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VALUING WATER: HOLISTIC APPROACH TO VALUE OF WATER – ECONOMIC, ENVIRONMENTAL, SOCIAL AND CULTURAL DIMENSIONS

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Valuing Water: Holistic Approach to Value of Water – Economic, Environmental, Social and Cultural Dimensions

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Introduction and Background

There is growing literature available on water valuation indicating that several water valuation frameworks are being considered to provide stakeholders with an explicit, transparent and scientifically sound valuation of water resources. They include traditional economic tools providing frameworks to compare and integrate the different components that make up the value of water, building on concepts such as total and full economic value, water accounting and the water value flow concept. The total economic value and the similar full economic value concepts are often used. The advantage of these frameworks is that they offer a relatively straightforward procedure for aggregating different value components into one overarching value. However, although the social and environmental values can be captured conceptually in these frameworks, the emphasis in their use in practice is on monetary expressions of producer and consumer values.

Realizing such a stakeholder-oriented approach to water valuation is not self-evident. It requires stakeholders and experts to overcome several challenges throughout the valuation process. Some of these challenges are related to strengthening the links between water valuation as an analytical activity and water valuation as it is being done, implicitly or explicitly, by stakeholders as part of their water resources management process.

An analytical challenge, to broaden the scope of valuation to include economic, social and environmental/ecological service values, to provide insight into stakeholder-specific values as well as relevant trends and dynamics. An adaptive challenge, to adapt to the working conditions for local water resources management in developing countries, requiring one to adapt valuation to the existing institutional setup and to the available data, knowledge, expertise, time and resources (and to the limitations thereof). Equally important is a participatory challenge, to embed water valuation in local stakeholder processes, combining stakeholder judgement, local knowledge and scientific inputs, through a process that is driven by stakeholders.

The paper would look into these innovative ideas that underline a broader scope when valuing the water resource, not only looking through economist lens but more an integrated look, these are central to this paper that follows.

Key role of Agriculture in Water Valuation

Agriculture is the backbone of Pakistan's economy. Pakistan's agriculture is mostly dependent on irrigation from surface and groundwater resources. Table below

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present a basic data for water accounting and auditing, giving us a preview of water values in Pakistan. Kharif (June– October) and Rabi (November– April) are the two principal agricultural seasons. Annually, out of total available water for irrigation, about 84 percent flows during kharif season and only 16 percent flows during rabi season. In the Indus Basin, water is delivered to farms by watercourses based on "warabandi". Warabandi is a continuous rotation of water generally lasts 7 days. The duration of supply to each farmer is proportional to the size of the farmers' land holding. Wheat is the basic staple food for the entire population, followed by rice, the second most important food grain in Pakistan. The crop yield in Pakistan is low as compared to other countries like China, Egypt, and USA. In Pakistan, the agriculture is characterized by increased demand for higher agriculture productivity, low irrigation systems performance, non-availability of water for irrigation and uncertainties resulting from global climatic change. Driven by increasing population, rapid urbanization and industrialization, there is an ever-growing demand and pressure on water resources and it is likely to increase dramatically in years to come. The future demand for the year 2024-25 has been estimated as follows:

Figure-1 Irrigation Water Requirements

Sr. No	Requirement/ Availability	2000-01		2010-11		2024-25	
		MAF	BCM	MAF	BCM	MAF	BCM
1	Net Irrigation Water Requirement	77.31	95.32	88.94	109.65	92.08	113.52
2	Non-irrigation Requirement	5.09	6.27	8.93	11.01	15.32	18.87
2.1	Urban Water Supply	3.10	3.82	5.10	6.90	10.24	12.60
2.2	Rural Water Supply	0.81	1.00	1.86	2.30	3.24	4.00
2.3	Industrial Use	1.18	1.45	1.47	1.81	1.84	2.27
3	Return Flows to River	-1.44	-1.78	-1.90	-2.34	-7.53	-9.29
4	Total Net Water Requirement	80.93	99.82	95.97	118.35	99.85	123.12
5	Groundwater Availability	30.75	37.91	31.25	38.53	31.75	39.14
6	Net Surface Irrigation Requirements	50.18	61.91	64.72	79.82	68.10	83.98

Sr. No	Requirement/ Availability	2000-01		2010-11		2024-25	
		MAF	BCM	MAF	BCM	MAF	BCM
7	Canal Head Requirement	116.42	143.53	135.74	167.35	134.07	165.28
8	Mean Annual Surface Water Available						
8.1	With Additional Storage Scenario	103.81	128.00	103.81	128.00	121.81	150.30
8.2	No Additional Storage Scenario	103.81	128.00	103.81	128.00	103.81	128.00
9	Shortfall						
9.1	With Additional Storage Scenario	12.61	15.53	31.93	39.35	12.26	14.98
9.2	No Additional Storage Scenario	12.61	15.53	31.93	39.35	30.26	37.28

Source: Pakistan Water Sector Strategy (2002)

Need to Rationalize Water use in Agriculture

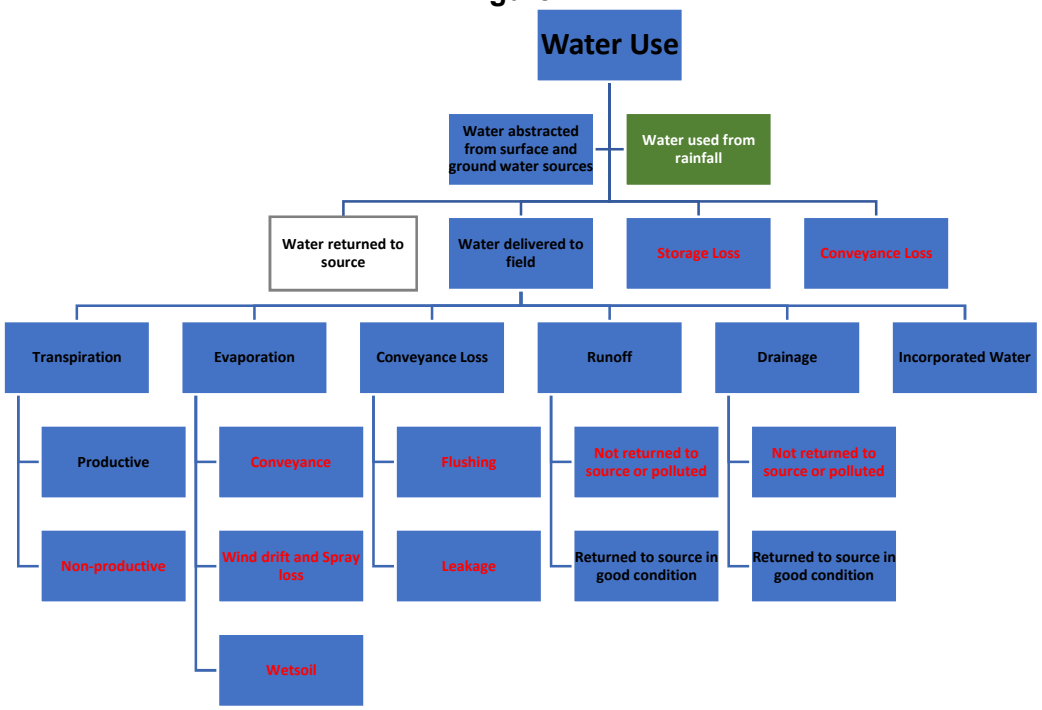
Agriculture in Pakistan use most water (96%), waste most and pays the least. It carries huge potential to add value per unit of water as it holds on to the lowest ranking. Water saving in agriculture relate to reducing the amount of water used for agriculture. However, this is not the only possible way to reduce the pressure on water sources. Reductions in the pressure on water sources can be realized by using appropriate techniques for irrigation, relevant management practices, by using water from alternative sources or by influencing parameters that will impact the socio-economic context, resulting in water saving. Two approaches can be used to reduce the water loss in agriculture.

- *Technological and improving management practices* ***(Wrong path of technology choice)***
- *Better inter and intra-allocation of water* ***(more crop and value per drop****)*
- *Shift to other source of water approach* ***(Use of recycle water)***

A water accounting framework is presented below to outlining the possibilities generating water values even at cost saving and generating additional revenues. The broad classification is green, blue, grey water and return flows. Each carries a tradeoff of generating supply or saving water at cost and value. This also called

as DPSIR framework that provides better understanding Issues linked to quantitative management of water.

Figure-2



Source: Bio Intelligence Service (2012), Water saving potential in agriculture in Europe: findings from the existing studies and application to case studies, Final report prepared for. European Commission DG ENV

Water as a Social and Economic Good: From Practice to Realities - The Cost of Water

While the value of water depends on its use, the cost of water is usually associated with the infrastructure of storing and delivering it the "use cost." The use cost can be calculated based on historical cost, on the cost of replacing the infrastructure (replacement cost), or on the cost that would be incurred if infrastructure capacity were expanded to produce another cubic meter of water (marginal cost). Another cost component, often ignored, perhaps because of the difficulty to grasp and measure it, is the "opportunity cost" of having the water in its present use[3]. As water becomes more scarce (both in terms of quantity and quality), the opportunity cost of the water becomes more acute and important to consider.

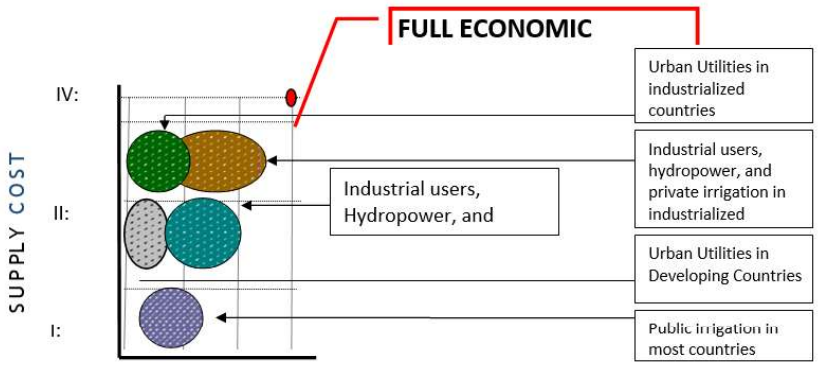
The opportunity cost of water is especially important when dealing with bulk water, since, the way water is allocated for use among sectors and regions will carry the

[3] Winpenny 1994, Briscoe 1996

opportunity cost component for all calculations of costs and values along the distribution path. At the bulk water level, allocation is considered mainly among sectors. Each sector is usually associated with different "water value" levels that result from its use. Cited values range from less than US$1/m^3 in agricultural uses to nearly 100$US/m^3 in residential and industrial uses[4].

Defining the link between water use and the opportunity cost of water introduces another concept— water allocation—into the framework[5]. Public water allocation is the least effective and efficient mechanism. Determining the right mix of pricing, market, and user-based allocation approaches is more complicated. The remainder of this chapter offers guidance for making such a determination.

Figure-3



OPPORTUNITY COST

Legend:

Supply Costs:

I: Operations and maintenance costs only

II: Average financial (capital + O&M) cost, with capital valued in terms of historical costs

III: Average financial (capital + O&M) cost, with capital costs computed

In light of the above, setting the achievement of full economic cost recovery as a bulk water pricing objective seems to be neither appropriate, sensible, nor attainable. In terms of cost recovery for use costs, there is still a long way to go just to achieve marginal cost pricing for average financial costs across all use types. As for charging opportunity costs, as a cash price, it is nearly impossible to make a good argument that reformers should integrate opportunity cost pricing

[4] Gibbons 1986, Young 1996, Briscoe 1996

[5] Spulber and Sabaghi, 1998

into their systems for two reasons. First, demand for water is only somewhat elastic. Non-agricultural consumers can only use so much water at prices higher than agricultural users pay. Once non-agricultural users get an increased water allocation, the opportunity cost will drop. Second, socioeconomic realities in most countries, particularly developing countries, would render any implementation of opportunity cost pricing highly impractical. In fact, as the 1997 International Commission on Irrigation and Drainage Conference concluded, it would be inappropriate to roll opportunity costs into water tariffs for three main reasons:

- because the information requirements are onerous (opportunity costs vary dramatically by place and season);
- because levying such charges would (usually correctly) be perceived as expropriation by those who currently use the water;
- because it would defy common sense—using the numbers cited earlier in this paragraph it would mean that farmers in, for example, Chile, Australia, and California would be asked to pay more than 10 times the cost of providing the services they receive!

More and more international experts[6] conclude that from a conceptual, practical, and political perspective, the appropriate approach for ensuring that the scarcity value (i.e. opportunity costs) of water is transmitted to users is to clarify property rights and to facilitate the leasing and trading of these rights. This means creating the necessary conditions for water markets to emerge.

Balancing Water Cost with Values

According to Jhon Briscoe (1996), value of water is the maximum amount a water user would be willing to pay for its use. Others (ICID, 2004) termed Value is the opportunity cost of water which provides the regulator (service provider) sufficient information to allocate water efficiently. However, due to non-existence or imperfect water markets, it is quite difficult to determine the actual value of water for different users (Briscoe, 1996). In addition, value of water varies among users, sectors, locations, seasons, times, quality and reliability (ibid). Thus, unlike other economic goods, proper valuation of water is not simple due to large scale complexities involved in water sector. It is generally perceived that the actual value of water is mostly not recognized due to which majority of water management project could not be sustained. Similarly, under-valued water encourages wasteful usage. Thus, for water to be considered as an economic good, it needs to flow to the high-value end use.

Value of water, is the sum of the economic and intrinsic value. The economic value includes the:

- Value to users of water for productive activities, such as irrigated farming;
- Net benefits of return flows of water diverted for agriculture and other users,

[6] Briscoe 1997, Bromley 1998, OECD 1999

which may also include groundwater recharge, although these benefits will depend on the lost to evapotranspiration.

- Net benefits from indirect use, such as drinking water for domestic purposes and providing habitat for flora and fauna, although these benefits can be offset by various negative environmental externalities, such as salinization of soils and pollution of water from farm chemicals used in irrigation; and,
- Adjustment for social objectives and values, such as the additional increase in commodity production gained from irrigation, higher employment and benefits for rural development.

The intrinsic value of water is linked to the attributes of water that are the most difficult to assign values, for example, the aesthetics of waterscapes and recreational attributes.

Water Value as Full Cost and Value adding Social and Environmental Dimensions

Figure-4

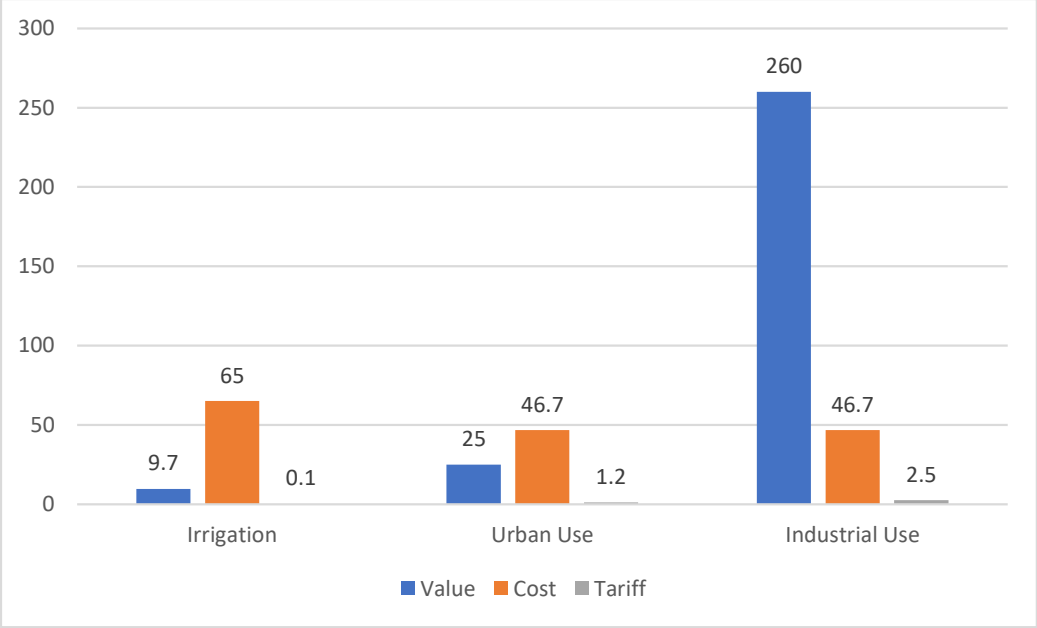
<table>
<tr><td colspan="3">Environmental Externalities</td><td rowspan="5">Full Cost = Sustainable value in use</td></tr>
<tr><td colspan="2">Economic Externalities</td><td rowspan="4">Full Economic Cost</td></tr>
<tr><td colspan="2">Opportunity Cost</td></tr>
<tr><td>Capital Charges</td><td rowspan="2">Full Supply Cost</td></tr>
<tr><td>O and M Cost</td></tr>
</table>

<table>
<tr><td>Intrinsic Value</td><td></td><td rowspan="5">Full Value</td></tr>
<tr><td>Adjustment for Societal Objectives</td><td rowspan="4">Economic Value</td></tr>
<tr><td>Net Benefits from Indirect uses</td></tr>
<tr><td>Net Benefits from Return flows</td></tr>
<tr><td>Value to users of Water</td></tr>
</table>

Ratios		
Irrigation	Urban Use	Industrial Use
Cost/Value =	Cost/Value =	Cost/Value =
Tariff/Cost =	Tariff/Cost =	Tariff/Cost =
Tariff/Value =	Tariff/Value =	Tariff/Value =
Figure in cents per m^3 $1 = 100 c		

Source: Rogers et al. (2002)

Figure-5



Considerable work has been done on the issue of water pricing and cost recovery, but literature is rare on the issue of full cost pricing and real value of water. The work by (Pogers.P, Silva.R, Bhattia. R 2001) provides a good insight for Subernareka Basin in India. It compares costs, values and tariff in agriculture, Urban and Industrial use, and a case where water competes for both sector Figure-5. Clearly the value of water in industrial use is far higher than urban and agriculture, which is the lowest. The high cost in agriculture is primarily due to opportunity cost as there is often possibility to divert water from low value use in agriculture to high value use in other sectors. It is also interesting to note that water tariff is only .01 cents m3 for agriculture compared 1.2 and 2.5 cents m3 for urban and industrial use, in other words an implicit cross subsidy from industrial sector goes to urban and to agriculture sectors. Growth in water scarcities, will tend to equate the three prices, though in realty food security concerns will keep this gap till countries' economies fully develop and less dependence on one sector.

Water Values – Pricing and non-pricing Issues

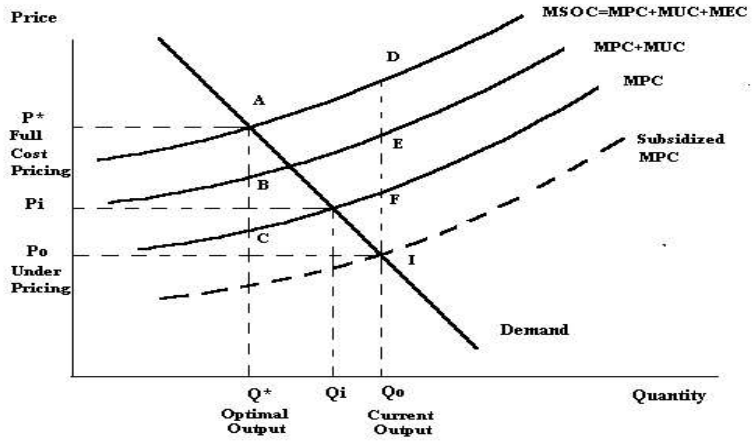
From economic prospective using above tools price is established where value in use should just equal the full cost of water that applies classical economic models where social welfare function is maximized. This is presented in figure below.

Pakistan provides an example where policy, institutional and market failure are pervasive and concept of full cost pricing is hardly debated. But the cost and forgone benefits are huge. With new flat rate policy farmers are paying for Rabi and Kharif seasons at new rate per hectare Rs124 for Rabi and Rs210 for Kharif crops, regardless of the type of crops grown in each season. Again, when we compare

these water charges to average annual per hectare groundwater cost that for small farmers (less than 10 ha) ranges from Rs3209 to Rs4555 signifying the degree of rent seeking exists in canal water use, indicating degree of policy failure. The institutional failure contributes to low price because it is an open resource. Another farmer can obtain the same cheap water and does not need to pay a high price. If the resource is closed and rights are distributed the water will become valuable and any increase in its value would go to the farmer or farmer association instead of Government. On market failure the externalities (unpaid cost) generated from non-point sources are quite dominant in agriculture sector. Watercourses are classic common property, shared by a number of farmers. The economic cost of poor maintained watercourses is borne by the tail end farmers, case very common in Pakistan. The environmental costs in the form of water logging and salinity are largely externalized to farmers downstream [Qutab 1993].

The most common divergence occurs due to policy failure often measured by the amount of direct or indirect subsidy provided. Institutional failure. This is often reflected in open access of resource use (lack of well defined, secure and tradable property rights) and weak and inappropriate land tenure arrangements. The last important component is environmental externality due to market failure (public good and natural monopoly) often referred to as marginal environmental or damage cost (MEC).

Figure-6



How to internalize these costs is directly or indirectly at the center of policy reform debate in Pakistan. Promoting policies that reduce the wedge between private and social cost can include

(1) Instituting a price regime which meets the financial needs

(2) Provide secure water rights so individuals or farmer organizations feel to own the resources and invest in its betterment and

(3) Institute a tax on penalty for user who pollute the valuable resources.

Among available economic and non-economic instruments, developing water rights/markets is one option that can internalize the above costs.

Such a policy action would need developing water rights that reflect the capitalized value derived from water (rent seeking and excess profit).

Table-1

Inter-sectoral Allocation: Marginal value of Water in different uses in Pakistan, (Rupees per 1000 liters)	
Agriculture	.4
Hydro-power	.9
Industry	2.0
Domestic	5.0-8.0
Tourism	8

Source: Harvard Case study on: "Water Submit In Kaula Region of Pakistan. 1996

In light above analysis, it is often argued the value of water in agriculture is much higher than stipulated as .01 cents per m3. A recent work (Hussain, 2006) argues that the value of irrigation water varies from US$0.004/ m3 to US$0.38/ m3 in the Asian countries, with higher values for Chinese and Vietnamese systems than for South Asian systems (see figure-7). Further, the value of irrigation water is higher when all direct and indirect broader-level benefits and impacts of water are taken into account. His work on Pakistan reveals that, the value of irrigation water increases from US$0.04/ m3 (in terms of productivity-related benefits) to US$0.12/ m3 when local-level benefits from other uses of water are also accounted for, which further increases to US$0.24/ m3 when local-level social benefits of poverty reduction are accounted for. These local- level estimates increase to US$0.48/m3 when quantifiable major direct and indirect national level economic and social benefits are included. If this is case, the value of water use in agriculture can be more than urban use but still far behind the willingness to pay by for industrial use.

It can be concluded that water values are not as low as often cited in the literature, but consider gap exist in willingness to pay for use of water in high value sectors such as livestock, domestic, industrial and tourism. In future water scarcity would put pressure on agriculture to release some water for high demanding use.

In practice, there is no single prescription for water pricing, each country needs to adjust its policy in way that results in saving water and its management. A broad cost recovery policy that takes into account (1) revenue needs of the system (2) distribute the cost equitably (3) provide incentive for efficient use of water and

capital (4) keep the tariff rate structure as simple so it can be well understood and implemented and (5) protects environments (Ahmad 2002). In short tariff regime gradually moves toward full cost pricing

Brief Case Studies

Pakistan: Turning cost of subsidies to beneficial values

Reforming and redirecting environmentally harmful subsidies in such areas as fossil fuels, agriculture, fisheries, transport and water could provide significant benefits for nature as well as for government budgets. Two case below showcase innovative policy reforms in Pakistan and Israel. The graphs below for Rice shows that simple and cost effective technology like raise bed and mulching resulted in that there is % increase in income and % drop in cost, similarly for sugarcane our study recorded is 43 % increase in income and 80 % drop in cost. The analysis shows policy shift of moving from conventional farming to sustainable for sugarcane entails 42 % increase in income and 95 % drop in cost. Adopting SNAS brings huge benefits to the farmer and more important making farmers profitable and competitive with cost reduction. The intervention contribute as net benefits of mobilizing or saving a unit of water.

The second is case of Israel where waste water has been transformed into valuable water resource to its most beneficial use, reducing waste and getting environmental benefits. The price of treated waste water per cubic meter has been set below those of fresh and brackish as an incentive for farmers to use it. This acted major Policy Shift, Provided incentive to shift.



Figure-7: Israel, Turning Waste water into generating values

fresh water for urban use – Used price as a tool. The end result being that recycled water was that in 1985 recycle water held a minor share in water supply to agriculture, today it hold a major share and expected that all water demand in agriculture would be met through waste water recycle. The figure below highlights the case.

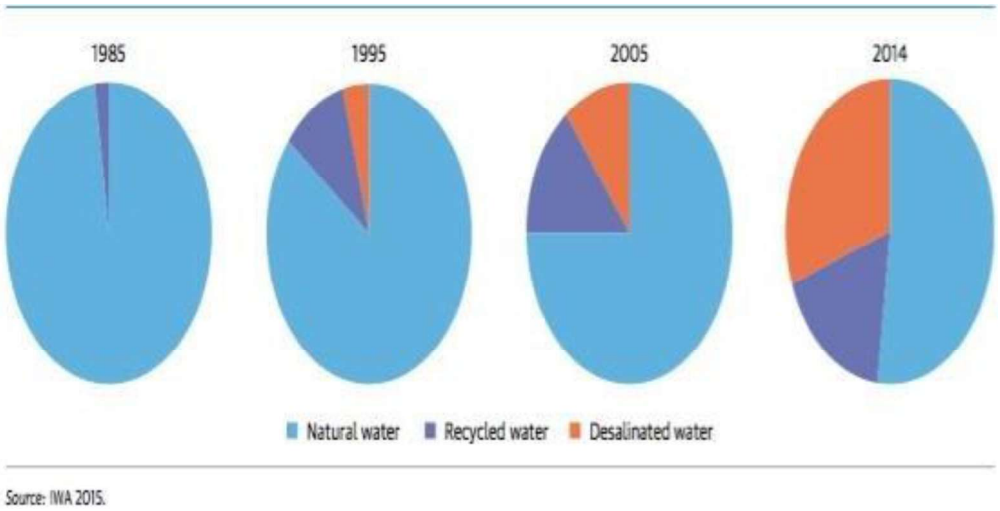


Figure-8

Source: Marin, Philippe, Shimon Tal, Joshua Yeres, and Klas Ringskog. 2017. Water Management in Israel: Key Innovations and Lessons Learned for Water-Scarce Countries. World Bank, Washington, DC.

India: Community Ground water Management – turning from depleting the water resource into valuable society assets

According IWMI report, at local level the community monitors hydrological information sharing, capacity building in groundwater management, hydrological data, prepare crop water budgets, and identifies over exploited aquifer zones. Strict regulatory actions included sanctions on excess water users and declared borehole drilling holidays to allow aquifers to recover. Water was used based on comparative advantage of a given crop and blended well with adoption of good agriculture practices. The typical institutional structure at a local level in is presented below. The core organizational component of the project is the groundwater management committee, and a village- level community-based institution comprising of all groundwater users. The committees are in turn grouped into hydrological units. The key is that its builds a strong link between hydrological and agronomic data, done through monitoring of rainfall and groundwater levels on one side and crop water budget on other. The World Bank reports that the state of Andhra Pradesh has produced the first global example of large scale success in self- regulation of groundwater use. It incurs a cost of US$2,200 per village per year with benefits as farmers have doubled their income, while bringing their groundwater use close to sustainable levels. In many cases, farmers have voluntarily reduced their water use, while continuing to safeguard their crops.

The results being sustainable use of ground water, higher water productivity, higher profitability and crop diversification – creating a win- win outcome.

Golden Rules and Lessons

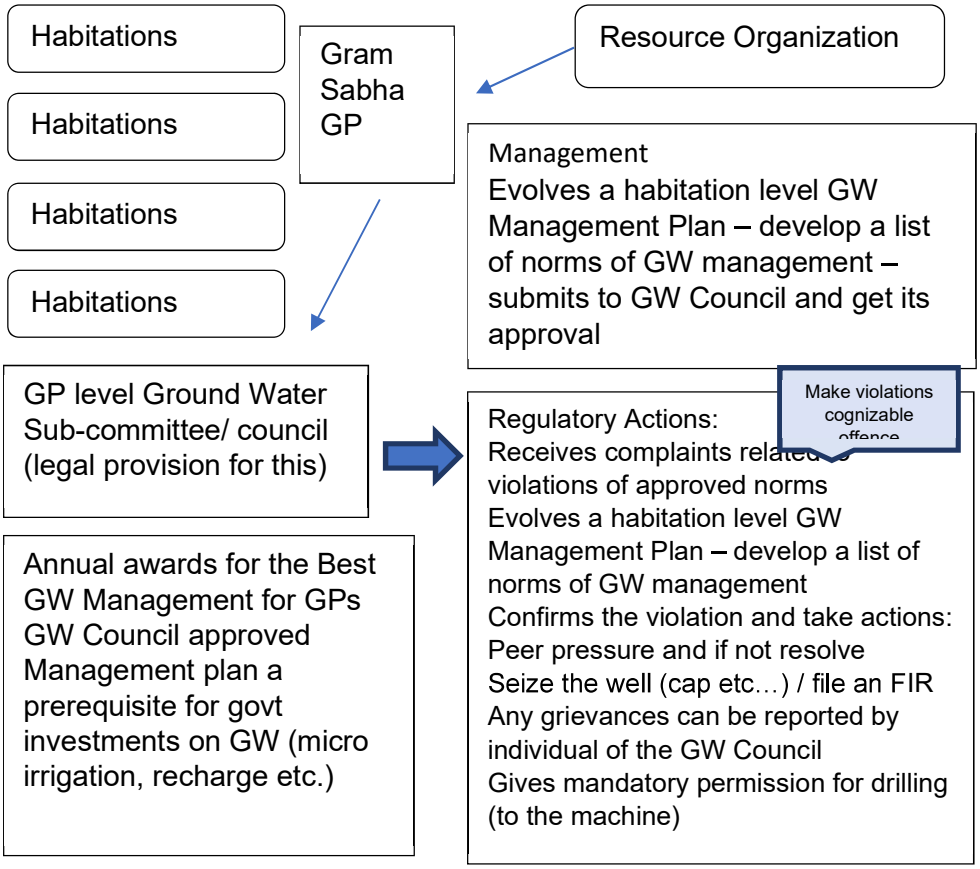
There is need to ***cognize three values*** often ignored dealing with water issues – first the environmental valuation, second the eco-system service and third the social dimensions. Climate change (too much or too little water) puts pressure on ecosystem invoking the need to provide ecosystem services that effects the people livelihood and test their adaptive capacity/vulnerability. The people are expected to respond with or without ecosystem based adaptions and mitigations. The present valuation hardly underpin this dimensions of water changing water cycle.

Make Water Values Visible: Water as public good results in widespread neglect of natural capital, leading to decisions that degrade ecosystem services. Decision makers at all levels should take steps to assess and communicate the role of ecosystem services in economic activity, and for *human well-being*. Such assessments should include analysis of how the costs and benefits of ecosystem services are spread across different sections of society, across localities, and over time. A good example in Pakistan – HIEC technology (High Efficiency Irrigation System) is very slow in Pakistan because water values are low. Global experience, Israel and Morocco case shows.

Water as a key natural capital -- pricing the priceless. Water as a natural capital delivers multiple services from local to global levels. On the other hand, the natural science under- pinning many *economic valuations* remains poorly understood. Nevertheless, both economics and ethics demand more systematic attention to the values of natural capital and ecosystem services. Substantial progress has been made in valuation methodology and the process should be uncontroversial for many ecosystem services, especially at the local scale. Further guidance is needed on how, in what context, and for what purpose to use which kind of valuation method, illustrated with quality examples, which are increasingly available. Focusing on how decision makers can include the benefits and costs of conserving or restoring nature in their considerations. Once the relevant ecosystem services have been identified, the context of the decision will determine which methods and what degree of quantification and monetary valuation is appropriate.

How we value the future is important – Depends to a large extent if it is public or private good. Discount rates reflect our responsibility to future generations and are a matter of ethical choice, our best estimates about technological change and the well-being of people in the future. Different discount rates should be used for different types of assets and services, factoring in their nature as public goods or private assets, and also whether they are capable of being manufactured or not (i.e. social discount rates for public goods and natural assets versus market discount rates for private goods and manufactured assets). Groundwater is a good example in Pakistan

Poverty and Natural Capital: Poverty is a complex phenomenon and the relationship between poverty and natural capital is not always clear-cut. In many countries poor households rely on *natural capita*l for a disproportionately large fraction of their income (e.g. in agriculture, poor quality water and forestry). Moreover these households have few means to cope with losses of critical ecosystem services, such as drinking water purification or protection from natural hazards. Sustainable management of natural capital is thus a key element to achieving poverty reduction objectives as reflected in the Millennium Development Goals. A good example is watershed management in Northern Areas

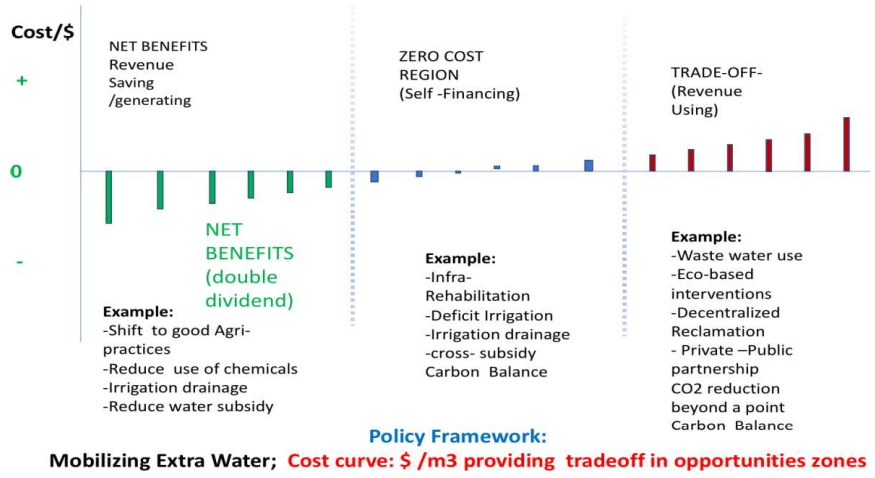


Source: Dr. Arif Anwar, Farmer Participatory Groundwater Monitoring: A Blueprint for Pakistan, Principal Researcher, International Water Management Institute (IWMI).

Value of water determine technology take off. Generating socially optimal combination of environmental quality and productivity, Technology take off will not happen as long two policy environments prevail.

Changing Incentive is key: *Economic incentives* including market prices, taxes, subsidies and other signals play a major role in influencing the use of *natural*

capital like water. In most countries, these market signals do not take account of the full value of ecosystem services; moreover, some of them unintentionally have negative side effects on natural capital. Reforming and redirecting environmentally harmful subsidies in such areas as fossil fuels, agriculture, fisheries, transport and water could provide significant benefits for nature as well as for government budgets. Ongoing work at WIT LUMS showcasing how Sustainable Natural Intensification System (SNAS) for Rice.



Mobilizing Extra Water; Cost curve: $ /m3 providing tradeoff in opportunities zones

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