Application of AWS and SEEA to Accounting for water: China industrial park demonstration

Final Report

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6 September 2018

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EXECUTIVE SUMMARY

The IDEEA Group and members of AWS Asia-Pacific conducted a mission to Tianjin Economic Development Area (TEDA) and the Kunshan Economic and Technological Development Zone to assess how the System of Environmental Economic Accounting (SEEA) can support the monitoring, impact evaluation and reporting of the AWS Standard. Prior to undertaking the mission, a desktop study was undertaken to assess the potential benefits of linking the SEEA and the AWS to help achieve AWS water outcomes.

The study determined that the SEEA could be used to undertake:

- a comparison of performance (benchmarking) among firms, within catchments, across countries, and within and across industries and sectors with respect to water use and water stewardship;
- extended measures and indicators of water stewardship based on the integrated nature of the SEEA framework, for example, with respect to productivity, sustainability and capacity;
- improved risk management, for example in relation to resilience to drought and response to the effects of climate change;
- communication of water stewardship performance in broader sustainability discussions; and
- exchange of information across scales, for example the use of AWS collected data to support compilation of SEEA based accounts and the use of SEEA based data to support improved understanding of the environmental context for any individual entity.

Building on those findings the mission to China examined the two industrial parks as examples of how the SEEA and the AWS can be linked more explicitly. The findings of the mission included:

- the SEEA Central Framework can be used in TEDA to compare the water performance and efficiency of industries within the parks and develop benchmarks for comparison with other parks;
- the SEEA Central Framework supply and use tables for water can be used to demonstrate the benefits of employing a circular economy approach used in TEDA;

- the application of ecosystem accounting in the Kunshan Economic and Technological Development Zone can be used to report on environmental sustainability;
- the SEEA can be used to account for issues such as resilience to drought, e.g. the transfer of water from south to north in China;
- the Central Government of China (National Statistics agency) are embarking on a program to implement the SEEA. The alignment of reporting methods between government and industry would help communicate water stewardship performance in central and provincial policies. This will reduce transactions costs associated with the collection and reporting of information for different policy purposes;
- the SEEA can be used to frame local data (such as that held by academics in Nanjing), such that local decision makers (the mayor of Nanjing) can use the information to make environmental related decisions and investments;

The findings from the two case studies indicate opportunities to apply environmental economic accounting to other industrial parks in China. The SEEA can be used to describe the environmental context for individual companies and can help companies reduce compliance costs associated with reporting information to the multiple ministries. Most importantly, it is clear that by adopting and accounting approach of the SEEA that the data and information gathered can be applied to support the monitoring and evaluation phases of the AWS Standard.

The process of collecting and collating data to build accounts demonstrates to stakeholders where there may be gaps and opportunities to refocus efforts. Further, the process facilitates the development of policies that are linked to water use and brings in other players and data-holders that would not normally be engaged.

To employ the accounting techniques described in this document, it is necessary to invest in the appropriate people and technology. Skills in economics, accounting, ecology and Geographical Information Systems (GIS) will be required, as will be the technology to undertake the accounting, such as GIS software, modelling software and database management systems. Future capacity building will require liaisons with various private, public and government organisations and may include the establishment of research bodies.

This report was sponsored by Water Stewardship Australia and funded by the Australian Water Partnership (AWP). The work has demonstrated that there are a range of opportunities for environmental-economic accounting across China that IDEEA Group is interested in exploring together with other AWP members.

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1 BACKGROUND AND CONTEXT

Following the release of the paper “Linking AWS and the SEEA: Applying advances in accounting for natural capital to support the implementation of AWS” (hereafter referred to as Project One), the Institute for the Development of Environmental Economic Accounting (IDEEA Group) and the Alliance for Water Stewardship (AWS) are collaborating to explore the practical aspects of integrating the AWS International Water Stewardship Standard (AWS Standard) and the System for Environmental Economic Accounting (SEEA).

The aim of this report is to explore how the SEEA can be applied to support the monitoring and evaluation phases of the AWS Standard. Importantly, the processes underpinning the SEEA means that it can account for multiple policy drivers that influence AWS efforts. As a first step towards achieving the shared goal of improving water related outcomes, this document discusses the applicability of the SEEA to two Chinese industrial parks in partnership with the AWS.

To demonstrate how AWS outcomes can be accounted for in each of the industrial parks, a conceptual model based on the SEEA has been developed. The practical aspects of application such as the datasets available for populating the conceptual model and accounting for water are discussed for each park. A key outcome of the industrial park analysis is a set of recommendations on an approach to monitor and evaluate the AWS standard. Due to the variation in context and data within each park this report demonstrates the flexibility of the SEEA in its application. In addition to park specific recommendations, areas of capacity building that will help monitor and evaluate the success of the AWS using the SEEA framework are also described.

The report is structured as follows: first, the AWS and the SEEA are discussed, along with the benefits of integrating them (Section 2, Section 3, and Section 4 respectively). Two of China’s industrial parks are used to demonstrate the practical application of the SEEA framework to account for water in Section 5. Broad Activities that help build the long-term effectiveness of the SEEA, as a framework for the monitoring and evaluation phase of the AWS, are discussed in Section 6.

2 THE ALLIANCE FOR WATER STEWARDSHIP STANDARD

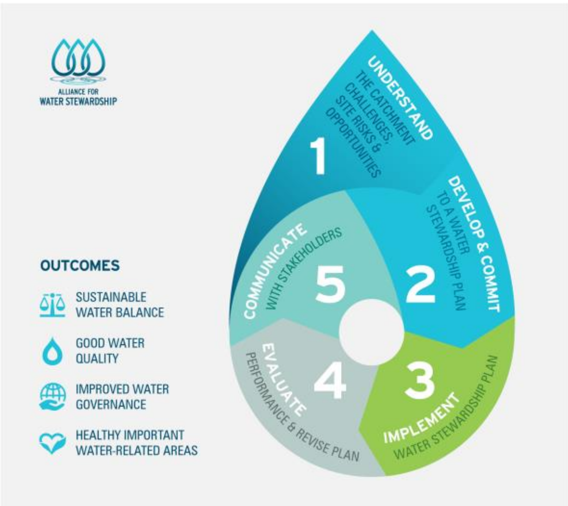
The AWS Standard is a globally-applicable framework for major water users to understand their water use and impacts, and to work collaboratively and transparently for sustainable water management within a catchment context. The AWS Standard is intended to drive social, environmental and economic benefits at the catchment scale.

The AWS Standard aims to achieve this by engaging with water-using sites to understand and address *shared* catchment water challenges as well as site water risks and opportunities. It asks water-using sites to address these challenges in a way that progressively moves them to best practice in terms of four outcomes:

1. Sustainable water balance;
2. Good water quality;
3. Healthy important water-related areas (sites and values); and
4. Good water governance.

The AWS Standard provides water stewards with a six-step continual improvement framework that enables sites (water users) to commit to, understand, plan, implement, evaluate, and communicate water stewardship actions. There are three Water Stewardship achievement levels: core, gold or platinum stewards (see Figure 1 below). Levels are reached by complying with the core and advanced level criteria in each of the six steps in the AWS improvement framework.

Figure 1: Water stewardship steps and achievement levels



Source: (The Australian Water Partnership, 2018)

3 THE SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING

The System of Environmental Economic Accounting (SEEA) is an internationally agreed accounting-based framework for recording environmental and economic data in a comprehensive and integrated way. The framework is fully aligned with the standard approaches used to measure economic activity at the national level, including measures of Gross Domestic Product (GDP), productivity, saving and national wealth. The SEEA approach to measuring and reporting on the environment is also compatible with standard approaches to corporate financial and management accounting.

A key feature of the SEEA is the implementation of common terms and definitions to describe a comprehensive set of environmental stocks and flows, including natural resources, physical flows, land and ecosystems, ecosystem services and biodiversity. A common measurement process means that accounts and therefore any indicators that are developed, are comparable across spatial units at any level (i.e. landscape, national, catchment).

The four key components of the SEEA are shown in Figure 2 below. While each of these components is distinct, information in one component is consistent with information collected in another. The relationships between each of these components play an important role in determining how the SEEA measures the environment as a system. This is an important distinction from other indicator-based frameworks which are targeted at a particular aspect of the framework and often can't be integrated with other indicators.

Figure 2: Key components of the SEEA

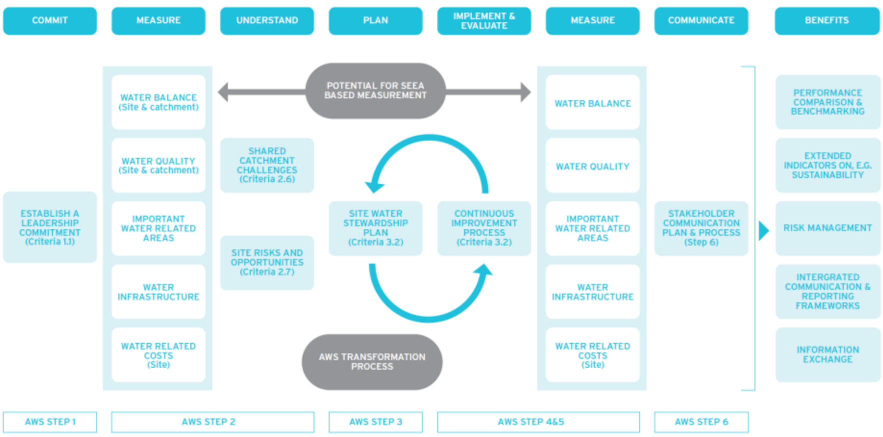
Each of the components identified in Figure 2 is contained in one of two publications – the SEEA Central Framework (SEEA CF) and the SEEA Experimental Ecosystem Accounting (SEEA EEA)[1]. Although the perspectives on measurement are different between publications, both feature accounting for stocks and flows of water resources and their connection to the economy and the environment.

Both frameworks are very relevant to measuring and reporting on all four AWS outcomes. The SEEA CF focuses on the physical accounting for transfers between the economy and the environment and changes in the stocks of water resources. Subsequently, it is most relevant for sustainable water balance, water quality and measures of productivity and efficiency. The SEEA EEA provides an extension to the SEEA CF by accounting for the health of important water-related areas (water related ecosystems). The SEEA EEA recognises the role that ecosystems play with respect to water supply and quality and water flow regulation and water purification. Together, both the SEEA CF and SEEA EEA can provide a framework for monitoring and reporting on the AWS outcomes, including good water governance, using an integrated and comprehensive approach.

4 INTEGRATING THE AWS AND THE SEEA

In Project One it was recognised that the SEEA can play an important role in all six steps of the AWS Standard, however, its effectiveness is most prominent in the measurement and evaluation steps (see Figure 3).

Figure 3 Connecting the SEEA and AWS Standard



Source: (Obst & Eigenraam, 2017)

[1] There are also technical guides for energy and water that build on the SEEA CF.

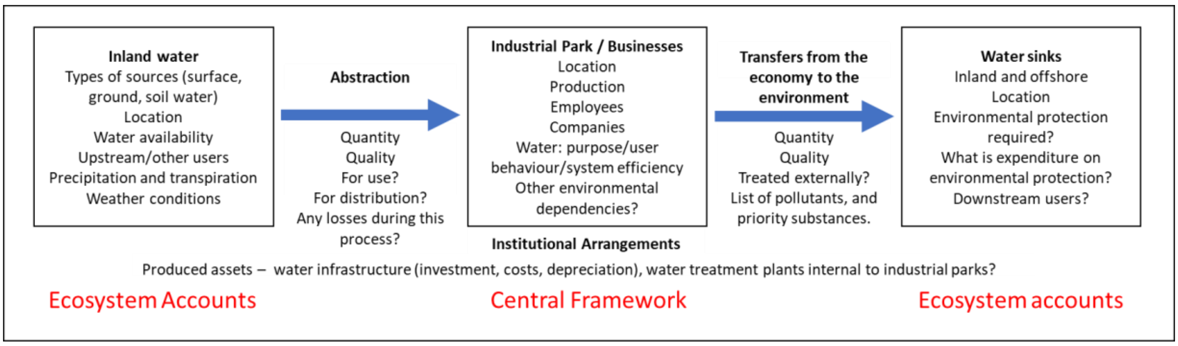
Key benefits of using the SEEA include:

- comparison of performance (benchmarking) among firms, within catchments, across countries, and within and across industries and sectors with respect to water use and water stewardship;
- extended measures and indicators of water stewardship based on the integrated nature of the SEEA framework, for example, with respect to productivity, sustainability and capacity;
- improved risk management, for example in relation to resilience to drought and response to the effects of climate change;
- communication of water stewardship performance in broader sustainability discussions; and
- exchange of information across scales, for example the use of AWS collected data to support compilation of SEEA based accounts and the use of SEEA based data to support improved understanding of the environmental context for any individual entity.

4.1 Accounting for AWS outcomes

To demonstrate the practicality of integrating the AWS and the SEEA, it is necessary to show how the SEEA can account for the AWS outcomes. The conceptual framework (Figure 4) describes the relationship between industrial parks, water (flows of water) and the subsequent impact on water assets. The figure also shows how the two SEEA frameworks, the SEEA CF and the SEEA EEA are linked to the industrial parks and apply to the economy and the environment, respectively. It should be noted there is not a strict delineation in the application of the two SEEA frameworks but it is useful for illustrative purposes and will be used in the analysis of the parks later in the report.

Figure 4: Conceptual Framework linking the environment to industrial parks



Industrial parks are at the centre of the framework, recognising that they receive flows of water from the environment for use in production, and release flows of water back into the environment. Included in the flows of water back into the environment are residuals in the form of pollutants in the water. Water related assets include those at the source (catchments, wetlands, rivers, dams), and those receiving flows from the industrial parks, again a similar set of spatially defined assets. A key feature of the framework is an attempt to make explicit the relationship between industrial parks, water use, and water related assets.

The conceptual framework addresses three links between the environment and the economy that can be measured for reporting purposes, including:

1) Flows from the environment to the economy (industrial park);
2) Flows within the economy (between industrial park businesses); and
3) Flows from the economy (industrial park) to the environment.

For items 1 and 3 the focus is on understanding the services and benefits the environment is providing to industrial parks, while item 2 focuses on how industrial parks are taking steps to minimise their use of water and discharge of waste water to the environment. Included in both 1 and 3 are considerations of the ecosystem services being provided by the environment including clean water from the source and water filtration at the sink. Accounting for steps 1 to 3 facilitates the evaluation of 2 of the 4 AWS outcomes, namely, sustainable water balance (between the environment and industrial parks) and good water quality (clean water from the environment to industrial parks).

Outcome 3 of the AWS is reflected in items 1 and 3, namely the health of important water-related areas including sites and values. For example, the capacity of upstream and downstream assets to provide ecosystem services to other beneficiaries that may not be located inside the industrial park is dependent on items 1 to 3. For upstream assets, over-withdrawal by an industrial park may affect farmer yields in region or lower groundwater levels where it is also being used for domestic consumption. For downstream assets, discharge into them by the industrial park may affect their condition and therefore their capacity to provide suitable habitat to fish. Further, the upstream assets provide ecosystem services that reduce the costs associated with extreme flows of water such as flood regulation, or increase the benefits provided by upstream ecosystems such as clean water for consumption by parks and others (water purification services). Finally, the downstream assets provide ecosystem services that reduce the costs associated with the discharge of water, such as water filtration, and therefore restore the benefits of a natural functioning ecosystem so that downstream users can benefit. Accounting for environmental assets and the ecosystem services they provide using the SEEA EEA means that the third AWS outcome, healthy important water-related areas (rivers, wetlands, catchments) can be measured and accounted for.

The final outcome of the AWS, good water governance, is reflected across the conceptual framework. The further a firm or industrial park can go with respect to reporting on the dependencies and engaging with stakeholders linked with environmental assets in a transparent manner the better they are performing with respect to water governance.

An important element of good governance is meeting legislative and legal requirements. The accounts can be used to underpin legislative reporting as they facilitate the provision of consistent standardised reporting by both government agencies and private firms. For example, legal compliance in terms of benchmarks on water use and water discharge can be accounted for under the accounting framework, as can the auditing of environmental information. The benefits associated with linking private and public initiatives to account for water will be further advanced since the national government via the National Statistics Office is also embarking on a program of SEEA accounting.

The extent to which the conceptual framework, and by extension the AWS outcomes, can be measured in full at each Industrial Park will depend on the data that is available and any other institutional constraints that may exist. In a perfect scenario, accounts would completely describe the system of flows between the environment and the economy, and every water-related asset and the ecosystem services they generate and the users that benefit. Under such a scenario, good water governance (incorporating accounting and reporting of water across the whole system within the operations of industrial parks) could be measured and accounted for.

However, as discussed below this is rarely possible. Practical methods for making the best use of available data, as well as a parallel body of work that builds capacity to move towards a state of best practice accounting is required.

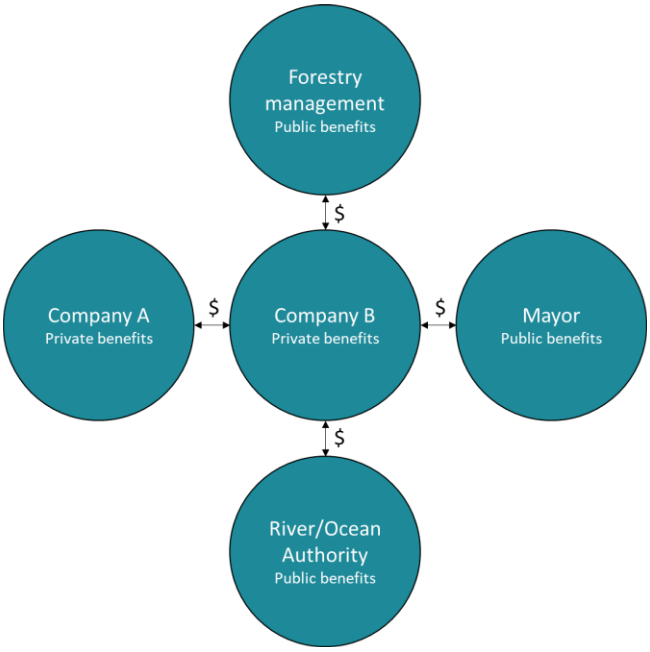
4.2 Integration at the business level

The practicality of linking the AWS and the SEEA is also evident at the business level. A key application of the SEEA at a business level is to support internal management and decision making around natural capital. Regarding water, this means that firms can consider objectives such as water-related efficiency and the sustainability of the upstream and downstream assets which the business relies on. For example, a business can work with the community to better schedule withdrawals from groundwater reserves or may manage the land to ensure recharge rates are sufficient to keep the groundwater system fully charged. For downstream water assets they may schedule the release of effluents, so they don't go into a stream at the same time as releases from other firms, or they may introduce new technology to reduce the impacts of the effluent on the environment.

Businesses that adopt the SEEA as a tool to support their AWS Standard Certification will be able to integrate information on environmental stocks and flows into day-to-day management practices. The *accounting* approach of the SEEA is a natural fit with current business accounting practices so many of the links between businesses and environmental assets can be better reflected in financial reports of firms. Further, firms could engage more effectively in environmental markets because the investments they are making in the environment will be recognised as investments in assets that are providing a service to the business that have monetary significance.

Figure 5 below provides an example of some of the potential channels through which environmental markets exist. Company B, positioned in the middle of the figure, is the company that is seeking monetisation for its asset management. Four stylised relationships are shown, each with different market actors. Starting at the top of the diagram, Company B may be willing to enter into an agreement with the Forestry Management Ministry. The Forestry Management Ministry may be willing to pay Company B to reduce water withdrawals during periods where water is scarce or alternatively, Company B may wish to pay for forest management to have clean and reliable water available for use in production.

Figure 5: Examples of potential environmental markets



Moving clockwise, the local mayor (of Company B) may be willing to enter in a partnership with Company B, and other companies within an industrial park, to deliver enhanced public benefits. For example, the Mayor may be willing to allocate a portion of their budget to co-invest in wetlands that provide amenity, biodiversity improvements and filter the water (of Company B) in the same way an industrial treatment plant would.

The group at the bottom of the figure shows the river/ocean authority and the potential for a financial relationship between it and Company B. The river/ocean authority may be willing to enter into an agreement with Company B if it is able to remove harmful nutrients and effluent from the water before it is discharged into a downstream asset (river/ocean). Such an agreement may help maintain the sustainability of the downstream assets and retain its ecological properties.

Moving clockwise again, the final relationship shown in the diagram is that between Company A and Company B, were both companies are inside the industrial park. Partnerships may exist between companies whereby water is recycled and transferred between them at a price that is lower that seeking new water. This is not only of advantage to the companies, but agreements can also be reached with other bodies that are influenced by the reduction in water withdrawn from upstream assets.

Accounting for assets and the links to return on investment will enable AWS companies to target and reach AWS objectives more cost effectively. Furthermore, the collection of information provides companies with the opportunity to partake in environmental markets. Without the collection of information, the opportunities to participate in such markets would be difficult because there would not be an agreed set of information for monitoring and reporting.

While firms may already employ one of many methods for assisting with natural capital decision making[2], there are several benefits associated with adopting the SEEA framework. The application of the SEEA framework:

- ensures that data from public data sources can be combined with data from private sources, where both are using common accounting methods;
- reduces the costs of data collection and reporting (i.e. compliance costs) where firms are required to report on multiple policies and programs;
- reduces associated costs of training and data infrastructure development due to commonality and replicability of methods etc;
- increases the potential for comparison across sites and catchments and across scales;
- improves the alignment of data across different aspects of water resources measurement (e.g. between condition of water resources and the condition of IWRA);
- supports consistency of messaging on the status of water resources from the site level (business, industrial park) to catchment and national levels;
- has powerful network effects – increased application by different companies increases the strength of the system/community. Currently, businesses use different approaches and different sets of information making it hard to focus on common goals and maximise joint investment in outcomes;
- can align information with that understood by government agencies to facilitate lower transaction costs in public/private partnerships in environmental markets;
- support the facilitation of conversations between different stakeholders and government agencies, both horizontally and vertically. There are several Chinese ministries in charge of water related issues and efforts are sometimes at cross purposes due to inherent differences in their characterisation of the environment and its links to the economy.

[2] Water risk monetiser (Ecolab)

Accounting using the SEEA framework facilitates the delegation of clear responsibility and means that consistent and structured conversations can be had; and

- places in context a range of other tools and indicators that may be used for managing water resources and other aspects of natural capital such as the water risk monetiser, natural resource balance sheets, and gross ecosystem product.

Indeed, the information in the SEEA framework can be used to generate various indicators, recognising that the use of indicators alone is not sufficient for supporting management decisions. The capacity to assess trade-offs between different management approaches is a key application of the SEEA.

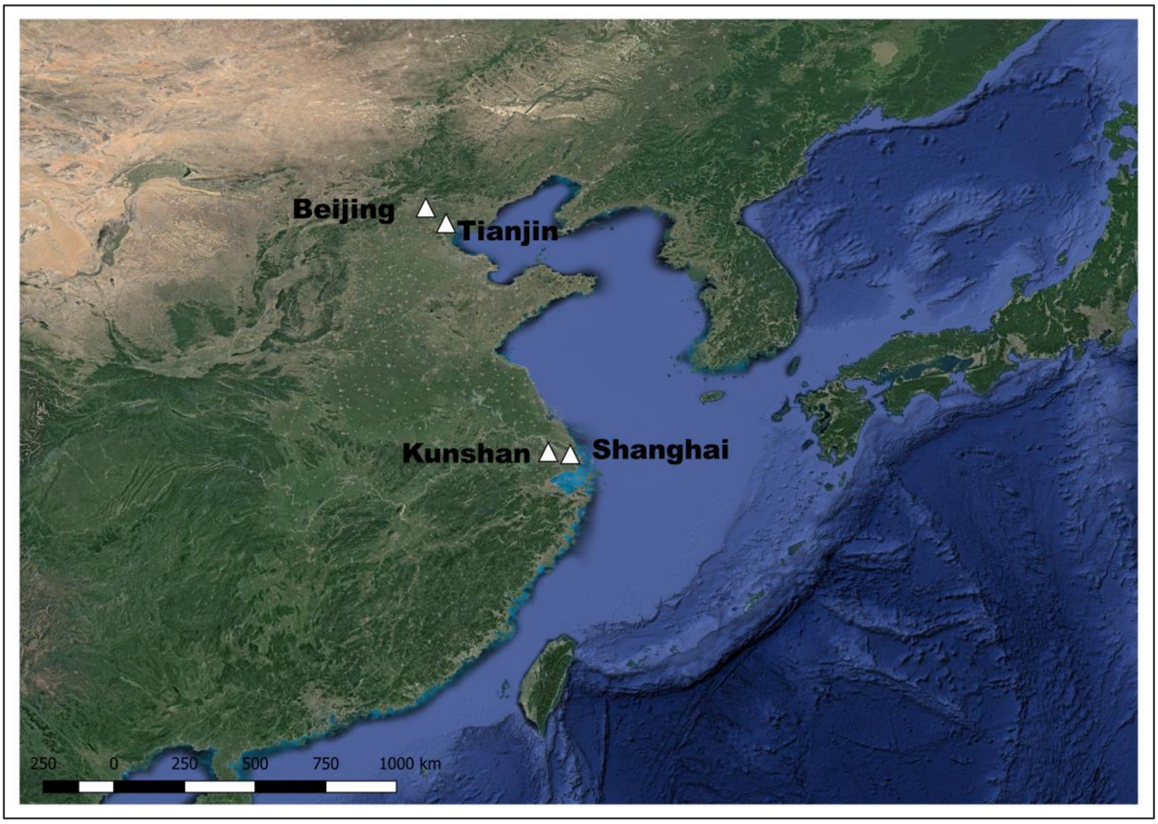
5 CHINA'S INDUSTRIAL PARKS

The National Economic and Technological Development Zones (NETDZs) are key drivers of growth in the China's national and regional economies[3]. The NETDZs, of which there are 219 in China as of 2016, contributed 11.5 per cent to Chinese GDP and accounted for 20.2 per cent of the national industrial value add in 2015. The NETDZs consumed a total of 5700 million cubic meters of water and accounted for 4.3 per cent of the national industrial water use. Fresh water consumption of unit industrial added value was 11.9 cubic metres per 10,000 yuan (2,000 AUD), approximately one fifth of the national total consumption per unit of industrial added value (Green Development League of National Economic & Technological Development Zones, 2016).

The NETDZs attach great importance to water related issues. Key features of NETDZs include the saving and recycling of water, the coordination of water and energy conservation efforts, and the establishment of systems of water resource cascade use, centralised wastewater treatment, and the regeneration and reuse of water. The NETDZs' experience and achievements in water reservation, recycling and integrated utilisation are paradigms for other areas (Green Development League of National Economic & Technological Development Zones, 2016). The two industrial parks that are used as examples in this report – located in Kunshan and Tianjin – are shown in Figure 6.

[3] Including designated industrial parks with the same policies approved by the State Council

Figure 6 Kunshan and Tianjin



5.1 Policy drivers

Changes and updates to environmental policy are occurring on an increasingly regular basis in China. While economic growth may have been the focus in the past, much greater importance is being placed on the environment now. This is demonstrated in comments such as those made by President Xi Jinping at the Third Plenary Session of the 18th Central Committee of the Communist Party of China on November 12, 2013 - *"we (China) will improve the development progress evaluation system and correct the bias of evaluating political achievements merely by the economic growth rate."*- the Government subsequently adopted a long-term strategy of ecological civilisation[4]. The essential requirement of ecological civilization is that nature must be respected, accommodated and protected. Congress stated that the idea of ecological civilization must be incorporated into all aspects of economic, political, cultural, and social progress.

[4] Ecological civilisation was elevated as the national strategy of the Communist Party of China in 2012.

To inform the long-term strategy of ecological civilisation, methods to better measure the relationship between the economy and environment have been developed. Work is being completed across the following initiatives:

- Green Gross Domestic Product – the deduction of costs of resource consumption and environmental degradation (costs of GDP) from GDP to arrive at green GGDP (Wang, 2016);
- Gross Ecosystem Product – total values of ecosystem products and services for human welfare and sustainable development (Ouyang et al, 2013)
- National resource balance sheet - the development, utilization and protection of natural resources should be reflected in the form of a balance sheet (Shi Dan, 2015).

In addition to this long-term strategy, there are numerous water-related policies and reforms that have been implemented in China. Some of these include:

The Water Ten Plan – an action plan to increase the prevention and control of water pollution and ensure national water security. The plan sets out 10 general measures which can be broken down to 38 sub-measures with deadlines with responsible government departments identified for each action. The plan includes several components such as stronger regulation across several industries, advancing industrial water efficiency and improving water use, improved monitoring and enforcement, stronger water-focused institutions and public participation and advanced market mechanisms such as water trading[5].

Environmental Protection Law (EPL) – since the implementation of the new EPL in April 2014 there has been increased responsibility at local levels of government regarding the environment. By way of example, during the mission to China it was revealed that the town mayors need to produce quantitative information to demonstrate their contribution to a better environment. Partnerships between mayors and industry has been suggested as an approach to achieving change and using the SEEA as the reporting framework. China also enacted two additional environmental protection laws at the start of 2018 – one to formalize the emissions discharge fee into a tax collected from industrial polluters, and the other to combat water

[5] See http://chinawaterrisk.org/notices/new-water-ten-plan-to-safeguard-chinas-waters/ for more information

pollution more effectively. Changing perceptions regarding the environment at all government levels are likely to increase demand for better reporting by local businesses and industrial parks.

Water Resource Tax Expansion – expansion of a pilot from several provinces to nationwide. The aim of the tax is to prevent unreasonable usage of surface and underground water. It includes higher taxes for overexploitation of water above quotas and tax breaks for the use of recycled water. It is unclear at this stage how these objectives will be set and further how they will be measured and reported consistently across regions which may provide an opportunity for the broader application of SEEA and AWS.

River Chief system – over 900,000 government stewards have been tasked with controlling pollution in waterways. They are held accountable for environmental damage in bodies of water under their supervision. It is unclear at this stage how both damage and water bodies will be measured and reported on consistently across regions which may provide an opportunity for the broader application of SEEA and AWS.

Ecological red lines policy – "insurmountable boundary" policies of highest national priority. The aim is to protect the integrity of important ecosystems and meet stakeholder needs by securing diverse and coupled ecosystem services. Red lines to control water use, improve water efficiency and control water pollution were implemented in 2011. The SEEA EEA can support businesses and industrial parks by linking their adoption of the AWS to the preservation and protection of important ecosystems.

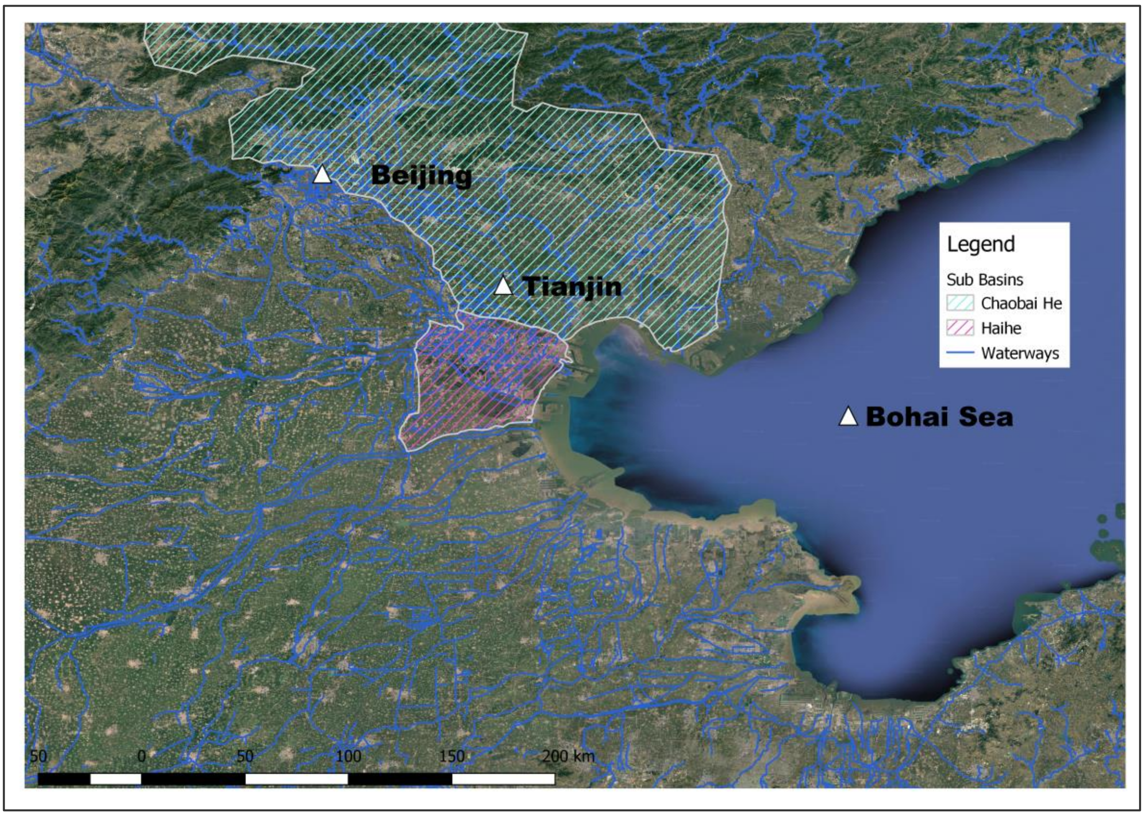
The polices discussed above are variable both in their design and application, creating uncertainty for many businesses and industrial parks as they try to respond. The SEEA can play an important role by providing one set of data and information for reporting on all policies, and providing the information required for management *within the business* in a changing political and business climate.

AWS monitoring and reporting that is aligned with the SEEA framework is an important consideration for policy makers and makes the AWS ever more relevant to both policy makers and businesses in common.

5.2 Tianjin Economic-Technological Development Area

Tianjin Economic-Technological Development Area (TEDA) was founded in 1984 and was approved by the State Council in conjunction with 13 other national development zones. It is located at the intersection of the economic belt surrounding the Bohai Sea and Beijing-Tianjin-Hebei circle (see Figure 7). With an output of nearly 800 billion yuan (160 billion AUD[6]), TEDA has become a core landmark in the Tianjin region. TEDA features multiple industrial parks and covers 418 square kilometres. It includes industries in electronic information, auto-making, petrochemical, equipment manufacturing, and medicine. It is the national development zone with the largest economic scale, highest openness and most favourable investment environment. (Green Development League of National Economic & Technological Development Zones, 2016).

Figure 7 The Tianjin Economic-Technological Development Area (TEDA)



There are several park specific initiatives in place that indicate TEDA's commitment to the environment including ISO14001, GRI reporting, Eco Logo on industrial solid waste management, and energy/carbon emission audits. TEDA is a leader in Eco-Industrial Park Construction and aims to have a complete set of programmes covering water, solid waste, and energy (carbon) management (Green Development League of National Economic &

[6] Using an exchange rate of 1 yuan to .2 AUD

Technological Development Zones, 2016). TEDA also employs a circular economy model to measure and report water use.

The whole water supply network in TEDA is part of the municipal pipelines. The primary water mainly comes from the Luanhe River and Yuelong groundwater, and the recycled water is the output of Level II bio-chemical treatment by TEDA Sewage Plant. The total daily supply capacity in TEDA is 575,000 tons/day, and the recycled water facilities processes 20,000 tons of sewage daily. The seawater desalination plant in Nangang is in the pipeline (TEDA Development and Reform Bureau, 2014).

The primary issue concerning water in the TEDA region is scarcity. Since the late 20th century, the regions where Beijing and Tianjin are located have imported water from the south of the country. Being a key industrial user of water in China, TEDA and its constituent industrial parks have a role to play as water stewards in the region to maintain water balance and other AWS water outcomes. TEDA is already progressing towards these outcomes with fresh water consumption falling 6.3% per 10,000 yuan of industrial value add.

All water used by TEDA, except for precipitation within the boundaries of the parks, enters the park through single node and exits through a single node before being transferred back to the environment. This is in contrast with Kunshan, where there are multiple entry and exit points to and from the park. Most water from TEDA will finally be discharged to the Bohai Sea and bay area at the bottom of the catchment. However, prior to entering the bay the water travels through a number of rivers that are relevant from an ecosystem accounting point of view.

5.2.1 TEDA data assessment

There has been a significant amount of data collected by the TEDA Eco-Centre through the application of the circular economy model. This data is sourced from numerous businesses within the Industrial Park and includes water use, recycling and discharge. The circular economy model was introduced as part of a national circular pilot. There is the potential for businesses to self-report using the circular economy platform developed at TEDA Eco-Centre.

Initial mapping of infrastructure and source assets for the supply of water via the entry point has been completed. It is unclear at this stage as to whether this is sufficient to describe the flows from the environment to the industrial park. It is also unclear as to how much information there is on the volume and quality of water discharged into the sink asset, Bohai bay, and its potential impact on the condition of the bay. Other data may be available from ministries, academics etc but this was unclear at the time of writing the report.

5.2.3 TEDA observations

The analysis provided above indicates that TEDA would be an appropriate region to pilot the SEEA CF. Supply and use tables – a feature of the SEEA CF – include data on flows between the environment and economy and flows within the economy. It appears that flows from the environment to the economy, and from the economy to the environment are relatively simple given there are singular points at either ends of the system. Discussions with TEDA Eco-Centre indicated that their circular economy model and data could be used as the foundation for the development of SEEA CF supply and use tables which can be linked to ecosystem accounting. Stylised examples of supply and use tables are provided in Table 1 and Table 2 below to domenstrate the link with SEEA CF accounting[7].

Table 1, the water supply table, shows the volume of water supplied by different units across the top row of the table including households, industry and the environment for example. The left-hand column shows the source of supply by the units. From the table the environment sources 74 units of abstracted water in which 20 units come from surface water, 30 units from groundwater and the remainder from other sources. The supply of abstracted water is separated into distribution and own use across industry, water collection, sewerage and households.

For TEDA the links to Table 1 and Table 2 include the sources of abstracted water return flows ,respectively. In Table 1 the total voume of water entering TEDA may be 74 units or it could be broken down into inland and other sources. In Table 2 the water leaving TEDA (return flows) may be reported as a total volume, 70 units, or disagregated into the areas in which the flows return too.

The wastewater and reused water are the key link to the circular economy data and the model created by the TEDA Eco-Centre. The circular economy estimates may or may not include the abstracted water but almost always include the measurement of water treatment and reuse. The remainder the supply table shows the supply of water as return flows to the environment from industry, water collection, sewerage and households. These values can be seen in the both

[7] Detailed information on the central framework is provided in appendix 2.

the supply and use (Table 2) tables, in the supply table 24 units of water are supplied and the use table the environment is receiving using 24 units of water.

The development of the SEEA CF water supply and use tables provides an opportunity to extend the boundary of the circular economy analysis and link explicitly to each of the sources and sinks in the environment. Further, the SEEA EEA provides the framework and methods for disaggregating the environment unit into specific ecosystem assets including rivers, wetlands etc. Ecosystem accounting would also be insightful given that there are dependencies on both the source and sink water assets. Source assets are extremely important for regional agricultural activity and the Bohai bay is important for aquaculture and marine biodiversity.

An additional observation is that there are potential connections for the work in TEDA to connect to recent discussions on Ocean accounting that were held in Bangkok in August[8]. There was a Chinese contingent in attendance and they expressed interest in linking to the AWS monitoring and reporting using accounts.

Table 1 Stylised example, water supply table

	Industry	Water collection, treatment and supply	Sewerage	Household	Imports	From environment	Total supply
Sources of abstracted water							
Inland water resources							
Surface water						20	20
Groundwater						30	30
Soil water						5	5
Total						55	55
Other water sources						0	0
Precipitation						9	9
Sea water						10	10
Total						19	19
Total supply abstracted water						74	74
Abstracted water							
For distribution	0	29	0	0			29
For own-use	36	2	7	0			45
Total abstracted water	36	31	7	0			74
Wastewater and reused water							
Wastewater	0	0	0	0			0
Wastewater to treatment	12	0	0	13			25
Own treatment	0	0	0	0			0
Reused water produced	0	0	0	0			0
For distribution	0	0	2	0			2
For own use	1	0	0	0			1
Total	13	0	2	13			28
Return flows of water							
To inland water resources							
Surface water	22	1	0	1			24
Groundwater	9	1	11	0			21
Soil water	0	0	0	0			0
Total	31	2	11	1			45
To other sources	5	0	19	1			25
Total return flows	36	2	30	2			70
of which: Losses in distribution	0	1	0	0			1
Evaporation of abstracted water, transpiration and water incorporated into products							
Evaporation of abstracted water	1	0	0	0			1
Transpiration	2	0	0	0			2
Water incorporated into products	1	0	0	0			1
Total supply	**89**	**33**	**39**	**15**		**74**	**250**

[8] https://seea.un.org/events/asia-and-pacific-regional-expert-workshop-ocean-accounts

Table 2 Stylised example, water use table

	Industry	Water collection, treatment and supply	Sewerage	Household	Accumulation	Exports	To environment	Total use
Sources of abstracted water								
Inland water resources								
Surface water	16	4	0					20
Groundwater	6	24	0					30
Soil water	5	0	0					5
Total	27	28	0					55
Other water sources	0	0	0					0
Precipitation	0	2	7					9
Sea water	9	1	0					10
Total	9	3	7					19
Total use abstracted water	36	31	7					74
Abstracted water								
For distribution	14	0	0	15				29
For own-use	36	2	7	0				45
Total abstracted water	50	2	7	15				74
Wastewater and reused water								
Wastewater	0	0	0	0				0
Wastewater received from other units	0	0	25	0				25
Own treatment	0	0	0	0				0
Reused water produced	0	0	0	0				0
Distributed reuse	2	0	0	0				2
Own use	1	0	0	0				1
Total	3	0	25	0				28
Return flows of water								
To inland water resources								
Surface water							24	24
Groundwater							21	21
Soil water							0	0
Total							45	45
To other sources							25	25
Total return flows							70	70
of which: Losses in distribution							1	
Evaporation of abstracted water, transpiration and water incorporated into products								
Evaporation of abstracted water							1	1
Transpiration							2	2
Water incorporated into products					1		0	1
Total use	89	33	39	15	1		73	250

The practical benefits of implementing the SEEA CF in TEDA include the following:

- adoption of the SEEA by the TEDA would provide exposure to the SEEA for constituent companies. It is a good entry point for large corporations to gain familiarity with the SEEA, and many of the efficiency measures (i.e. volume of water used per unit of output – water use as shown in Table 2) already used by businesses have strong links to the SEEA CF accounts;
- demonstration by TEDA, recognised as a leader by other industrial parks, would provide an important example for the integration of the SEEA and AWS for other industrial parks;
- trialling of incentive-based mechanisms for good water behaviour. There are multiple companies competing inside the industrial park and there would be identical information (i.e. volume of water abstracted from various environmental assets as shown Table 2) on all companies within the industrial park if the SEEA was adhered to;
- the SEEA CF accounts can be used to quantify the benefits of the circular economy model (measures of recycling can be calculated by using figures Table 1 and Table 2, and the

impact on upstream and downstream assets shown in 2) and further it is a low-cost entry point given the data already collected by TEDA Eco-Centre; and
- Opportunities to expand the relevance of AWS and link it to the SEEA Oceans initiative (supply of water to oceans may be recorded in return flows in both Table 1 and Table 2).

5.3 Kunshan Economic-Technological Development Zone

The Kunshan Economic-Technological Development Zone (KETD) was established as a county level development zone in 1985 before it was recognised as a provincial level development zone in 1991, and later elevated to the national level in 1992 because of its success. Kunshan is located 50 km to the west of Shanghai (see Figure 8). The development zone is the impetus in Kunshan's economic development and scientific and technological progress and has been ranked as the most developed county-level city in China. As of 2010 the park covered 115 square kilometres and is home to industries such as electronic materials and high-end automotive component manufacturing and trade logistics.

In contrast to TEDA, the flow of water between the environment and KETD enters and exits the industrial park through multiple nodes. While it is unclear if this type of relationship has been mapped, it is evident that Kunshan are thinking about the links to the environment and how to measure it (see Figure 9).

The primary water-related concern in Kunshan is pollution. Changes to local and central government expectations regarding water-related outcomes mean that industrial enterprises are being forced to change their practises to adopt more positive and systematic ways of looking after the environment. The severity of the issue is well described by the fact that many companies have been forced to shut down production when pollution in the region is too high.

Figure 8 The Kunshan Economic-Technological Development Zone

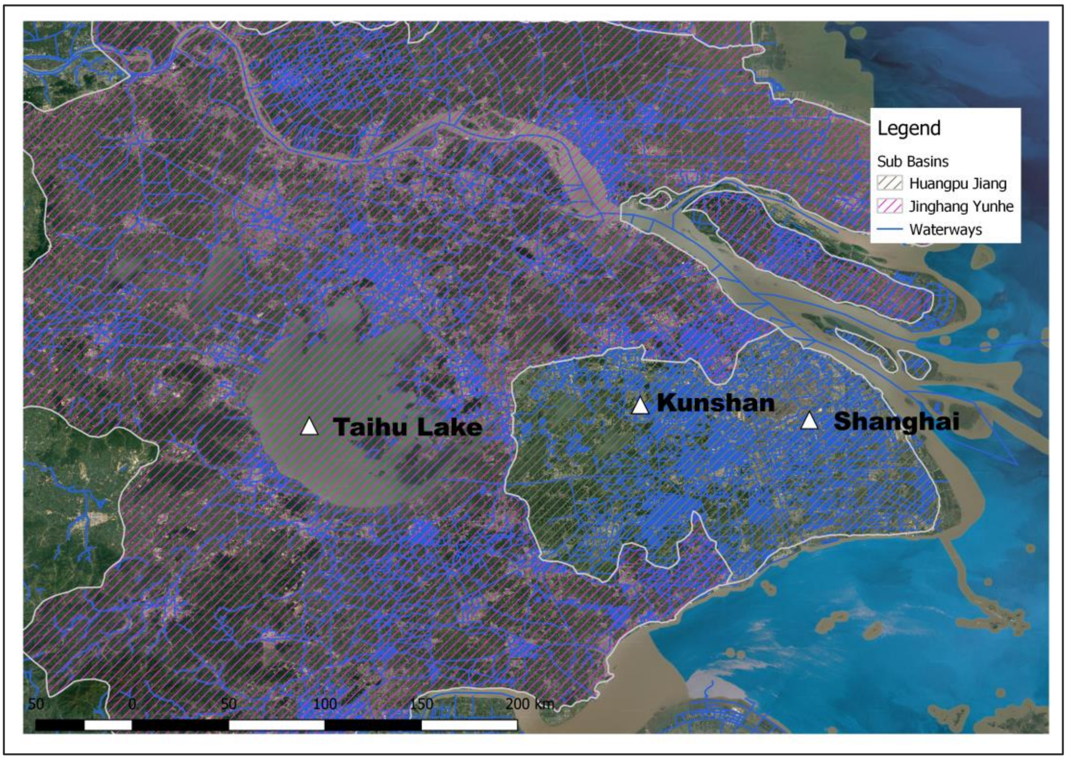
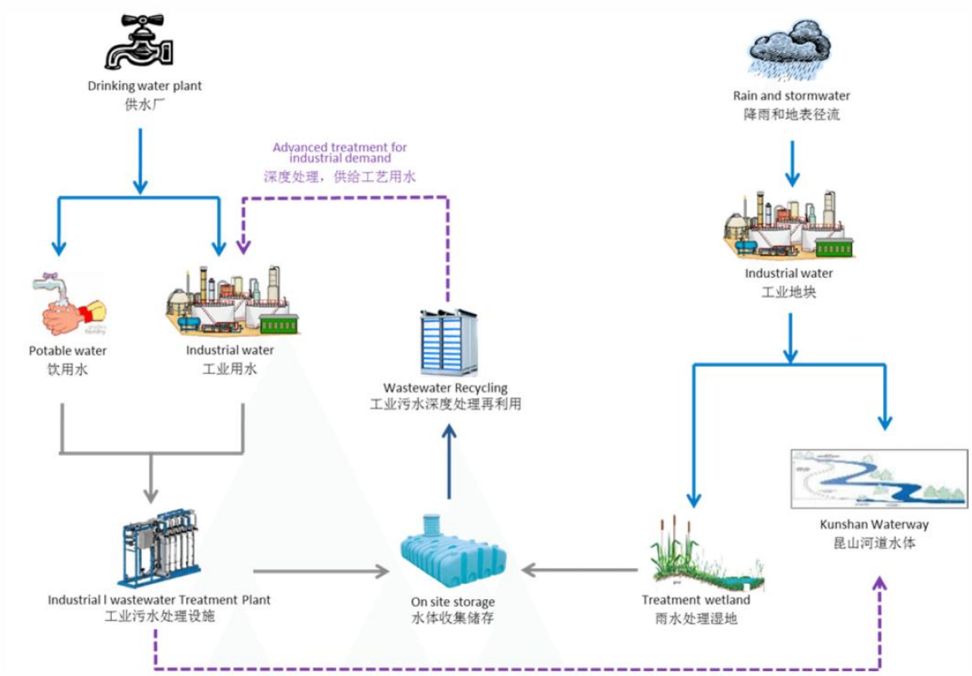


Figure 9: Water relationships in Kunshan



Source: (CRC for Water Sensitive Cities, 2014)

5.3.1 KETD data assessment

Discussions with government officials identified that there was data collected on the flows between the environment and the economy. However, unlike TEDA, the data collected was not consolidated into a single platform and appeared to focus mainly on pollution – it was unclear as to the degree of data collected on transfers within KETD.

Additionally, it was not evident that there was consolidated data on ecosystem assets from a systems perspective. However, data is believed to be held by academics from Nanjing at the sub-basin level. The academics had a wealth of data on the links between surface water and ground water flows including models that can be used to simulate those flows across the landscape. In addition, it is understood that the academics have data on other landscape characteristics that are integral to ecosystem accounting.

5.3.2 KETD observations

The analysis provided above indicates that KETD would be an appropriate region to pilot the SEEA EEA. While it is likely that the method could not be applied to the whole area, the application can demonstrate how it is carried out and identify potential opportunities for future projects. This would be a very useful partnership between the academics from Nanjing to gain access to the data required for ecosystem accounting. Further the academics expressed interest in understanding how their current and future modelling could be used in accounts to support the objectives of the AWS.

There also appears to be some commercial viability of such a project in Kunshan. The mayor of Kunshan is seeking support to develop local policies that consider economic, social and environmental outcomes. Currently, there are no frameworks to assist with environmental investments and decision making at the local government level such that the mayor and industry could co-invest in environmental outcomes. The core model of ecosystem accounting, as shown in Figure 10, will assist in delivering the information that can be used to inform land management decisions. Further, the core model can be used to elaborate on the information in supply and use table (Table 1 and Table 2 above) and can be applied to each of the water sources. Appendix 2 describes the core model of accounting in more detail.

Figure 10: The core ecosystem accounting model

There are several practical benefits that would accrue to the AWS and the KETD from applying the core model to local data held by academics from Nanjing, including:

- a local example of the links between water stewardship and ecosystem condition using the SEEA EEA;
- the reasonably high likelihood of gaining funding at the local level to implement a demonstration case study and provide a service to the mayor (links to benefits in the core model);
- demonstration of the links to the mayor also provides opportunities for businesses to co-invest with the mayor which would more generally support the emergence of environmental markets;
- in addition to the last point, businesses may recognise there is an incentive to reveal information and (populate) support the core model with respect to their contributions to the environment, and adopt the SEEA as an approach to monitoring and reporting under the AWS;
- demonstrate the key differences between the SEEA CF and EEA if the two approaches were followed through.

5.4 Recommendations on applying the SEEA in TEDA and KETD

The analysis of the parks above has shown that account development is feasible in both the TEDA and KETD. Data availability is a potential constraint facing implementation in both industrial parks. Table 3 (below)shows the data that is understood to be readily available in both industrial parks. The table indicates that the TEDA appears to be the most suitable of the two locations to pilot the SEEA CF accounts, while the KETD appears to be most suitable for SEEA EEA. TEDA has the existing infrastructure to collect and report data on the various flows:

environment to economy, within economy, and economy to environment[9] while there appears to be a neat application for ecosystem accounting in KETD.

For TEDA, data has been collected on a number of topics such as the supply of water by companies, volumes of abstracted water and volumes of waste water as part of the circular economy project. There is the potential to leverage this data moving forward and also align the ambitions of AWS with those of the circular economy whilst developing a set of accounts suitable to both. In contrast, the data in KETD mainly relates to that required for ecosystem accounting and is local in nature. This in no way discounts the value of undertaking a pilot set of ecosystem accounts particularly since there are strong links to local environmental policies and the needs of the mayor.

There are two key items that need to be addressed before the SEEA EEA and the SEEA CF can be piloted. Two bodies of work can be completed concurrently that will feed into the project directly. A contextual report - explaining the water issues, assets and industrial park in detail - and a detailed data scoping report and gathering exercise.

The contextual report should include Figure 4 as a template to record all important water related assets, industrial park companies and related infrastructure. Further, the contextual report should go into detail around the policy issues in TEDA and KETD. For both parks there is an opportunity to communicate and demonstrate how the AWS is policy relevant in many areas, as this did not seem to be appreciated or understood by stakeholders met during the mission. The data scoping report should extend on initial work shown in Table 1 to be more thorough. Additionally, various sources should be recorded, and any data gaps should be identified.

[9] As illustrated by Chen An's presentation on the circular economy platform

Table 3: Readily available data, TEDA and KETD, SEEA CF and SEEA EEA

	Status	
	TEDA	KEDA
Central Framework		
Supply and Use		
Amount abstracted, by water asset	✓	-
Supply of water by each company	✓	-
Use of water by each company, domestic, commercial, industry	✓	-
Discharge of water by each company	✓	-
Amount discharged by water asset	✓	-
Asset Accounts		
Infiltration by water asset	✓	-
Transpiration by water asset	✓	-
Evaporation by water asset	✓	-
Abstraction by water asset	✓	-
Ecosystem Accounting		
Underlying data		
Land cover data	-	✓
Topography	-	✓
Vegetation type and habitat type	-	✓
Species composition	-	✓
Hydrology	-	✓
Soil resources and geological data	-	✓
Meteorological data	-	✓
Bathymetry	-	✓
Administrative boundaries	✓	✓
Other official boundaries (basins, shorelines etc)	✓	✓
Population, built up areas and settlements	✓	✓
Transport and communication	✓	✓
Ecosystem Extent		
Relies on underlying data above	-	✓
Ecosystem Condition		
Relies on underlying data above	-	✓
Ecosystem services		
Requires modelling using underlying data	-	✓
Ecosystem benefits		
Requires modelling or market transactions	-	-
Socio-economic data		
population	-	-
employment	-	-
economic activity	-	-

6 BROADENING THE APPLICATION OF THE SEEA TO SUPPORT THE AWS

Clearly, the findings from the two case studies indicate opportunities to take environmental economic accounting to other industrial parks across China. Most importantly, by adopting an accounting approach of the SEEA, the data and information gathered can be applied to support the monitoring and evaluation phases of the AWS Standard. The compilation of data using the SEEA CF provides replicable measures of water efficiency and productivity, and links to the both the sources of abstracted water (groundwater, surface water, etc) and return flows to the environment. This information places the parks into the broad context of total water infrastructure and delivery, and into the focused catchment context that is relevant to each park, allowing for comparisons between industries and across parks. Finally, the SEEA EEA can be applied to the units listed in the abstracted water and return flows classes to disaggregate them into their ecosystem components including rivers, wetland and lakes etc. This last step is key to linking industrial parks to ecosystem services and environmental markets.

To do this, however, a broader program of work is required. The program of work, as described in this section, is relevant as it is common across all industrial parks and will need to be developed with all AWS Standard participants.

6.1 Progressing environmental economic accounting with incomplete data

It should be noted that a key value-add from undertaking environmental accounting is the ability to develop a narrative describing the relationship between the environment and the economy, not the production of accounts per se. The process of collecting and collating data to build accounts demonstrates to stakeholders where there may be gaps and opportunities to refocus efforts[10]. Further, the process facilitates the development of policies that are linked to water use and brings in many other players and data-holders that would not normally be engaged.

There may be instances where data is incomplete and cannot fully populate the SEEA CF and/or SEEA EEA. Rather than see this as a barrier to account production, it should be an opportunity to improve data collection and continue with account production. There may, for example, be data on water use and discharge for 60 per cent of all entities within an Industrial Park. In such

[10] Depending on the use of the accounting information, account detail may be important. For instance, a certain degree of confidence would be required for use of the information in environmental markets etc.

cases, it may be appropriate to estimate flows of water to and from institutions. For example, there may be a water discharge estimate for company A, which is the same size as company B and produces identical outputs. Based on the characteristics of company A, we can estimate (perhaps using regression techniques if there is a large sample of companies) company B's discharge. This could be reconciled at another point in the system where measurement occurs. An important feature of the accounting approach is the ability to reconcile data points and use modelling techniques to infill where data may not be available.

One key issue regarding ecosystem accounts is that the integration of physical data on water at relevant spatial levels (e.g., river basins), may not align with the available spatial detail for economic data (which are more commonly compiled based on administrative boundaries). As part of a data scoping exercise described in section above, it will be necessary to understand the spatial attributes of each data set collected. It is important to extend this spatial reference if water supply is from another basin and/or those affected by important water related areas extend across different basins. Undertaking a contextual report will help determine these types of issues.

Clarity on the spatial areas that have already been delineated by government agencies for administrative purposes will help determine the spatial system underlying ecosystem accounting. As a result, common areas of observation should be defined across data sets. However, it is possible that there will be data mismatches between areas

It should be noted that complete accounts are not required for monitoring and evaluation – in partial form the accounting framework can still produce indicators necessary for M&E. Undertaking the process also helps to develop a narrative with stakeholders and seek buy-in from stakeholders.

6.2 A strategy for data collection

A trade off exists between completeness of accounts, time and cost. Ultimately, a balance will need to be found between the data available and the intended use of the data that builds on an emerging understanding of the more relevant connections between ecosystems and economic and human activity.

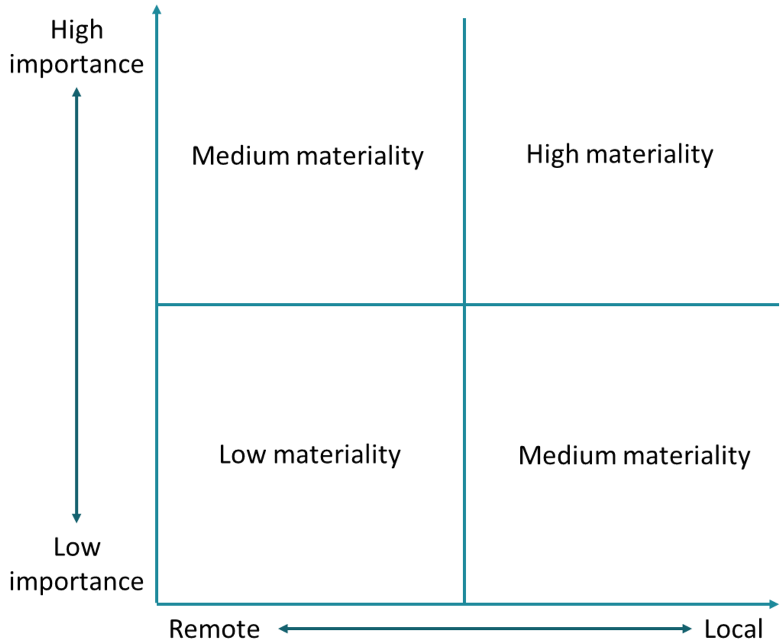
It is almost certain that there will be data that is not available during the first iteration of environmental economic accounting. A key theme identified during the mission to China was poor data sharing among agencies both within and across government and academia. However, it did appear that partnering with academic institutions is one way to overcome access to data if in the first instance the work is seen to support government understanding and implementation of its policies. To prioritise data collection for the first iteration, it is important to answer question such as:

- what data will add most value to our current suite of data. This needs to be informed by the needs of stakeholders and the use of the data;
- what accounts and indicators are necessary to the measure the current objective; and
- what is the cost of obtaining extra data?

A good starting point is to determine which economic and environmental assets to focus on, under both the SEEA CF and the SEEA EEA. This can be determined both qualitatively or quantitatively.

Figure 11 provides a general approach to assessing the importance of various upstream and/or downstream water assets or sinks. Water flows abstracted by the industrial park from an environmental asset, divided by water stock that asset holds, is one potential measure of asset importance. This is shown on the vertical axis. For instance, if 90% of the total water an asset has the capacity to hold is withdrawn annually one may see that as high importance since it is making a significant contribution from its own resources. On the horizontal axis, the metric might be distance from industrial park. Looking at the combination of these two metrics would give some indication of important water assets and the spatial area for analysis. As an alternative to distance from industrial park one could consider combining asset recharge rates and variability with the data on the Y axis. If most of the resource is drawn down each year and the recharge (replenishment) of that resource is highly variable it may be at high risk of environmental degradation.

Figure 11: Relative importance of various assets



A context report may provide important information regarding the appropriate boundary. For instance, should the framework include assets that are remote, or should it include assets that are only local in nature? It might be that ecosystem accounting relies on stakeholder consultation to determine important assets in the area.

An alternative to the diagram in Figure 11, is the use of a rule of thumb. For example, a metric such as 80 per cent of all water needs to be accounted for under the accounting system. In determining which companies to collect data from inside the economy, it might be that data is only collected form companies that produce 80 percent of residuals or consume 80 per cent of water.

6.3 Capacity building

To employ the accounting techniques described in this document, it is necessary to invest in the appropriate people and technology. Skills in economics, accounting, ecology and Geographical Information Systems (GIS) will be required, as will be the technology to undertake the accounting, such as GIS software, modelling software and database management systems.

This capacity building will require liaisons with various private, public and government organisations and may include the establishment of research bodies. By way of example, it will be necessary to develop an ecosystem type classification that is consistent across industrial parks and different regions within China. This will ensure that figures are comparable across AWS projects. Stakeholder consultation will be required to ensure the criteria aligns with government classifications. In addition to an ecosystem type classification, it will also be necessary to understand the ecosystem services typology and prioritise the collection of information so that it is most relevant to the objectives of the AWS and Chinese government polices as noted above.

Capacity building will be required not only for AWS, but also for the firms that implement the SEEA CF and SEEA EEA. The AWS will have a large role to play in ensuring that firms have the capacity to perform the tasks necessary to partake in data collection and collation for the purpose of environmental accounting.

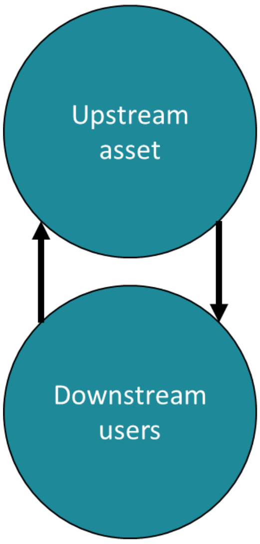
6.4 Institutional

Institutional relationships are central to environmental economic accounting. Each of the topics discussed in this section can be improved through institutional coordination. For example, data collection will be easier if there are strong relationships between the data custodian (ministries or provincial government) and the AWS, and expenditure on capacity building will be of greater value if AWS and government methods are aligned.

The AWS can report to various policies (i.e. the water ten plan, the ecological red line policy etc.) using standard measures that can be derived from a combination of environmental and economic accounts (GGDP, GEP etc.). Strategies that build relationships with government departments so that the SEEA is understood and correctly applied across all levels will help progress the shared goal of ecological civilisation in China and benefit the AWS.

The alignment of data, classifications and accounting methods across public and private institutions will help market participants capitalise on opportunities such as payments for ecosystem services. Information is critical to markets (actors need to know what they are buying and selling) and the SEEA can provide it. Figure 12 shows an example of the various contracts (payments for ecosystem services) that could involve the industrial parks. Agreements over the management of the upstream asset, and the services and benefits provided by it can be determined in a market situation. Agreements of the use of the upstream asset, can also be facilitated such that the capacity of the upstream asset to deliver ecosystem services and benefits remains at a level agreed upon.

Figure 12: Payments for ecosystem services



Entity	Receives $ from	Action
Forest Management (manages upstream asset)	One or more users within the industrial park	improves or maintains: -Flood regulation services -Water provisioning services -Water filtration services -Habitat provisioning services -Cultural services
Users within the Industrial Park	Forest management or pooled funds from upstream asset users.	retains upstream: - public benefits (such as those associated with biodiversity); and - private benefits (such as water provisioning used by agricultural industry).

7 APPENDIX I – MISSION REPORT

7.1 Background and context

As part of the project "Application of AWS and SEEA to Accounting for Water: China industrial park demonstration," Director of IDEEA Group Mark Eigenraam and Associate Reiss McLeod (here on referred to as the IDEEA Group) travelled to China for discussions on the application of the SEEA framework to support the AWS Water Stewardship Program.

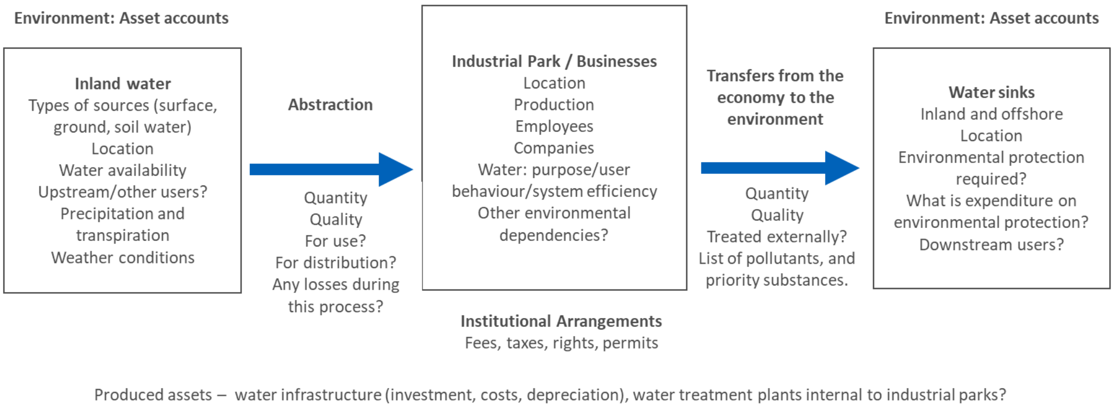
The purpose of the visit was to meet with stakeholders to present and discuss a conceptual model to monitor and report changes in water related environmental assets (including condition and extent) and provide a basic introduction to the System of Environmental-Economic Accounting (SEEA). This short report discusses the key findings of the visit to China. The findings in this report will feed into a larger report that discusses how the AWS and SEEA can be used systematically to report on water use and supply using the industrial parks in Kunshan and Tianjin as examples.

7.2 The Conceptual Framework

The conceptual framework, introduced in Section 4.1, is a description of:

1) how an industrial park may interact with water across two domains: the abstraction of water from the environment, and the flow of water back to the environment. This section will be referred to as Part 1. It includes the infrastructure required to sustain this flow, the purpose of abstraction, and the requirements of various actors within the park and their characteristics; and
2) water assets that are used as sources of water abstraction or as sinks for transfers from the economy. This section will be referred to as Part 2. It includes characteristics of the water assets such as source type and location, as well as upstream and downstream dependencies on these water assets.

Figure 13: Conceptual Framework linking the environment to industrial parks



*flow of water within park also of interest

7.3 Stakeholder Consultation

From the perspective of IDEEA Group, the aim of stakeholder consultation was to develop an understanding of local dependencies on water related assets, and to assess the types of information available to populate and inform the conceptual model for both Industrial Parks. IDEEA Group would like to thank Zhenzhen Xu and Michael Spencer from the Alliance Water Stewardship (AWS) for their involvement in the project. Both Zhenzhen and Michael identified a number of stakeholders important to the project. Each of these private, public and academic stakeholders were met by Zhenzhen and IDEEA Group, either in person or by conference call (a detailed itinerary of the trip and topics covered is provided in appendix 1). Stakeholders include:

- Professor Shi Han, City University Hong Kong
- An CHEN, Deputy Head of Consulting & Strategy Department, TEDA Eco Centre
- Shiwei GENG, The Environmental Protection Bureau, TEDA
- Feng NI, Department of Environmental Protection and Safety, Kunshan Qiandeng Township
- Junjie ZHANG & Kathinka Fürst, Duke Univeristy
- Donglin ZHU, Nanjing University (previously Jiangsu Engineering Consultancy Centre)
- Raj V. Rajan, VP Global Sustainability, R,D & E, Ecolab

7.4 Findings

Consistent with the nascent nature of the SEEA, uptake of the framework in Chinese applications appears to be slow, but there is great potential. For instance, the Chinese Government have flagged their interest in using the SEEA at a national level, with meetings being undertaken by the United Nations Statistical Division (UNSD) and the Chinese Bureau of Statistics. Various academics also flagged their interest in applying the SEEA during talks with the project team.

There are also a number of variations of, or methods related to the SEEA that are currently in circulation in China. These include the ***Natural Resources Balance Sheet***[11] ***(NRBS)*** and ***Gross Ecosystem Product (GEP)***. There is scope to investigate and contrast these methods for recording the relationship between the environment and the economy in China. There is significant interest from Prof. Shi Han to undertake some research to compare and contrast NRBS, GEP and SEEA. This work would be useful for future implementation of the AWS as many stakeholders are confused by the array of methods that are available.

Overall, stakeholders appeared to understand the conceptual model in Figure 1. The consensus is that part 1 of the model, and ideas around efficiency are better understood by industry, while academia and government are more aware of issues outside the fence such as the extent and condition of ecosystem assets and the services they provide. Increasing awareness related to issues outside the fence will continue to be an important objective of the AWS as it continues to educate stakeholders.

The use of the SEEA to support the AWS is a long-term prospect. While the SEEA is consistent with the measure and evaluation phase of the AWS standard, there are challenges to overcome to ensure the SEEA can be implemented effectively.

Data standardisation and accessibility appear to be primary challenges. Many different institutions, both public and private, collect data on water and the environment however there is little or no incentive for agencies to share data and compare outcomes. Motives, however, are usually project based and as a result data is collected at different times and for different

[11] Preliminary discussions indicate this is similar to the SEEA Central Framework reporting

outputs/outcomes. Further, the competitive nature of different administrative regions means that information is not shared and is therefore often underutilised.

If the AWS is to implement the SEEA framework effectively, they have a role to play in improving the way that data is collected and organised by relevant authorities in China. Further, the data needs to be accessible when it is required. AWS will benefit from monitoring the SEEA framework as its uptake, and the information base associated with it continues to grow.

Regarding the implementation of the SEEA framework in China, discussions with Donglin ZHU from Nanjing University were extremely promising. IDEEA Group look forward to liaising with Donglin ZHU in the coming months to develop a better understanding of the feasibility of a joint project close to Kunshan. The data available to Donglin ZHU will provide a good example of how the SEEA can be used to measure and track water related outcomes in Kunshan.

From the perspective of industry and Part 1 of the conceptual model, the presentation given at TEDA Eco Centre by An Chen on the Circular Economy Platform is a good example of how to record and monitor water use, pollution and the transfer of water by Industry. There are real opportunities to use the platform to report water flows to and from industrial parks in a standardised manner, however it is subject to the information being made available outside the project (this will be explored in the future). As real-time monitoring and the internet of things is further developed, the quality of information will continue to improve.

Professor Shi Han has strong links with TEDA. If AWS want to implement the SEEA framework in the Tianjin Economic Development Zone, his experience with the SEEA and his connections will be important. IDEEA Group also recognise the opportunity to pilot the application of the SEEA framework in other locations with Prof. Shi Han and will follow up this lead.

The mission also identified one other opportunity to work with industry. Dr. Raj Rajan of Ecolab identified EarthCheck as a potential partner for the application of the SEEA framework. EarthCheck is the world's largest dedicated research centre specialising in sustainable tourism and research. Given their position, a strong relationship with EarthCheck gives the platform for sector level discussions. Further, IDEEA Group recognise that a partnership would coincide nicely with work being completed by the World Tourism Organisation. Dr. Raj will make an additional connection with Marriot, whom Ecolab have a strong relationship.

Funding is an important aspect of each of these projects. It is likely that project co-financing will be necessary and would need to include a Chinese academic institution to improve access to government data sets. A list of potential partners should be explored: IDEEA Group will determine a list of potential donors such as the Australian Water Partnership in partnership with AWS.

Given the relevance of the SEEA framework to the M&E section of the AWS, IDEEA Group recognise that they should continue to develop their relationship with the AWS. The immediate applicability and relevance of the SEEA framework to both industry parks is clear, however given the current constraints on data an application would be some way off. IDEEA Group will provide a mock example of how the SEEA may be applied to these industrial parks in the final report. This should inform AWS of the SEEA requirements in terms of data needs and can be used as a communication example with partners in each of the parks.

7.5 Mission Agenda

Location	Date and time	Stakeholder	Topics
Tianjin	28/5/2018 10:00	Professor Shi Han, City University of Hong Kong	Policy experience in china and links to Gross Ecosystem Product (GEP) and ecosystem accounting Application of SEEA in China (past and present) Undertaken ecosystem accounting work in south Hai Nan Island Government responsibilities regarding the environment Future opportunities to work together
Tianjin	28/5/2018 13:00	Geng Shiwei, Environmental Protection Bureau, TEDA	
Tianjin	28/5/2018 14:00	An Chen, Deputy Head of Consulting & Strategy, TEDA Eco Centre	TEDA overview Presentation on the TEDA circular economy platform Sources of water for TEDA Water deposits TEDA
Tianjin	29/5/2018 09:00	An Chen, Deputy Head of Consulting & Strategy, TEDA Eco Centre	Presentation by An Chen
Tianjin to Shanghai	29/5/2018 13:00	Travel	
Kunshan	30/5/2018 09:00	Feng Ni	

Kunshan (Duke University)	30/5/2018 13:00	Junjie Zhang, Kathinka	
Shanghai	30/5/2018 15:00	Aquatech meeting discussion	
Shanghai	31/5/2018 09:00	Aquatech Forum	
Nanjing	31/5/2018 16:00	Dr Donglin Zhu	Data in Kunshan province Husong river basin work Set of slides
Shanghai	01/6/2018 9:00		
Shanghai	01/6/2018 14:00	Ecolab	

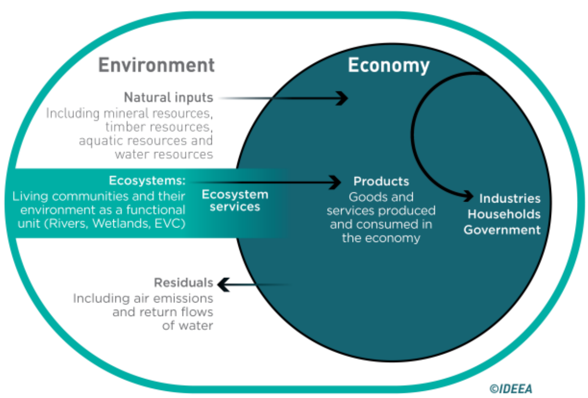
8 APPENDIX II – OVERVIEW OF SEEA CF AND SEEA EEA

8.1 The SEEA Central Framework

The natural starting point for water accounting is the SEEA CF. Stocks and flows of water between the economy and the environment are organised and integrated in the SEEA CF and the resulting accounts are especially useful for analysing water supply and use for a given area or business (national, regional, catchment, industrial park).

Stocks of water are measured in terms of megalitres (ML) of surface, ground and soil water and the various changes in those stocks over each accounting period. Physical flows are reflected in the movement of water between the environment and the economy. Flows from the environment to the economy are recorded as natural inputs; flows within the economy are recorded as product flows; and flows from the economy to the environment are recorded as residuals (for example, return flows of water).

Figure 14 Physical flows in the SEEA CF



The SEEA CF describes two accounts for water resources:

a) supply and use tables (SUT) in physical and monetary terms describing all flows of water (inputs, products and residuals), in volumetric terms. A valuable extension is to monitor the quality of these flows too. Formulation of SUTs are is consistent with phase 2.4 of the Standard – understand water within the site.

b) asset accounts for individual water assets in physical terms showing the stock of assets at the beginning and the end of each accounting period and the changes in the stock;

Physical flows in the SEEA CF

Physical supply and use tables (PSUT) for water can be compiled at various levels of detail, depending on the required policy, analytical focus and data availability. A basic PSUT for water contains information on the supply and use of water and provides an overview of water flows. The PSUT for water is divided into five sections which organize information on (a) abstraction of water from the environment; (b) distribution and use of abstracted water across enterprises and households; (c) flows of wastewater and reused water (between households and enterprises); (d) return flows of water to the environment; and (e) evaporation, transpiration and water incorporated into products.

A stylised example of a supply and use tables is shown in Table 4 and Table 5. Notice that the supply and use table have the following features:

a) the table balances – for instance the amount of water abstracted from the environment is equal to the amount of water discharged back into the environment, plus water contained in products. Further, the amount of water used by both vertical and horizontal categories (with the exception of the water from the environment and water to the environment columns) is the same in the supply table and the use table.
b) the table captures losses during the distribution of water – for instance some water is lost during the distribution process of the water collection, treatment and supply category. This is captured by the losses in distribution row which is contained in the return flows of water section of the supply table. This row ensures that the difference between the sources of abstracted water section and abstracted water section is accounted for.
c) the table captures differences between abstracted water and return flows – for example notice that return flows are not equal to total supply of abstracted water. This is because some water is evaporated, transpired or included in products.
d) the table captures the exchange of water within the economy – for example notice that total supply is equal to total supply within the boundary – the same cubic metre of water

can be passed to many economic units within the production boundary. Take wastewater for example, it is passed around but still exits as a return flow.

Table 4 Stylised example, water supply table

	Industry	Water collection, treatment and supply	Sewerage	Household	Imports	From environment	Total supply
Sources of abstracted water							
Inland water resources							
Surface water						20	20
Groundwater						30	30
Soil water						5	5
Total						55	55
Other water sources						0	0
Precipitation						9	9
Sea water						10	10
Total						19	19
Total supply abstracted water						74	74
Abstracted water							
For distribution	0	29	0	0			29
For own-use	36	2	7	0			45
Total abstracted water	36	31	7	0			74
Wastewater and reused water							
Wastewater	0	0	0	0			0
Wastewater to treatment	12	0	0	13			25
Own treatment	0	0	0	0			0
Reused water produced	0	0	0	0			0
For distribution	0	0	2	0			2
For own use	1	0	0	0			1
Total	13	0	2	13			28
Return flows of water							
To inland water resources							
Surface water	22	1	0	1			24
Groundwater	9	1	11	0			21
Soil water	0	0	0	0			0
Total	31	2	11	1			45
To other sources	5	0	19	1			25
Total return flows	36	2	30	2			70
of which: Losses in distribution	0	1	0	0			1
Evaporation of abstracted water, transpiration and water incorporated into products							
Evaporation of abstracted water	1	0	0	0			1
Transpiration	2	0	0	0			2
Water incorporated into products	1	0	0	0			1
Total supply	**89**	**33**	**39**	**15**		**74**	**250**

Table 5 Stylised example, water use table

	Industry	Water collection, treatment and supply	Sewerage	Household	Accumulation	Exports	To environment	Total use
Sources of abstracted water								
Inland water resources								
Surface water	16	4	0					20
Groundwater	6	24	0					30
Soil water	5	0	0					5
Total	27	28	0					55
Other water sources	0	0	0					0
Precipitation	0	2	7					9
Sea water	9	1	0					10
Total	9	3	7					19
Total use abstracted water	36	31	7					74
Abstracted water								
For distribution	14	0	0	15				29
For own-use	36	2	7	0				45
Total abstracted water	50	2	7	15				74
Wastewater and reused water								
Wastewater	0	0	0	0				0
Wastewater received from other units	0	0	25	0				25
Own treatment	0	0	0	0				0
Reused water produced	0	0	0	0				0
Distributed reuse	2	0	0	0				2
Own use	1	0	0	0				1
Total	3	0	25	0				28
Return flows of water								
To inland water resources								
Surface water							24	24
Groundwater							21	21
Soil water							0	0
Total							45	45
To other sources							25	25
Total return flows							70	70
of which: Losses in distribution							1	
Evaporation of abstracted water, transpiration and water incorporated into products								
Evaporation of abstracted water							1	1
Transpiration							2	2
Water incorporated into products					1		0	1
Total use	**89**	**33**	**39**	**15**	**1**		**73**	**250**

Note that emissions to water (e.g., plastic pollution) are recorded in a separate PSUT that records flows of pollutants or solid waste from the economy to the environment. It is therefore necessary to consider what other physical flows might impact water assets within the area of interest and potentially capture them in a PSUT. The broader issue of the impact of economic activity on the quality of water requires an assessment of the quality of the stock of water resources.

Asset Accounts

The use of natural inputs of water by the economy, as described in the supply and use table above, is linked to changes in the stock of water resources. The discharge of residuals into the environment, also described in supply and use tables, is also linked to changes in the stock of environmental assets (rivers, wetlands, oceans, etc) that accepts those residuals. Asset accounts for water resources and other environmental assets are an important feature of the SEEA CF.

Asset accounts for water resources focus on the inflows and outflows of water to and from the land surface and subsurface, and on the destination of these flows. In conjunction with information on instream uses of water (e.g., fish breeding, run-of-the-river hydropower generation), seasonal variation of flows of water, and other factors, a focus on water resources allows assessment of the availability of water to meet demands from the economy and to assess whether those demands are consistent with the longer-term sustainability of water assets.

The asset accounts themselves present information on the stock of water at the beginning and end of an accounting period, whether it is in artificial reservoirs, lakes or rivers, or stored as groundwater or soil water. The accounts then record the flows of water as it is abstracted, consumed, added to through precipitation, or changed through flows to and from other countries and returns to the sea. The structure of the physical asset account for water resources is shown in Table 6.

Table 6 Stylised physical account for water resources (cubic metres)

	Type of water resource						Total
	Surface water				Groundwater	Soil water	
	Artificial reservoirs	Lakes	Rivers and streams	Glaciers, snow and ice			
Opening stock of water resources	1 500	2 700	5 000		100 000	500	109 700
Additions to stock							
Returns	300		53		315		669
Precipitation	124	246	50			23 015	23 435
Inflows from other territories			17 650				17 650
Inflows from other inland water resources	1 054	339	2 487		437	0	4 317
Discoveries of water in aquifers							
Total additions to stock	1 478	585	20 240		752	23 015	46 071
Reductions in stock							
Abstraction	280	20	141		476	50	967
for hydro power generation							
for cooling water							
Evaporation & actual evapotranspiration	80	215	54			21 125	21 474
Outflows to other territores			9 430				9 430
Outflows to the sea			10 000				10 000
Outflows to other inland water resources	1 000	100	1 343		87	1 787	4 317
Total reductions in stock	1 360	335	20 968		563	22 962	46 188
Closing stock of water resources	1 618	2 950	4 272		100 189	553	109 583

8.2 SEEA Experimental Ecosystem Accounting

The methods and tables described in the SEEA CF are the basic requirement for water accounting. There are, however, a number of reasons why ecosystem accounting is a valuable addition to the methods described above.

The main value add is that the SEEA EEA extends the range of flows measured in physical terms. While the SEEA CF describes the relationship between the environment and the economy, it does not consider the importance of the environment and its systemic impact on water-related outcomes. Take, for example, the role that a natural wetland located 5 kilometres downstream of Kunshan might play in maintaining or improving water quality. Approaching water accounting from the perspective of the SEEA CF enables measures of efficiency and productivity whereas the SEEA EEA aligns with the important water related areas outcome of the AWS, particularly the catchment focus and links to catchment environmental assets.

Ecosystem services related to water that are captured in the SEEA EEA include the provisioning service of water when it is abstracted for use (irrigation, drinking, hydropower), the regulating role of water bodies in filtering pollutants and other residual flows, and the cultural services associated with water such as fishing and other recreational activities. In addition, there are a number of ecosystem services to which water is linked, for example, the regulation of water flows by vegetation in catchments to provide flood protection benefits and the capture of excess sediment by freshwater ecosystem assets.

Further, the SEEA EEA has a distinct perspective on the measurement of environmental assets. The approach assesses how different individual environmental assets interact as part of natural processes within a spatial area to provide a range of services for economic and other human activity. Ecosystem assets are thus environmental assets as viewed from a systems perspective. Accounting from the perspective of experimental ecosystem accounting ensures spatial delineation of the various systems and allows identification of ecosystem assets that are important in achieving water-related outcomes. The scope is broader than the asset boundary established by the SNA and applied in the SEEA CF, which is limited to those assets that have an economic value in monetary terms.

From a measurement perspective, ecosystem accounting focuses on (a) the flows of ecosystem services to enable improved understanding of the relationship between ecosystems and economic and other human activity; and (b) the stock and changes in stock of ecosystem assets to enable an understanding of changes in ecosystems and their capacity to generate ecosystem services in the future. The basic logic of ecosystem accounting is shown in Figure 15.

Figure 15 Core ecosystem accounting framework

There are five core ecosystem accounts as listed in Table 7. Depending on the measurement pathway that is pursued, which in turn will be linked to the intended application of the accounting information, different accounts will be of greater or lesser focus in compilation.

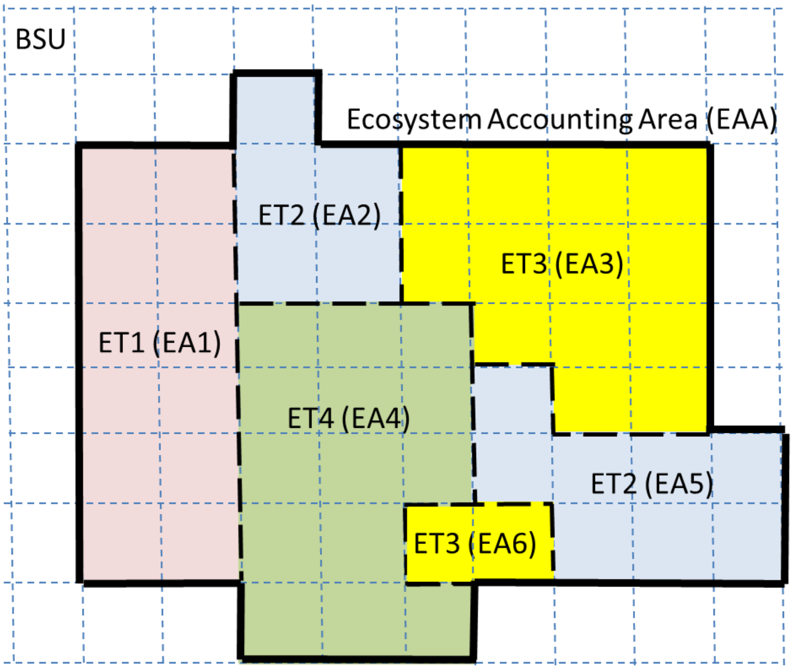
Table 7 Core ecosystem accounts

1.	Ecosystem extent account – physical terms
2.	Ecosystem condition account – physical terms
3.	Ecosystem services supply and use account– physical terms
4.	Ecosystem services supply and use account – monetary terms
5.	Ecosystem monetary asset account – monetary terms

Defining ecosystem assets

Before discussing how to compile the accounts listed in the table above, one must first create a system for the integration of data. Ecosystem accounting involves the integration of data relating to three types of spatial units – ecosystem assets (EA), ecosystem types (ET) and ecosystem accounting areas (EAA) (see Figure 16 below). These areas are key elements of the ecosystem extent account and provide the basis for spatial analysis in the other ecosystem accounts.

Figure 16 Relationships between spatial areas in ecosystem extent accounts



Source: Adapted from SEEA EEA Figure 2.4 (UN et al., 2014b). Note that Ecosystem Assets (EA) represent individual, contiguous ecosystems. Ecosystem Types (ET) are EA of the same type.

In defining ecosystem assets, it is necessary to select the Ecosystem Accounting Area, in this case the relevant catchment is the starting point. Depending on the types of issues surrounding the industrial park, this may also encompass areas outside the primary catchments. For example, one might be interested in analysing the impact that TEDA has on the bay, or on the original water source from which water is transferred from south to north. For Kunshan, the Ecosystem Accounting Area may be more local in nature.

Next, it is necessary to define ecosystem types across within the Ecosystem Accounting Area (EAA). For example, these may be grassland, plantation forest, agricultural areas, water bodies or natural areas. It should be recognised that spatial units are three dimensional in nature and either sit in the atmosphere, on land, or below land (water table). This is especially relevant to water accounting. It is also important for definitions across ecosystem types to be consistent across areas of measurement, so the analysis is comparable.

The definition of ecosystem types will need to be completed in concurrence with data inspection and analysis. This requires the partitioning of the EAA into Basic Spatial Unit (BSUs). In defining BSUs and analysing spatial data, a flexible approach is proposed in recognition of the large differences across countries in terms of spatial area, ecological heterogeneity and data availability. A fundamental choice in setting up the spatial data infrastructure is whether to use a reference grid and use this reference grid to integrate all data layers, or to allow different datasets to have different formats (grid or vector) and/or different grid sizes.

The delineation of units should be undertaken in concert with the development of spatial databases in geographic information systems (GIS). These databases could contain information on, for example, soil type and status, water tables, rainfall amount and pattern, temperatures, vegetation, biodiversity, slopes, altitude, as well as, potentially, information on land management and use, population, and social and economic variables. This information might also be used to assess flows of ecosystem services from given spatial units to relevant beneficiaries. After listing all the ecosystem types within the landscape, it is necessary to assign every BSU to an ecosystem type. This exercise will determine the Ecosystem Assets within the Ecosystem Accounting Area.

Ecosystem extent

Ecosystem extent refers to the size of an ecosystem asset. For ecosystem assets, the concept of extent is generally measured in terms of surface area, for example, hectares of a land-cover type. Where there is a mix of land covers within an ecosystem asset (e.g., a river basin or a mixed agricultural landscape), ecosystem extent may be reflected in the proportion of different types of land cover. Changes in the proportions of different land covers within a defined EAA may be important indicators of changes in ecosystem assets.

Ecosystem condition

Ecosystem condition reflects the overall quality of an ecosystem asset in terms of its characteristics. The assessment of ecosystem condition involves two distinct stages of measurement with reference to both the quantity and the quality aspects of the characteristics of the ecosystem asset. In the first stage, it is necessary to select appropriate characteristics and associated indicators of changes in those characteristics. The selection of characteristics and associated indicators should be carried out on a scientific basis so that there is an assessment of the ongoing functioning, resilience and integrity of the ecosystem asset. Thus, movements of the indicators should be responsive to changes in the functioning and integrity of the ecosystem as a whole.

Measures of ecosystem condition may be compiled in relation to key ecosystem characteristics (e.g., water, soil, carbon, vegetation, biodiversity) and the choice of characteristics will generally vary depending on the type of ecosystem asset. Further, the selection of characteristics should take into account current and expected future uses of the ecosystem (e.g., whether for agriculture, forestry, carbon sequestration, recreation), since these uses are likely to impact most directly on certain characteristics and hence on the overall condition and capacity of the ecosystem asset to generate alternative baskets of ecosystem services. Usually, there will not be a single indicator for assessing the quality of a single characteristic. Both the selection and measurement of characteristics and associated indicators are likely to present measurement challenges. Table 8 illustrates potential indicators of ecosystem condition.

Table 8 Examples of indicators of ecosystem condition

	Characteristics of ecosystem condition				
	Vegetation	Biodiversity	Soil	Water	Carbon
Indicators	leaf area index biomass index	species richness relative abundance	soil fertility soil carbon soil moisture	river flow water quality fish species	net carbon balance primary productivity

In the second stage, the indicators are related to a common reference condition or benchmark. The use of a common reference condition relative to all indicators for an ecosystem asset can support an overall assessment of the condition of the asset.

There are a number of options, with different conceptual underpinnings, available for determining a reference condition. One approach, reflecting an accounting perspective, is to measure changes relative to the condition at the beginning of the accounting period. Thus, when accounts are compiled for any given accounting period, the measure of change in condition should refer to the change from the beginning of the period to the end. This reference condition is sufficient for accounting purposes but is limited in providing an assessment of the relative condition of multiple ecosystem assets since, when this approach is used, all ecosystems are assumed to have the same condition relative to their specific characteristics at the beginning of the period.

A common starting point for determining a reference condition is application of the idea of close-to natural or pristine condition where the reference condition reflects the condition of the ecosystem asset if it had been relatively unaffected by human activity. In many cases the application of this reference condition is done by selecting a point in time at a pre-industrial stage. In Australia, for example, the year 1750 is commonly used.

Ecosystem services

Each ecosystem asset provides a basket of ecosystem services. The basket and its composition covaries with ecosystem extent and condition. Trade-offs among ecosystem services are particularly important as human intervention and natural phenomena can alter ecosystem assets and the ecosystem services they provide.

To support evaluation of these trade-offs, ecosystem services are grouped into different types. SEEA Experimental Ecosystem Accounting, building on a number of large ecosystem service measurement projects, uses the following three broadly agreed categories of ecosystem services:

a. Provisioning services, which represent the material and energy contributions generated by or in an ecosystem, for example, fishes or plants with pharmaceutical properties;
b. Regulating services, which result from the capacity of ecosystems to regulate climate, hydrologic and biochemical cycles, Earth surface processes and a variety of biological processes. These services often have an important spatial aspect. For instance, the flood control service of an upper watershed forest is relevant only in the flood zone downstream of the forest;
c. Cultural services, which are generated from the physical settings, locations or situations that give rise to intellectual and symbolic benefits obtained by people from ecosystems through recreation, knowledge development, relaxation and spiritual reflection. This may involve actual visits to an area, enjoying the ecosystem indirectly (e.g., through nature movies) or the satisfaction gained from knowing that an ecosystem containing important biodiversity or cultural monuments will be preserved.

The measurement units used for recording flows of ecosystem services will vary significantly by type of ecosystem service. Provisioning services will generally be measured in units, such as tons or cubic metres, that reflect the relevant physical properties of the underlying input. However, they may also be measured in units specific to the type of service. For example, biomass-based energy may be measured in joules. All measures should reflect the total flows of the ecosystem service over an accounting period, which is usually one year.

Regulating services will also be measured in a variety of units depending on the indicator used to reflect the flow of service. For example, the service of carbon sequestration would normally be measured in tons of carbon sequestered.

Cultural services are likely to be measured in units related to the people interacting with the ecosystem and using the ecosystem service. Possible measurement units include the number of people visiting a site or the time spent using the service. Also, since the volumes of cultural services are likely to be related to the quality of the ecosystem, it may be relevant to take into account changes in ecosystem condition and ecosystem characteristics. For example, visits to national parks may be linked to the general condition of the associated ecosystems.

The supply of ecosystem services is assumed to be able to be attributed to specific ecosystem assets. By definition, the total supply of a single ecosystem service should equal the total use of that service. However, the use of services generated by a single ecosystem asset may not all take place within that ecosystem asset. For example, urban areas will benefit from the air filtration services provided by nearby forests. It may therefore be of interest to further disaggregate the information on the use of ecosystem services by spatial area distinguishing between those services that are used by people within the ecosystem asset and those used by people outside the ecosystem asset.

The attribution of the supply and use of ecosystem services to type of economic unit (e.g., enterprises, households, government) will require certain assumptions regarding the nature of the ownership and management of the ecosystem assets in relation to the various ecosystem services. Table xx presents one way of organizing information on the generation and use of ecosystem services by economic units. The measurement of these flows may be of particular relevance in accounting for ecosystem degradation.

Table 9 Generation and use of ecosystem services for an ecosystem asset

	Generation of ecosystem services					Use of ecosystem services				
	Enterprises	Households	Government	Rest of world	Total	Enterprises	Households	Government	Rest of world	Total
Type of ecosystem services										
Provisioning services										
Regulating services										
Cultural services										

Benefits

Flows of ecosystem services are distinguished from flows of benefits. In the SEEA EEA, the term benefit is used to encompass both the products (goods and services) produced by economic units as recorded in the standard national accounts (SNA benefits) and non-SNA benefits that are generated by ecosystems and consumed directly by individuals and societies.

SNA benefits are goods or services (products) produced by economic units (e.g. food, water, clothing, shelter, recreation) currently included in the economic production boundary of the SNA. Defining ecosystem services as “contributions” highlights the fact that ecosystem services are only one part of a broader set of inputs which are combined to provide these benefits. For example, the benefit of clean drinking water is, most commonly, the end result of the abstraction of water from an ecosystem through the use of human inputs of labour and produced assets (e.g., pipes, wells, filtration equipment). These combinations of inputs may be considered examples of joint production and are a feature of the production of SNA benefits.

Non-SNA benefits accrue to individuals, or society generally, that are not produced by economic units (e.g. clean air). By convention, the measurement scope of non-SNA benefits for ecosystem accounting purposes is limited to the flow of ecosystem services with a direct link to human well-being. There are usually few human inputs into the generation of non-SNA benefits; hence, the ecosystem service and the associated benefit may, in effect, be equivalent.

In the accounting system, for each supply of final ecosystem services there is a corresponding use that leads to the production of either an SNA or non-SNA benefit. Further, in each sequence of use of ecosystem services and production of benefits, there is an associated user being an economic unit – business, government or household. Thus, every final ecosystem service flow represents an exchange between an ecosystem asset (as a producing/supplying unit in the accounting system) and an economic unit.

8.3 Data management

From a technical perspective, it is recommended that the integration of data with spatial platforms considers a range of issues such as the data formats such as the reference coordinate systems used by other agencies. This assessment should include documenting the most commonly used GIS software packages and understanding the requirements/applications of GIS. Relevant elements to consider in building upon an existing, or establishing a new spatial data infrastructure include, but are not limited to, the coordinate and spatial projection system, and whether a reference grid will be used. A reference grid may be most relevant in case of large areas, large datasets, and restrictions in computing capacity. If a reference grid is used, the size of the grid cells needs to be established. The development of spatial data infrastructure also requires selecting hardware with sufficient processing, storage and back-up capacity, and GIS software.

When integrating or collecting data, it is important that the reference periods for the different data items be aligned. The calendar year is the recommended temporal reference. However, in practice, water and economic data may not be available for calendar years. For example, for national accounts some countries use a financial year, while for water statistics, they may use a hydrological year. Financial and hydrological years may be the same as or different from calendar years. It is also noted that in some cases high seasonal variability in the relationship between the demand and supply of water may mean that annual data does not properly explain variation in water assets and supply and use.

The way data is organised and collected is extremely important. Data should be regarded as an asset and data infrastructure should be invested in. The starting point in creating and utilising data infrastructure is by developing an inventory of spatial data infrastructure that exists, within government agencies such as spatial planning or environmental agencies. This is an extension to project specific data scoping and should be done as soon as possible. It is important that the data infrastructure is linked to existing infrastructure held by other parties.

9 REFERENCES

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