in the water permit application
Timing	Restrictions on the time that the right may be used, i.e., the times that the volume/flow may be abstracted or time waste may be discharged	January to December (annual); no restriction on time of day as long as within the allowable lps
Conditionality	Conditions of use (e.g., use of water for intended purpose, prompt payment of water charges, measurement of water abstracted, measures to protect water resources, and installation/maintenance of devices/structures by the rights holder in relation to the subject water resource)	Specific conditions e.g., installation and maintenance of devices such as water meters duly inspected and calibrated by the Monitoring and Evaluation Division of the NWRB
Use	Specific purpose for which water is abstracted (e.g., municipal, irrigation, power generation, etc.)	Beneficial use: Domestic, Municipal, Irrigation, Power generation, Fisheries, Livestock raising, Industrial, Recreational and Other Purposes
Duration and Ownership	Length of time the holder is entitled to the right granted. Water rights may be permanent or time-bound.	No expiration
Transferability	Specifies whether the right may be sold or transferred to another individual/firm, or inherited	Transferable
Price	Fixed and/or variable fees paid for the right granted	Annual water charges according to water quota expressed in lps
Security and Enforcement	Regulator/administrative body with the legal mandate to grant the right	NWRB

Source: NWRB, ADB

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