wtrmrq.com

WATERMARQ

Summary Prospectus

Advancing water security and basin resilience through 'shadow' pricing

WATERMARQ

Contents

About Watermarq

Watermarq produces public and private goods to advance water security and basin resilience. We provide data, insight and capacity to government agencies, companies and financial organisations. We are developing a scalable subscription proposition to support our long-term financial sustainability. In the near term, we use a combination of grants (via a separate nonprofit entity) and consultancy engagements for our funding.

Watermarq works at the intersection of economics, policy and technological innovation. The solutions we are developing are novel, and require validation. Our team already has most of the technical and managerial expertise that we need to do this, and we have a strategy to fill any gaps in our own capacity.

Our unique contribution is the development of a series of 'shadow' water prices for each basin that we analyse. These are produced through a socio-technical process of discovering the underlying value of water to different users (domestic, agricultural, industrial) within a basin, based on the marginal utility that they derive from the water they use. This is a fundamental departure from traditional approaches that focus almost exclusively on volume rather than value. In addition, we source the best estimates available of the financial requirements for each basin to sustainably achieve SDG targets 6.1 and 6.2. We apply our value framework to these estimates to generate a series of shadow water prices for the different user groups. We socialise and disseminate this data with our end users to support their allocation, stewardship, pricing and investment decisions; consistent with advancing water security and basin resilience.

Context is key, and our shadow pricing model currently reflects local dynamics of resource availability, supply and demand. Over time, we will incorporate dimensions of water quality and access into this approach, and will also integrate sensitivities such as basin health, climate stressors, regulatory regimes, policy considerations and other variables into the value and shadow price framework.

The opportunity

The financial, economic and environmental case for incorporating value into decisions on water resource management and services is self-evident. Water is used inefficiently, and often wastefully, in almost every sector of almost every economy in the world. But, in our view, the societal case for using a value-based framework in decision making is not being made effectively enough. We believe that there is instead an excessive reliance on volumetric approaches that emphasise planetary boundaries, abstraction rates and 'replenishment accounting'. We consider that this emphasis on volume over value is a key reason why water resource management and service provision is characterised in practice by chronic underinvestment, across many parts of the world.

We see a societal and market need in breaking the status quo. It requires a novel and radical approach to valuing water that – in addition to volume – accounts for differences in who is using it, where, and how it is being used. Our innovation is in developing and then applying this approach within specific basins to support dynamic, contextual value discovery. To operationalise the output for decision making, we generate a series of shadow water prices for each basin.

Our solution involves the use of remote sensing, in situ and contextual data, which we enhance through machine learning and AI. Our mission is to provide decision makers responsible for resource allocation, investment and water stewardship with information that is both useful – and used.

To date, there is little empirical evidence of public agencies applying shadow water prices to inform policy, regulatory or allocation decisions. In the private sector, the concept of shadow (or internal) water pricing has existed for some time, but the available evidence suggests that it is used sporadically, often incoherently, and invariably inconsistently.[1] We intend to bring methodological rigour to the approach, so that a price-based value signal for water could be applied at scale.

1 Ceres (2023) Valuing Water Finance Initiative Benchmark (pp 26-7)

Rationale

We propose the development and deployment of shadow water prices as a solution that cuts the 'Gordian knot' around valuing water.

> **Gordian knot** • \GOR-dee-un-NAHT\ • noun. 1 : an intricate problem; especially : a problem insoluble in its own terms 2 : a knot tied by Gordius, king of Phrygia, held to be capable of being untied only by the future ruler of Asia, and cut by Alexander the Great with his sword.

There is a body of literature[2] in environmental economics regarding the use of shadow pricing, where market based prices do not adequately or comprehensively reflect the economic, environmental or societal costs associated with consumption of a resource. Existing shadow price frameworks typically require a monetary impact to be assigned to all favourable or unfavourable impacts, to determine a net benefit.[3] The methods for applying this approach to water have not changed much in the past 50 years. They have also proven remarkably difficult to use in practice and at scale. This is the problem that we identify as the Gordian knot.

Our solution is comparatively simple. We use technology to derive volumetric and contextual data on water at high resolution and at scale. We use economics to ascribe differentials in the value of water being used, depending on who is using it. We use external estimates of the investment required to advance water security and basin resilience. With this we produce a series of shadow water prices, differentiated by user groups and calibrated for local context. At every stage, we provide transparency on our method and assumptions.

We do not make any generalising statement about the intrinsic value of water. Nor do we claim to address every externality consideration regarding when, where, how much or by whom water is being used. Instead, we offer a value-based comparative assessment of these factors, with the objective of advancing water security and basin resilience. We describe this as cutting the Gordian knot.

2 For further reading, these resources from the GWP are a good starting point.

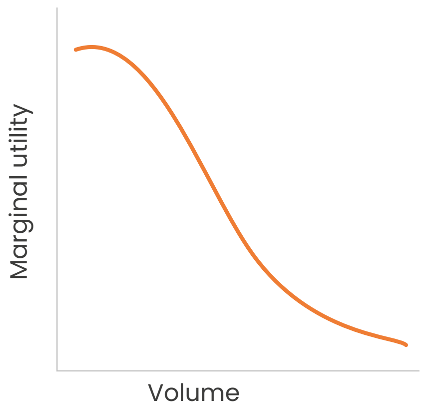
3 Stokey, E. and Zeckhauser, R. (1978). A Primer for Policy Analysis. W.W. Norton.

The value of water

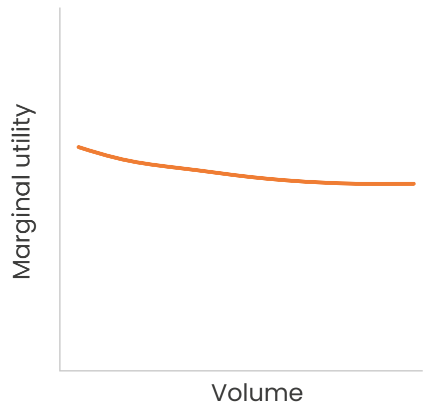
Water is an exemplar of the paradox of value.[4] This draws on the concept of marginal utility, i.e. the incremental value associated with an additional unit of consumption. In orthodox economics, the low price of water relative to its value is explained by its diminishing marginal utility ; i.e. its relative abundance means that unit prices are low despite the high marginal utility (MU) of the first units consumed.

Our approach challenges this orthodoxy on two grounds. Firstly, the assumption of abundance is context specific. In many parts of the world, demand for water is increasing much faster than available supply. Secondly, the assumption of diminishing MU does not hold for all water users. In many cases, MU stays relatively constant, even as additional units are consumed. The charts below illustrate how the MU (or value) of water for individuals quickly falls after basic needs such as hydration, cooking and hygiene are met. But where water is a factor of production (e.g. in industry), the MU stays relatively constant.

Individual consumption of water



Industrial consumption of water



Current approaches to valuing water through price do not routinely reflect these differentials in MU. Dynamic pricing such as rising block tariffs can offer a partial solution, but basing price purely on volume consumed is a suboptimal response to address differences in the value of water across user types; and can moreover lead to highly regressive outcomes in terms of social justice.

4 The most celebrated proponent of this argument is the economist Adam Smith, who referred to the 'diamond-water paradox' in *The Wealth of Nations* (1776)

WATERMARQ

From value to price

Our proposition is that differences in the value of water between types of users can be represented in financial terms. We consider this a necessary signal to influence consumption, stewardship, governance and investment. Price is the ubiquitous market signal, but pricing water to reflect its value is uniquely challenging given its context-specific attributes. We address this challenge through 5 steps:

1. Generate data on resource availability at basin scale
2. Generate value profiles for different types of user
3. Build a bridge between value and price
4. Generate shadow water prices
5. Calibrate to account for context

Step 1

Generate data on resource availability at basin scale. Specifically, we estimate the quantum of (and forecast changes to) water supply and water demand at a much higher resolution than existing tools allow, through a combination of remote sensing and in situ measurement (with climate modelling and analysis using AI in development). Our processes here are well advanced, and we can provide evidence of successful execution. Also in our development pipeline are solutions to include water quality and access (WASH) as part of this contextual analysis.

Step 2

Generate water value profiles for different types of users, using a marginal utility function. These stylised profiles require us to use various economic assumptions, which we validate through econometric analysis. We start with three profiles (domestic, agricultural and industrial users), which we'll iteratively extend, to incorporate differences between e.g. rural and urban domestic users; irrigated and non-irrigated agriculture; and specific industry sectors (food and beverage, clothing and apparel, mining, technology etc.). We publish our methodological framework for transparency, and to enable others to easily generate value profiles based on different assumptions.

Step 3

Build a bridge between value and price by 'financialising' marginal utility. Our initial approach uses estimates of current annual spending in the water sector, plus the estimated additional annual spending that is needed to achieve SDG 6.1 and 6.2, as a proxy for advancing water security and basin resilience. The gap between current spending and the estimated requirement to achieve the SDG targets varies markedly between countries, and we use the best available peer-reviewed data, at both country- and basin-level resolution, for this analysis. Finally, we synthesise data from the previous steps to derive net present values of current and required spending relative to annual and projected demand from the specified user groups. Again, we publish our methods for transparency and to enable different assumptions to be used.

Step 4

Generate a series of shadow water prices for specific user groups within each basin. Our working proposition is that if every user specified paid the respective price per unit for each unit of water that they consume, the total income generated would be sufficient to advance security and resilience. We acknowledge the limitations inherent in this approach. For example, it aggregates and internalises the significant costs that are associated with maintaining ecosystem health and advancing basin governance, allocative administration, redistribution, equity, inclusion, service delivery, regulation and enforcement. Our intent is to generate a baseline, using an open and transparent methodology, which can be iteratively improved upon by ourselves and others.

Step 5

Calibrate shadow water prices to account for context. In the first instance, this will be a function of resource availability, supply and demand. Future iterations will incorporate dimensions of water quality and access (WASH). Over the medium term, we will progressively sensitise the calibration to incorporate contextual variables including basin health, competing uses, climate stressors, allocative infrastructure, policy directives, regulatory regime, social licence, gender equality & social inclusion (GESI), and other factors. The approach inevitably relies on heuristics, and we are committed to providing full transparency throughout on our application of method, for example through version-tracked documentation and peer review.

Current progress

Watermarq was awarded a grant of approximately US$500k in 2023 from the UK government to develop and validate foundational components of our approach. We have used this to build up our capacity to systematically generate data on resource availability at basin scale, through a combination of remote sensing and in situ measurement. Examples of this work are included in the Appendix.

In November 2023 we won our first consultancy contract to apply this approach. It involves a hydrological assessment of water risk in 24 basins across 15 countries where critical minerals are extracted or processed. The contract has an estimated value of US$200k over the next 12 months. We completed the first phase of this project in March 2024, and produced a report documenting our analysis. While the full report is client privileged, we can provide a summary document on request.

Our in situ analysis to date has prioritised the Zambezi basin, where we have appointed our first dedicated basin specialist. Through this work, we are building a unique and highly insightful dataset on demand vectors and temporal changes in groundwater levels across several key aquifers. Our work has focused on Zambia, where our specialist is working in partnership with local stakeholders including the Water Resources Management Authority (WARMA), Lusaka City Council, and the Lusaka Water Supply and Sanitation Company (LWSC), the country's largest water utility. Zambia is also a priority focus country for us because of its high reliance on hydropower for electricity generation; and the economic, environmental and societal implications of the severe drought that is currently being experienced.

Other activity includes the development of an innovation pipeline and partnerships strategy. This work has been supported by our Advisory Board, which includes representatives from the University of Oxford, the International Water Management Association (IWMI), Anglo American, GSK, Franklin Templeton, Jefferies and others. Project-specific partnerships are currently in development with Deltares, the Water Research Commission of South Africa, the World Resources Institute, the Alliance for Water Stewardship, and the Private Infrastructure Development Group (PIDG).

Consultancy offering

Watermarq is committed to developing both public and private goods. We believe that the status quo of endemic water insecurity can only be broken by addressing the challenge of chronic underinvestment in basin resilience. This requires targeted and sustained collective action. Information asymmetries between public agencies and other stakeholders contribute to low levels of trust, which undermines many collective action efforts.

We generate data and insight to reduce these asymmetries. We also provide capacity and support to ensure useful information is actually used by decision makers. Public sector water management agencies in many of the most vulnerable basins face financial constraints in accessing decision-useful data. Our product development pipeline therefore includes solutions targeting differentiated end uses, such as basin-scale data provided for a low/zero fee to end users in the public sector, and asset-level data provided on commercial terms.

We are developing a business model to offer these different solutions at scale, through a combination of grants and subscription income. Subscription-based services are a work in progress and we presently generate organic revenue through bespoke commercial consultancy services.

Within our consultancy offering, we focus on companies who prioritise an active water stewardship agenda. We have excellent in-house capabilities for high resolution hydrological assessments of companies' supply and value chains. We are also targeting opportunities to apply our water value methodology with businesses that operate in multiple basins, and/or in contextually specific environments. Finally, we are building capacity to support companies that are subject to enhanced mandatory regulation and disclosure requirements, such as ESRS E3. Our emphasis here is on going beyond volumetric evaluation, to incorporate insight on water value.

For more information about our consultancy offering, please contact us.

Grant funding

We request grant funding to achieve outcomes which: i) are unlikely to be funded by Watermarq's current or future non-grant income; and ii) support the provision of public goods that are core to our mission. We have established a separate non-profit entity (Watermarq Public CIC) for grant-funded projects, and are in the process of securing Equivalency Determination. Our grant funding requests are targeted, specific and time-bound. We are currently soliciting funding totalling US$750k for three projects, for execution from July 2024 though January 2026.

1) Disaster related policy response (US$250k)

Focused on policy options to support the government of the Republic of Zambia develop adaptive responses to the current drought. Working with the highest levels of national government, via the Presidential Delivery Unit. Project involves providing government agencies with high resolution data and policy-facing support to enable contextual, dynamic water pricing; consistent with the Water Act (Chapter 198).

2) Incorporating WASH within a value framework (US$ 350k)

Focused on using results-based data and contextual information via AI to inform a scalable applied framework that incorporates WASH as a parameter of water value. Working with prospective partners including the Uptime Catalyst Facility. Project involves using information on performance, reliability, consumption and payment; for value discovery and to calibrate shadow prices at basin and/or national scale.

3) Collective action to advance basin resilience (US$ 150k)

Focused on socialising data and insights on water value with public, private and third sector actors that support the mobilisation of investment for resilience. Working with development banks, public agencies and prospective partners such as the Alliance for Water Stewardship. Project involves quantifying the economic, social and environmental returns – in financial terms – from specific interventions.

For more information on planned grant funded projects, please contact us.

WATERMARQ

Appendix

1. Codebase

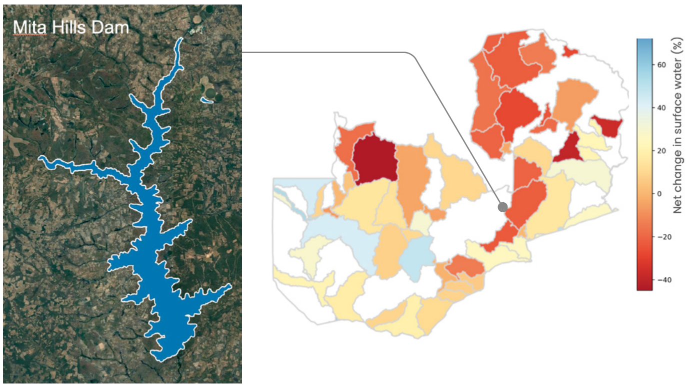
Our technical team has already built, tested and validated several methods to extract insights from high-resolution geospatial data. Our work to date has focused on temporal changes in surface water, agricultural demand (land cover and crop type), and domestic demand (population distribution and density). Our methods are documented, with the codebase available on our GitHub. We continue to develop and refine our technical capabilities, for example by resolving interpolation issues due to data gaps in pre-processed imagery.

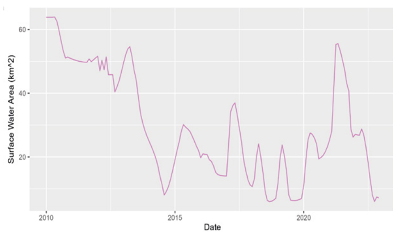
Excerpt from codebase (reservoir data)

```
def to_geopandas(data):
    """
    Ingests list of reservoirs and converts into a geopandas GeoDataFrame for further analyses

    """
    gdf = gpd.GeoDataFrame.from_features(data, crs=4326)
    # reserovir ids are not in the feature itself, add explicitly
    reservoir_ids = [int(f["id"]) for f in data["features"]]
    gdf["id"] = reservoir_ids

#     geoms = [shape(f["geometry"]) for f in data]
#     props = [{**f["properties"], **{"id": f["id"]}} for f in data]
    return gdf
#     return gpd.GeoDataFrame(props, geometry=geoms, crs=4326)


def get_reservoirs_by_geom(geom, base_url=base_url):
    """
    Gets reservoirs from API. Return dict with IDs.

    """
    url = f"{base_url}/reservoir/geometry"
    # do post request to end point with the serialized geometry as post data
    return requests.post(url, data=geom)

def get_reservoir_variable_ts(reservoir_id, variable_name, start=start, stop=stop):
    """
    Get time series data for a specific variable in a reservoir with the given ID
    """
    url = f"{base_url}/reservoir/{reservoir_id}/ts/{variable_name}"
    params = {
        "start": start.strftime("%Y-%m-%dT%H:%M:%S"),
        "stop": stop.strftime("%Y-%m-%dT%H:%M:%S")
    }
    return requests.get(url, params=params)

 #Can skip for more straightforward code, helps to visualize the shapefile basins being called
def plot_features_map(feats, ax=None, figsize=(20, 13), tiles=None, zoom_level=1, tiles_kwargs={}, **kwargs):
    """
    add a set of features to a GeoAxes map
    """
    if ax is None:
        f = plt.figure(figsize=figsize)
        if tiles is not None:
            tiler = getattr(cimgt, tiles)(**tiles_kwargs)
            crs = tiler.crs
        else:
            crs = ccrs.PlateCarree()
```

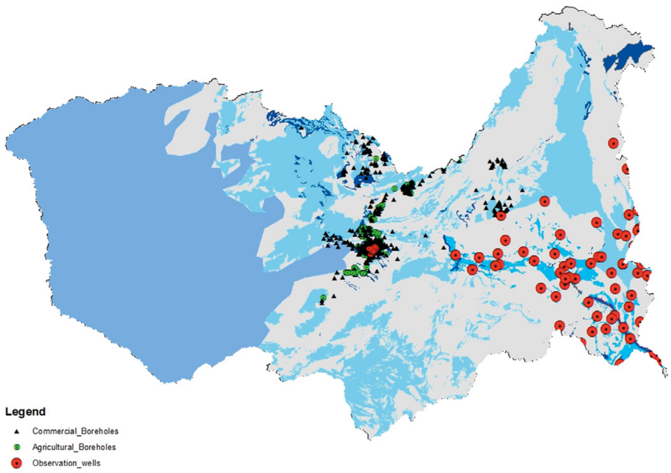
2. Visualisation

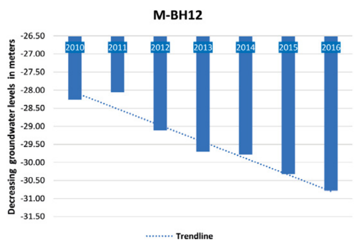
We run our code to generate insights within basins of interest. In this example from the Zambezi basin, we produce a visualisation of temporal changes (RHS) in surface water extent for a specific reservoir (LHS) based on geospatial data. We are able to perform this analysis for thousands of waterbodies across specified areas of interest in order to help build a detailed understanding of water supply dynamics.

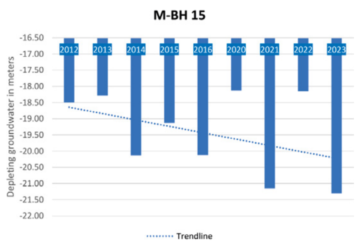




Geospatial data only provides a partial understanding of local context, and we use in-house basin specialists to measure changes in situ. In this second example from the Zambezi basin we combine aquifer productivity data with observation borehole locations (LHS), to measure temporal changes in groundwater levels (RHS)







3. Financial data

Our framework for deriving shadow water prices applies third-party estimates of the investment requirement needed within basins or countries to achieve water security and basin resilience. We currently use SDGs 6.1 and 6.2 as a proxy; recognising the limitations in doing so. Sourcing authoritative and up-to-date information on water financing requirements is a challenge. We use attributed sources for transparency, and are exploring how technologies such as generative AI could be applied to the large corpus of relevant information that is available, to enhance contextual analysis. Here we provide an example of third party estimates (source: World Bank, 2024). This particular dataset does not explicitly incorporate financing for self-supply, which is a significant component in many contexts, and one of the reasons we're prioritising approaches to improve the signal.

Excerpt from Funding a Water Secure Future (World Bank, 2024)

TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Angola	3.01	0.44	0.48	0.04	0.32	0.35	0.03
Benin	0.83	0.12	0.20	0.08	0.12	0.19	0.07
Botswana	2.28	0.37	0.52	0.15	0.22	0.35	0.12
Burkina Faso	1.35	0.31	0.31	0.00	0.26	0.26	0.00
Burundi	0.54	0.08	0.08	0.00	0.02	0.02	0.00
Cabo Verde	2.10	0.17	0.31	0.14	0.08	0.12	0.04
Cameroon	0.88	0.02	0.03	0.01	0.02	0.02	0.00
Central African Republic	1.83	0.31	0.44	0.13	0.21	0.29	0.08
Chad	1.29	0.15	0.24	0.09	0.16	0.23	0.08
Comoros	1.73	0.22	0.34	0.12	0.19	0.26	0.07
Congo, Dem. Rep.	1.79	0.23	0.32	0.09	0.18	0.26	0.09
Congo, Rep.	4.23	0.46	0.62	0.15	0.26	0.36	0.10
Cote d'Ivoire	1.17	0.21	0.30	0.09	0.17	0.26	0.09
Equatorial Guinea	1.64	0.33	0.47	0.14	0.21	0.33	0.12
Eswatini	1.49	0.27	0.39	0.12	0.20	0.28	0.08

table continues next page

WATERMARQ

Contact

Alex Money, CEO
alex.money@wtrmrq.com

Alex has 30 years of experience working in water, finance and sustainable development. Formerly a fund manager, he holds a doctorate in water risk from the University of Oxford.

Office Address: Grassroots Oxford, 46 Woodstock Rd, Oxford OX2 6HT, UK
Telephone: +44 (0) 1865 614 940. **Email**: info@wtrmrq.com **Website**: www.wtrmrq.com

Watermarq Limited (UK Registration no: 11287138)
Watermarq Public CIC (UK Registration no: 15776712)


WATERMARQ