Information and Communication Technology (ICT) Platform for Business Water Footprint – A Concept

A concept of an Information and Communication Technology (ICT) platform, "Enterprise Water Manager" (EWM) that enables business water accounting and disclosures for sustainable water management is presented. The platform draws from two widely accepted and mature methodologies- Water Footprint Network (WFN) and Life Cycle Analysis (LCA). EWM at an operational level provides comprehensive assessment of different water uses and discharges; this drives operational efficiency and process and product design for water sustainability. It incorporates local water resource context and regulatory and societal considerations. The platform scales-up to enterprise needs; integrates supply chain information helping managers to assess and be aware of upstream impacts of their purchasing choices; pulls together and presents enterprise wide picture of water use, discharge and impacts and helps identify hotspots and risks. A concept case of EWM application for an Oil Processing Terminal in Rajasthan (India) is presented.

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BACKGROUND

Water scarcity is a growing concern around the globe. Increasing demands for fresh water arise from a number of factors, including population growth, industrial development, improvement in standards of living; and this is compounded by contamination from harmful discharge of effluents and further by effects of climate change. According to an International Water Management Institute (IWMI) study nearly two-third of the human population will be facing water stress by year 2025, with nearly 25% of the population facing acute water scarcity (i.e. less than 500 m^3 of water availability per capita) (Seckler et al., 1998). Developing countries would be affected more including large countries like India and China. More than 33% of population in India and China will be living under absolute water scarcity. Water scarcity would force a redistribution of the available limited water between competing users. Inhabitants will have to reduce the amount of water use, especially in agriculture and transfer it to competing users thus increasing stress on food supply. Developing country like India with more than 15% of world's population but only 4% of the fresh water resources is facing both physical and economic water scarcity (Earthscan and IWMI, 2007).

Water quantity and quality issues pose serious threats to businesses in future (Gleick, 2006-2007). Industries and businesses are prone to be significantly affected by water scarcity since they are towards the end in priority for water supply. Businesses have realized they will no longer able to have access easily to relatively cheap and clean water and that they have to consider improving water efficiency and do away with discharge of wastewater in watersheds, ecosystems, and communities. Also, water scarcity in key geographic areas, along with expectations among stakeholders including consumers and investors, has created a compelling business case for organizations to pursue corporate water related initiatives as a strategy that drives down water-related impacts and the subsequent business risks (Barton, 2010). Businesses will need to assess and manage physical, regulatory and reputation risks related to water; critical elements of these risks could reside beyond their own operations in the supply chain and beyond the horizon in consuming markets.

Organizations have to assess the water use and effluent discharges for the goods and services produced across the supply chain for risk assessment and mitigation strategies. Comprehensive water accounting allows companies to determine the impacts of water usage and discharges on communities and ecosystems, evaluate risks and credibly report their consumption and discharge trends and impacts to key stakeholders. Corporate water disclosures are aided by third parties like Global Reporting Initiative (GRI) and Carbon Disclosure Project (CDP) Water Disclosure (GRI, 2011; CDP, 2011). GRI's G-3.1 guidelines encompasses five key metrics which Corporate have to report as part of water disclosure: 1) Total water withdrawal by source 2) Water sources significantly affected by withdrawal of water 3) Percentage and total volume of water recycled and reused 4) Total water discharge by quality and destination 5) Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the organization's discharge of water and runoff (GRI, 2011). The ability of the organizations to effectively account for corporate water use and impacts is critical to develop and align with stakeholders, as well as advance their sustainable water management.

This paper discusses the concept of a scalable Information and Communication Technology (ICT) platform, "Enterprise Water Manager" (EWM) that enables water accounting and disclosures for sustainable water management. The platform draws from two widely accepted and mature methodologies- Water Footprint (WF) and Life Cycle Analysis (LCA) (Hoekstra et al., 2009; Curran, 1996). EWM at a plant level provides comprehensive assessment of different water uses and discharges hence drives efficiency and process and product development for water sustainability. In addition it incorporates local water resource context and regulatory and societal considerations. The platform scales-up to enterprise needs; integrates supply chain information helping managers to assess and be aware of upstream impacts of their purchasing choices; pulls together and presents enterprise wide picture of water use, discharge and impact and helps identify hotspots and risks. In its essence it is also compatible with few existing accounting tools like – World Business Council for Sustainable Development (WBCSD) Global Water Tool (Global Water Tool, 2011) and Global Environmental Management Institute (GEMI) Water Sustainability Planner and Tool (GEMI, 2011).

WATER ACCOUNTING METHODOLOGY

Water Footprint

The water footprint originated as a water accounting parameter within geographically delineated area (province, nation and river basins). This approach was further extended to inter-nations trade, individuals, community and nation and very recently the framework has been translated for business water accounting and footprinting. Water footprint methodology is aimed at assisting businesses to prioritize water sustainability (Hoekstra et al., 2009). The water footprint of a business is the total volume of fresh water to run and support a business. Water use is measured in terms of water volumes consumed (evaporated/incorporated in the process/product) or polluted. It typically has two components; the direct water use by the producer (for producing/manufacturing and/or for supporting activities) and the indirect water use (in the producer's supply chain).

Based on the concept proposed by Hoekstra and others (Hoekstra et al., 2009) water footprints are categorized under the heads, Blue, Green and Grey: *Blue water* consumption is the volume of ground and surface water that evaporates during production. Thus, it comprises the amount of water that is not returned into the environmental compartment from which it has been withdrawn initially. *Green water* consumption describes the evapotranspiration of rainwater during plant growth, which is especially relevant for agricultural and livestock products. *Grey water* equals the volume of water required to dilute the discharged effluent until it reaches a regional water quality standards. A fundamental difference lies between the grey (a theoretical value based on water quality standards) versus the blue and green water component (actual measurements). The use of green water for e.g. has generally less negative environmental externalities than the use of blue water (irrigation with water abstracted from ground or surface water systems). The grey water component is the one associated with the most environmental externality.

Life Cycle Assessment

LCA methodology was developed from a process/product optimization standpoint. It was designed specifically for products and services through all components of the value chain and to measure its environmental sustainability including water (Curran, 1996).

The need for integrating water footprinting within LCA has been identified and has received renewed thrust by initiatives such as World Business Council for Sustainable Development (WBCSD) and the United Nations Environmental Program (UNEP-SETAC) Life Cycle Initiative (LCI, 2011). In a recent review Berger and Finkbiener (Berger and Finkbiener, 2010), identifies the need for important factors of consideration such as data precision, inclusion of local water scarcity and differentiation between water quantity and quality aspects for comprehensive and meaningful water accounting and sustainable water management. In the past LCA's has primarily been used for product/process improvement, policies at company level and environmental purchase and sales. This allows companies to identify opportunities for environmental improvement/optimization and measure the improvement along the entire supply chain. In addition businesses can develop a more rational and holistic view of the environmental impacts of their activities. This also aids as a support for environmental claims or as the supporting information for LCA-based eco-labels.

OVERVIEW OF DIFFERENT WATER ASSESSMENT TOOLS

Water scarcity and its associated challenges are increasingly capturing attention of businesses and the corporate sector. To respond effectively to the water related challenges, understand its impact and derive sustainable strategies many new initiatives and concepts have emerged since 2006. The initiatives to address these challenges are driven by business leaders in the field, civil society and governments. Most are global with multi-stakeholder representation; but some are also addressing more and more the specificities of water usage for a particular sector (for e.g. the beverage industry and the mining sector). (WBCSD, 2010)

Around seventeen tools/initiatives exist with reference to water accounting and footprint with the eventual goal to promote sustainable water management (WBCSD, 2010). The tools/initiatives developed so far use different approaches, including: guidelines, measurement methodologies, standards, reporting indicators and stewardship schemes. A review of these tools and initiatives is presented in a recent WBCSD publication – Water for Business (WBCSD, 2010). The report summarizes the tools and initiatives under heads of, risk identification and opportunities related to water use and impacts, measure water use and assess water related impacts, and develop response options and/or risk mitigation strategies. Further under the Water Footprint Neutrality and Efficiency (WaFNE) program, a thorough review and comparative of existing methodologies and supporting tools for corporate water accounting is covered in the report Corporate Water Accounting (Morrison and Schulte, 2010).

From the pool of existing tools/initiatives a few matured tools that address water accounting/footprint are, the WBCSD Global Water Tool (Global Water Tool, 2011), the Global Environmental Management Initiative (GEMI) Water Sustainability Planner/Tool (GEMI, 2011), and the WSP Tool (WSP, 2009), as given below:

WBCSD Global Water Tool

WBCSD Global Water Tool was launched in 2007. It consists of a spreadsheet based module that aims to couple corporate water usage, discharge, and facility information input with watershed and country level data (Global Water Tool, 2011). The tool uses an online mapping system that plots site locations with external water datasets and spatial viewing via Google Earth interface. It generates automatic outputs including GRI water indicators, inventories (water consumption and efficiency), downloadable metrics charts with combined company and country watershed data and geographic mapping. The tool allows the user to enter water-related data for suppliers and includes staff presence when accounting for water use. However the tool limits in the fact that it does not, address water quality/discharge-related risks, focus on impacts, assessments provide only rough estimates of risks (Jason Morrison and Peter Schulte, 2010) and does not provide specific guidance on local situations, which require more in-depth systematic analysis.

GEMI Water Sustainability Planner and Tool

The (GEMI), is a collection of dozens of mostly North American-headquartered companies working toward more responsible corporate environmental stewardship. The GEMI Water Sustainability Tool (2002) is an online tool that helps organizations to create a water strategy. It assesses a company's relationship to water, identifies associated risks and describes the business case for action, and helps address companies' specific needs and circumstances. It has five different modules under the heads of water use, impact, and source assessment, business risk assessment, business opportunity assessment, strategic direction and goal setting, strategy development and implementation. The tool falls short to include detailed risk and provides a rudimentary assessment of relative risks with no quantified results (Morrison and Schulte, 2010).

WSP Tool

WSP tool is a consulting level tool aimed to assist business management board to understand water related issues and develop a clear action plan and response (WSP, 2011). The tool measures, the water consumed in the supply chain, the water used in direct operations and the water used by customers using the products they've bought, identifies the products that use the most water and also where this water use is particularly sensitive. Thus enabling companies to protect their supply chain, identify areas of focus for supply chain sustainability programs and also enable them to engage with their customers. It maps the results in a simple, easily accessible and visual way.

Some Common Gaps in Existing Tools

Business water footprinting by available accounting tools are limited on account of the diversity of products and that of production chains, which are complex and different between nations and companies. Also due to lack of consistent metrics related to water assessment inconsistencies originate as a result of, intentional or unintentional improper accounting and/or reporting of water footprints. Further, water footprint is only one component of a larger water accounting and sustainability goals. The key value of the water footprint assessment for a business would exist in identification where it should target its efforts to ensure its water sustainability.

ENTERPRISE WIDE WATER MANAGEMENT MODEL

A comprehensive water management for an enterprise at an operational level must addresses efficiencies, product eco-design and water sustainable manufacturing, and at an enterprise level it should help businesses assess their risks and decide mitigation strategies (within and beyond its fence). For an enterprise it is important, to quantify its operation and supply chain water footprints, whether its water footprint lie in a water stressed geography and associated external factors (geo-political, climate change). The concept of water neutrality is a possible means for a business to reduce and offset the negative impacts of its water footprint. While an enterprise cannot operate on a zero water footprint as it uses resource and energy inputs, it can offset its water footprint.

FRAMEWORK

EWM, the business water accounting platform draws its framework from: Water Footprint Manual 2009 (Hoekstra et al., 2009) and Life Cycle Assessment (Curran, 1996)

Water Footprint Framework

The framework consistently accounts the water under operational and supply chain heads with further subsets as inputs and overheads. A series of well defined equations (1) – (7) used in the water footprint framework for business water accounting and footprinting are adapted (Hoekstra et al., 2009). The operational water footprint is equal to the consumptive water use and the water pollution that can be associated with the operations of the business. The overhead water footprint is associated with the supporting activities for the direct operation. Supply chain water footprint per business unit is calculated by multiplying the various input-product volumes by their respective water footprints.

$$WF_{bus} = WF_{bus,oper} + WF_{bus,sup} \qquad (1)$$

$$WF_{bus,oper} = WF_{bus,oper,\ inputs} + WF_{bus,oper,overhead} \qquad (2)$$

$$WF_{bus,sup} = WF_{bus,\ sup,inputs} + WF_{bus,sup,overhead} \qquad (3)$$

$$WF_{bus,sup} = \Sigma_x(\Sigma_i(WF_{prod}[x,i] \times I[x,i])) \qquad (4)$$

The water footprint of each specific output products can be estimated by dividing the business unit water footprint by the output volume or the economic values of the product.

$$WF_{prod[p]} = E[p]/\ \Sigma_p E[p] \times WF_{bus}/P[p] \qquad (5)$$

$$WF_{prod[p]} = WF_{bus}/P[p] \qquad (6)$$

The above water footprints are obtained at the level of a business with well defined boundary. For a large and heterogeneous business, divided into major business units and each major unit further subdivided into minor units. Water footprint is accounted at the lowest level and aggregated to the next higher level and eventually to the business/enterprise level.

$$WF_{bus,tot} = \Sigma_u WF_{bus}[u] - \Sigma_u \Sigma_p (WF_{prod}[u,p] \text{ x } P^*[u,p]) \qquad (7)$$

WF_{bus}, $WF_{bus,oper,}$ $WF_{bus,oper,overhead}$, $WF_{bus,sup,}$ $WF_{bus, sup,inputs}$, $WF_{bus,sup,overhead}$, $WF_{bus,tot}$ – water footprint of a business unit, operation and overhead, supply chain, operational and overhead (volume/time)

$WF_{prod}[x,i]$, $WF_{prod}[p]$ = Product water footprint of input product, output product p (volume/unit product), $I[x,i]$= volume of the input product (products units/time)

E_p, $\Sigma_p E[p]$ – Economic value of Individual or Total product (monetary unit/time)

$WF_{bus}[u]$, $WF_{prod}[u,p]$, - Water footprint of business unit ‘u’ and product ‘p within the same business unit (volume/time)

$P[p]$, $P^*[u,p]$ = Products volume, annual volume of output products ‘p’ from business unit ‘u’ to another business unit within the same business (products unit/time)

Life Cycle Assessment

The application of the life cycle perspective to product water footprints leads to methods that reveal the entire amount of freshwater required in producing a product. This comprises the water use in the manufacturing process as well as water used in background processes such as the mining of raw materials, the production of materials and semi-finished products, or the generation of electricity. Furthermore, the water used during the product’s use, disposal, or recycling is taken into account.

“ENTERPRISE WATER MANAGER” (EWM) – AN ICT PLATFORM FOR BUSINESS WATER ACCOUNTING

EWM in its essence incorporates the principles of LCA – input/output process/resource use; and it uses a consistent metrics for water accounting from the Water Footprint methodology. The scope of EWM spans from production/process up to the enterprise level. EWM provides indicators for product/process evolution for their water sustainability against global benchmarks or stated standards. For the enterprise while it makes available a global picture of its water use and impacts it also presents it spatially against local context. Ultimately it aids the enterprise in understanding where it stands on sustainability from a water perspective.

Data inputs serve as the basis of water footprint estimations and analytics. Hence the type, quality and precision of data determine the accuracy of water footprinting. EWM platform accomplishes this by focusing on operations and gathers both influent and discharge information at individual process level. A schematic of a metered plant operation for water accounting is shown in Figure 1. The process level information, the analytics and output obtained open up opportunities to drive process optimization and efficiency. Further this information can also be used for product / process redesign water sustainability.

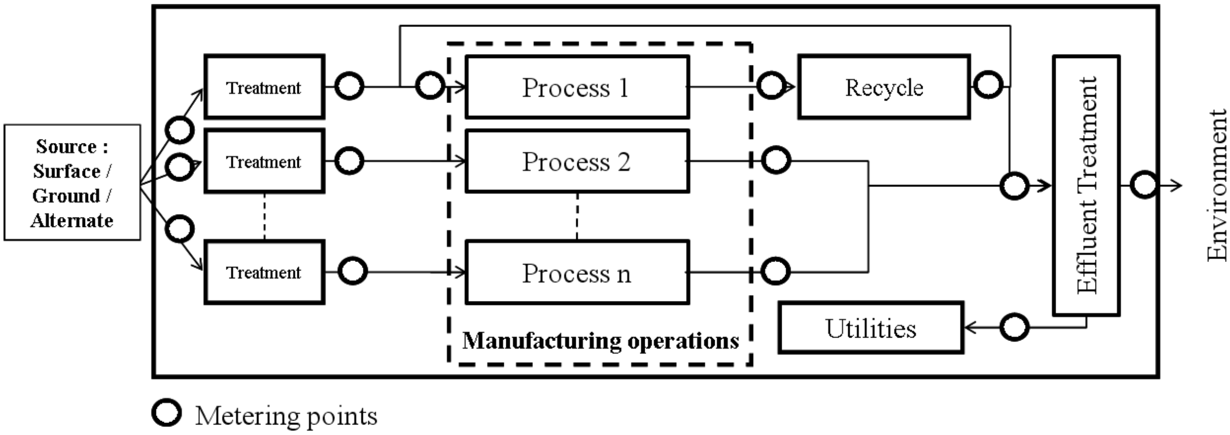

Figure 1. Plant Operations schematic

A conceptual framework of the EWM platform is shown in Figure 2. The broad components/categories under which input data are stored are plant water management, manufacturing process details, overhead water, local, regulatory, social and competing user information and local watershed data. In addition supply chain data and information related to geo-political factors and climate change and associated spatial-temporal hydrology is sourced separately as an external input.

Data inputs are obtained in the form of real time plant monitoring and also manually fed. The subheads under operation include the process and overhead water inputs. In addition data from bills of material for process raw material, supply chain data and for finished products is stored under individual sub categories. Associated water footprints for process input and supply chain are simultaneously stored under respective heads.

Data from various locations combined with the supply chain data is collated and simultaneously stored for process. EWM derives accurate water footprint at individual process and product levels as per the water footprint framework (Hoekstra et al., 2009). Further data at individual process level is used to obtain product water footprint both in terms of number output as well as economic value. Supply chain water footprint is estimated separately using the input data. Information obtained from multiple processes within each business unit is aggregated to obtain total operations water footprint of the business. Data for individual businesses can be collated to obtain overall enterprise level outputs.

As described in Figure 2 the output from the EWM is obtained for direct operations and supply chain respectively each of which are further subdivided into blue, green and grey water footprints and aggregated to obtain business and enterprise level information.

Outputs from the platform are presented both in report and real time formats. The key features of the Enterprise Water Manager include:

For operations:

- Water accounting and footprinting in direct operations
- Operational level process re-engineering, optimization and product/process evolution
- Interface with other existing tools

For the enterprise:

- Level of Water Neutrality – consumptive and discharge details presented for the enterprise with features to drill down to operational level.
- Risk assessment including those residing in the supply chain, assess and present hotspots against water strain in the area

- Water sustainability status for Operations/ Product / Process against global bench mark / standards
- GRI water indicators/disclosures, inventories (water consumption and efficiency), with combined company and watershed data.

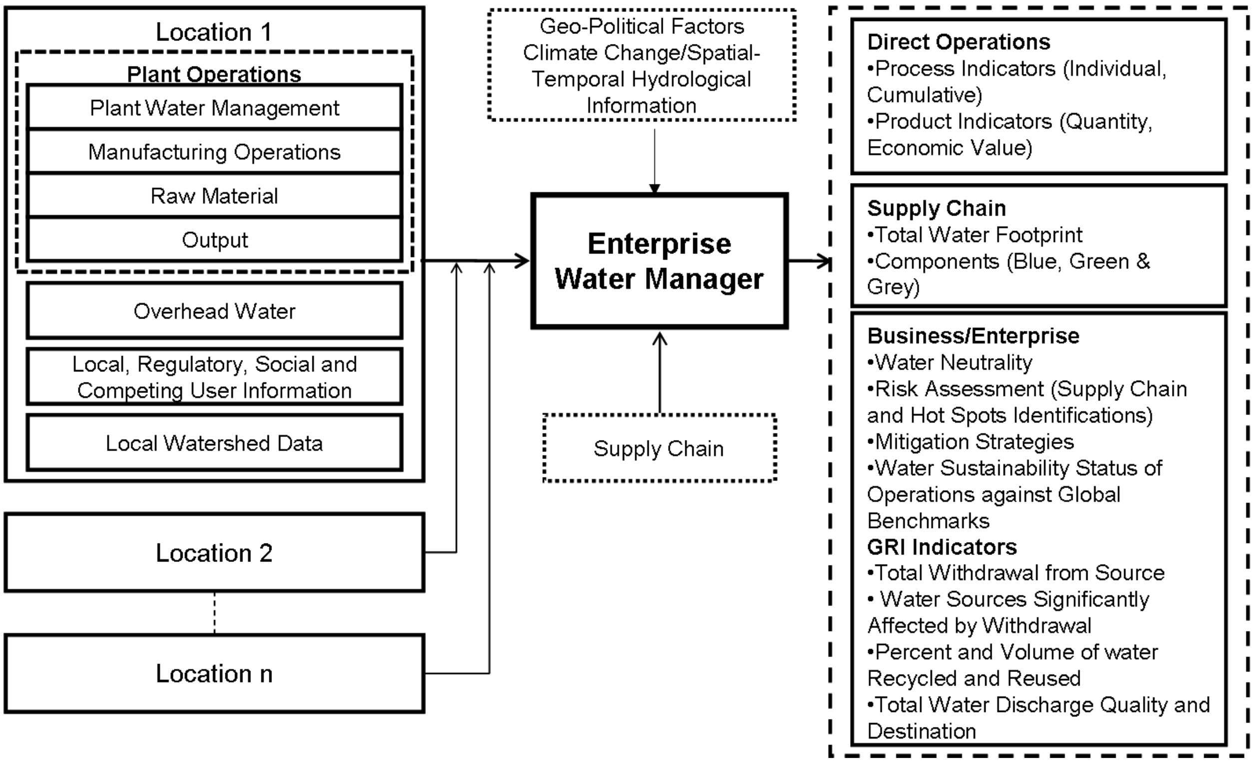

Figure 2. Enterprise Water Manager – Inputs and Outputs
(To be included with the Major Heading Section – Enterprise Water Manager Section)

CONCEPT CASE

The concept case presented here is for an Oil and Gas Enterprise with globally spread operations. One of the oil extraction and processing terminal is located in a fresh water scarce area; the processing terminal uses very high TDS (> 5000 PPM) brackish water from a deep aquifer; it is treated and used for both process and potable purpose.

The plant level functionality of EWM automatically sources the water consumed/discharged at each point (see Figure 3). It also keeps a tab on both quality and quantity of the input and output water. Operation data like production/process, raw material and output are sourced from the plant. Outside operations information such as overhead water, local watershed data (in this case includes for brackish water for underground aquifers) and regulatory and social context is inputted in the EWM. Water consumption in supply chain is fed into the EWM. Product water footprint both in terms of number output as well as economic value at individual process level is obtained. Supply chain water footprint is estimated separately using the input data. Information obtained from multiple processes within each unit is aggregated to obtain total operations water footprint of the business. Data for individual businesses is collated to obtain overall enterprise level report.

Few enterprise benefits: 1) Process optimization - Since the effluent of different processes are different, customized treatment can be provided to reduce the cost of recycling. 2) Risk Assessment and Mitigation – Business level outputs can be used to optimize the water footprint at different plants with implementation of water recovery and recycling process such as desalination. 3) Strategy - the water footprint of individual BU or product wise information can be used to decide the future strategy and CSR initiatives such as - assisting the local water starved community with their drinking water needs.

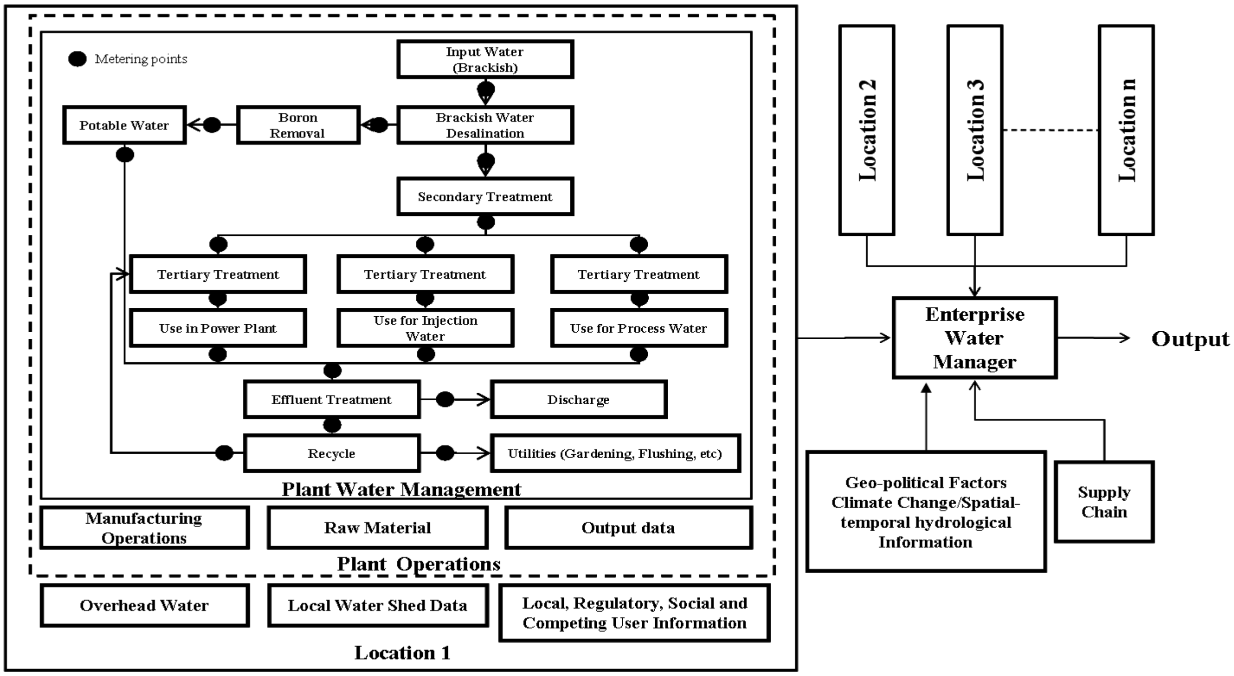

Figure 3. Model of EWM for Oil Processing Terminal in Rajasthan (India)

Conclusion

Building on the previous frameworks of WFN and LCA methodology, EWM has comprehensive capability to account water and derive accurate water footprints. EWM presents water analytics at various levels of scale, from individual process, to a specific division of a business up to entire enterprise thus differentiating itself in its span of coverage. EWM has an integrated approach and differentiates from other tools in its strength to drive operations and process efficiency. The operations water management functionality of the EWM is at a developed stage. Others are at various stages of development.

Once developed it would interface and complement most water accounting tools. This would enable the business to understand water efficiency of its processes and the output as a whole and optimization strategies can be planned accordingly. EWM would aid in supply chain sustainability strategy formulation to safeguard against supply disruptions in the future. It would incorporate current and future geographically specific information on levels of water stress in local watersheds. In addition it would help in the development of comprehensive sustainability reports for disclosures for e.g. GRI, CDP. The ultimate goal of EWM is to endow the enterprise business water sustainable, assess and monitor resident business risks and adequacy of mitigation strategies.

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