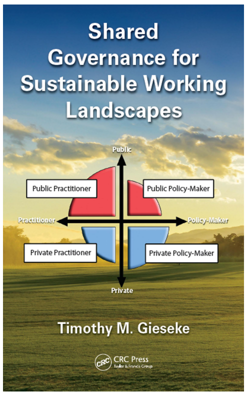

Shared Governance for Sustainable Working Landscapes

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A landscape language

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chapter seven

A landscape language

Communication is a key issue for solving wicked problems (Camillus, 2008). Language and communication have often been cited as barriers to interdisciplinary research (Stock and Burton, 2011). Such a scenario was illustrated in Chapter 3 with the various definitions of ecosystem services. These communication issues are exasperated as the number of individual sustainability stakeholders increases. Relationships become strained by a mutual lack of understanding of each other's goals and expectations relative to agriculture sustainability (Stokols, 2006).

Landscape indices can be used to bridge this communication gap and address the difficulties of directly measuring ecosystem outputs and outcomes at the landscape scale. Direct measurement is clearly impossible in the context of many of the most pressing questions of societal relevance, such as those regarding the impacts of climate change, large-scale agricultural intensification, and habitat loss. In these cases, indices are used as *measurements* to provide information on ecosystem structure, functions, and ecosystem service delivery (Stephens et al., 2015). Ecological indices have become an important topic of landscape research, as hundreds of indices are researched for landscape management and planning purposes (Uuemaa et al., 2009).

In this text, indices are proposed as the foundation for an agricultural landscape sustainability *language*. A common language is an important step to creating a more inclusive dialogue to overcome communication barriers. To be an effective communicator, an index should reduce a large quantity of data down to its simplest form while retaining essential information for the questions that are being asked of the data (Ott, 1978). In short, an index is designed to simplify. Landscape indices *package* complex data sets into a unitless number to provide information and insights related to land management in a succinct form (Bell and Morse, 2008).

In this form, indices can act as a common language that describes resource-management outcomes of the landscape in a succinct and transparent manner. Communication among government, environmental groups, conservationists, agricultural organizations, and farmers can occur relatively quickly at a scope and scale not possible with practice-based accounting. A functioning landscape language would include, as all functioning languages do, form, content, and use (Bloom and Lahey, 1978).

- *Form* refers to the structure of language. This includes the sounds, words, structures, and rules of sentences. The structure of a landscape language would be made of data points, data collection processes, index development, and calculations.
- *Content* refers to the meaning of the language overall, including the individual words that are used and the meaning created when these words are combined. The content of the landscape language is created by what the indices describe, such as the condition of the natural capital, the processes, and functions and its output. This content, referred to as landscape intelligence, may be spatial and temporal specific and scalable. Content consists of individual indices and portfolios.
- *Use* refers to the purpose of the communication, including why communication occurs. The purpose of an index-based landscape language is to transcend disciplinary and sector boundaries by supporting commonalities in defining, measuring, accounting, valuing, and exchanging values.

A primary purpose of creating a functioning landscape language is to create a common definition for ecosystem services. The four definitions from Chapter 3 are included: (1) the ability to relate MEA's ecosystem services to human use issues (Alcamo and Bennett, 2003), (2) align the definition with existing market definitions of goods and services (Brown et al., 2007; Daily, 1997), (3) recognize these values as spatially based (Luck et al., 2009), and (4) ensure relevancy within the broader economic system (Boyd and Banzhaf, 2007). Each of these attributes contribute to the overall goal of creating compatible aspects of accounting, measurement, ownership, valuation, and enabling transactions of ecosystem service assets.

7.1 Index-based language form

The structure of a landscape sustainability language should identify landscape data needs, data collection methods, types of indices, and index calculations or algorithms. It is analogous to a typical language consisting of sounds and letters, rules on how words are created, specific word types, and definitions. The form should create the basis to be able to "speak" to a broad audience on what is occurring on the landscape.

7.1.1 Landscape data

The landscape data needed to calculate index values includes the physical data of the landscape such as soil, topography, and vegetation, the management data, and environmental impacts associated with weather and various species. The number of data points can be numerous, but there is a limited amount of data to be collected from the landscape. For example, the AgEQA project required approximately 50 data points to calculate the five indices in the assessment portfolio, with each index requiring a different data subset.

7.1.2 Data collection

Data was collected using three primary methods: remote sensing, geographical information systems (GIS), and a participatory approach. This data was applied to a smart assessment process allowing data to be manipulated and to *flow* from the landscape upstream to those seeking sustainability values. To support an index-based language, each of these data sources must assess the landscape using smart methods, that is, the goal is to collect and compile the data in a format that creates new knowledge, and transfer this data and knowledge up the entire data supply chain to support each of the stakeholders as they seek and add sustainability values.

- Remote sensing is the use of satellite imagery, aerial photographs, or light detection and ranging (LiDar) to assess the condition or existence of land use or land-use responses such as the extent of forest cover and cropland, or the level of productivity of those land uses. LiDar is a remote-sensing system used to collect detailed topographic data. Remote-sensing techniques are useful for covering large tracts of land and can determine physical states as well as biophysical and chemical functions such as evapotranspiration and photosynthetic rates.
- A GIS is any system that captures, stores, analyzes, manages, and presents data linked to a location. Technically, a GIS is a system that includes mapping software and its application to remote sensing, land surveying, aerial photography, mathematics, geography, and tools that can be implemented with software that spatially maps and analyzes digitized data. This software can analyze temporal changes in ecosystems that correlate trends in ecosystem services with land-use changes. These data maps can also overlay social and economic information with the ecosystem information.
- A participatory approach is a method relying on farmers, stakeholder groups, resource managers, agroecological professionals, and scientific experts to supply resource information. It can be highly valuable as this approach collects knowledge not currently available in scientific literature, government agencies, and institutions. This information adds new perspectives, knowledge, and value to the assessments. The participatory approach is also the most challenging as there may be significant differences in the capacity of the individuals supplying the information and the costs to obtain it.

These data collection strategies can also be combined with each other to provide a more extensive measurement and analytical system. For example, the participatory approach could include gathering information from farmers on how they manage their production and natural resources. If this information is incorporated into indices within a common platform, then GIS and remote-sensing data could complement these participatory assessments.

7.1.3 *Smart assessments*

To create the basis for an effective landscape language, the data must become part of a *smart* assessment process that readily incorporates participatory data into GIS databases and remote-sensing data. According to the MEA project, a good assessment must be scientifically credible, politically legitimate, and useful for responding to the needs of decision makers. The assessment framework should be flexible in that the data is scalable, applicable in multiple manners, and creates knowledge to increase the resource-management capacity of the stakeholders (Alcamo and Bennett, 2003). A smart assessment begins at the landscape and is able to carry this data throughout the accounting, valuation, and transaction processes. It incorporates academic and nonacademic participants in the process of identifying sustainability values and creates a path toward interdisciplinary and transdisciplinary approaches.

Unsurprisingly, assessments focused on smaller areas or utilizing data collected at greater spatial resolution are capable of detecting greater variability than coarser, large-scale studies (Stephens et al., 2015). This local-level knowledge was explicitly valued by the MEA as it provides information that is often not documented by the science community. In the agriculture landscape, this local-level knowledge would consist of daily and seasonal activities that may impact the resources.

In the AgEQA case, the agronomist and farmer became the on-the-ground participants that brought new landscape knowledge to the watershed community. The indices were chosen from government agencies and scientific institutions and combined with GIS and remote-sensory production data. This smart assessment data became part of the farmer's ecosystem service portfolio that could be applied toward local, regional, and national objectives defined by government, NGO, and industry entities. The smart assessment captures the data and provides the path to transfer the data throughout value streams. These values are based on the index calculations.

7.1.4 *Index calculations*

Index calculations are based on specific data related to landscape features, management activities, weather, and environmental effects. For example, in the Agriculture Water Quality Certainty Program (AWQCP) case study, a water quality index (WQI) developed by the NRCS is calculated using data points such as field slope, soil hydrological group, soil erosion factors, soil organic matter content, nutrient management, tillage practices, weed and pest control, water management, and conservation practices.

Examples of other landscape sustainability indices include soil conditioning, habitat, and air quality indices. These indices represent the processes and functions of ecosystems that produce clean water and healthy soils, and sequester carbon. The number and types of environmental indices that can be developed is nearly limitless, with each potentially having multiple purposes and uses (Ott, 1978; Cvetkovic and Chow-Fraser, 2011; Uuemaa et al., 2009). Therefore, to support a landscape language, a smart assessment needs to have the capabilities to collect and compile data in a manner that enables index calculations with relative ease. The language form and structure creates the basis to be able to "speak" to a broad audience and relay the content of the language.

7.2 Creating language content

Content refers to the information to be conveyed by the language. In the case of landscape sustainability, the content of the landscape language is created by the data and the landscape indices that describe the condition of the natural capital: the processes and functions of ecosystems and their output. The language content creates *landscape intelligence*.

7.2.1 Landscape intelligence

Landscape intelligence is a similar, but broader term than *conservation intelligence,* which is described as described by Cox (2005) as the most up-to-date information about how landscapes are being managed for the purpose of directing government policy and programs.

Landscape intelligence is informed and guided by landscape properties that have only recently become available. Fulton (2011) defines landscape intelligence as an organizational and infrastructural layer to be used to develop new, alternative social–ecological conditions. It is required for the cultivation of more creative, ecological, and usable landscape practices better suited to the wicked problems faced in the twenty-first century.

Landscape intelligence begins with the collection and compilation of landscape data within a smart assessment process, applying this data to simple and compound indices, and compiling this knowledge into portfolios.

7.2.2 Simple and compound indices

If indices are viewed as the words of landscape sustainability, then simple indices describe a one-dimensional aspect of the landscape, and compound indices describe the combined effect of multiple dimensions of sustainability.

Simple indices calculate for just one component, such as a WQI. As a simple index, the WQI only shows the reader if the water quality meets a certain standard, and does not directly show the reader what actions are needed to improve the water quality or what is causing the particular outcome. Someone familiar with the index equation and the scientific principles included in the calculations would be able to identify actions that may increase or decrease the index score. Simple indices cannot illustrate the effects or the comparative value that the one component has relative to other measurements.

Compound indices combine simple, one-dimensional indices into a measurement capable of addressing many (environmental) issues at once. It allows aggregation and integration of dissimilar indices to present data into a tool capable of accommodating multiple data sets, adjusting weights, and being used to represent multiple stakeholder interests. The compound index is generally constructed so that the data sets are fixed and the weighting of values is implicit. In other words, the developer of the index inserts weighting and values within the structured index, rather than allowing the user to define these characteristics.

An example of a compound index is the Environmental Benefits Index (EBI) of the United States Department of Agriculture (USDA) Conservation Reserve Program (CRP). It contains five environmental components as well as a cost variable. The EBI functions as a static instrument to determine program eligibility for a particular year, but over the years, the parameters and weighting can be and are adjusted to accommodate new scientific findings, social interests, and political desires. Simple and compound indices represent ecological values that can be compiled into a portfolio representing natural capital asset management.

Indices represent compromise designs, involving trade-offs between ease and cost-of-data measurability, scientific validity, transparency, and relevance to users. At best, they are "optimally inaccurate" (OECD, 1999). They are representations of reality and do not have to be technically perfect (Bennun et al., 2014). This does not mean that indices have no value for measurement: rather their value depends on how they are applied and interpreted.

7.2.3 Natural capital asset portfolio

A natural capital asset portfolio is a grouping of agricultural landscape sustainability values. It is an extended use of the smart assessment. Table 7.1 is an example of the data associated with an agriculture landscape portfolio. Individual management units, such as fields, are the basis for

Table 7.1 A natural capital asset portfolio compiles index values representing ecosystem service outcomes of a landscape

Field nos.	101A	102A	103B	104B	**Totals**	
Hectares	80	120	100	300	600	
Index					**Range**	**HWA**
SCI	88	85	68	92	68–92	86.0
WQI	89	88	70	78	70–89	80.1
HSI	72	62	63	68	62–68	66.5
SLI	82	77	64	80	64–82	77.0

the index calculations, and are aligned with the Luck et al. (2009) service providing unit for ecosystem services. Three simple indices (soil conditioning, water quality, and habitat suitability indices) and one compound index (sustainable landscape index) are used as examples of potential portfolio values. The three simple indices are actual USDA-developed indices and the SLI is a fictitious index used to illustrate the use of a compound index. (An EBI would be a comparable compound index lands not actively farmed, such as restored to a prairie setting.)

Simple indices for soil, water, and habitat (soil conditioning index [SCI], WQI, and habitat suitability index [HSI]) account for individual resources, and a compound index (SLI) accounts for the sustainability status. In this portfolio, the value of each field, the range of scores, and the hectare-weighted averaging for each field and for the entire operation are provided

The portfolio provides additional content to the landscape language by connecting landscape units to index values and expanding the landscape intelligence. The hectare-weighted average (HWA) provides an index value relative to the overall landscape assessed.

The indices express the *ecological values* of the portfolio. The *economic value* is relative to the price sustainability demanders are motivated to pay. The portfolio expresses the intrinsic value associated with landscape management. The purpose and use of the portfolio is to identify and communicate the extrinsic value as it relates to societal sectors and the economic system at large.

7.3 Purposeful uses

The purpose of an index-based landscape language is to allow stakeholders to communicate the varied outputs and outcomes of natural capital in a far more productive manner than currently occurs in the system as it *is*. The usefulness is for stakeholders to identify commonalities and begin negotiations to achieve their sustainability objectives. A common language can transcend disciplinary and sector boundaries by allowing stakeholders to seek out and create synergies within the broad boundaries of landscape sustainability. By finding commonalities in how they define, measure, account for, value, and conduct transactions, stakeholders can begin to combine the low and diffuse values of ecosystem services and reduce and share the high transaction costs.

7.3.1 Another market marvel?

Economist Hayek called the free market system a marvel because just one indicator, *price*, spontaneously carries so much information that it guides buyers and sellers to make decisions to obtain what they want (Gwartney, 2010). Of course, this *marvel* is much easier to create when the commodity can be directly measured in kilograms and liters. But like the numerical indicator of price that reflects thousands of decisions made by people who do not know each other, a landscape index reflects the decisions, activities, and conditions of a particular parcel as it relates to sustainability criteria. A landscape index has functions similar to price.

First, the function of price is to enable commerce to be coordinated by transmitting information about available resources and the demands placed on them. Second, it provides incentives for people to adopt the least costly methods of production and to use available resources for their most highly valued uses. And third, prices determine how much income is distributed and to whom (Friedman, 1981).

By combining the attributes of these two indicators (price and index), a variety of uses related to assessment and valuation are possible. Beginning with a smart assessment, values can be attributed throughout the assessment, planning, assurance, and transactional processes.

7.3.1.1 Useful applications

A single index is able to address numerous aspects of the valuation chain beginning with the smart assessment and continuing through the valuation and transactional aspects of landscape sustainability. Nine useful aspects include the following:

1. Assessing of the condition of resources
2. Planning basis for legislators, agencies, corporations, and producers
3. Analyzing resource-management effects
4. Monitoring outputs and trends
5. Communicating resource conditions and trends
6. Educating the public, government, and producers about status and goals
7. Researching resource-management strategies and outcomes
8. Standard development for regulations, incentives, supply chains, and objectives

9. Valuation unit component for the following:
   a. Regulatory assurance
   b. Market access/participatory benefits
   c. Payment for ecosystem services
   d. Landscape intelligence data
   e. Liability/risk management
   f. Sustainability supply chain claims

Within the context of this language structure and content, ecosystem services can be defined, measured, owned, valued, and transacted.

7.3.1.2 Defining eco-services

To enable an index to be a *market marvel*, ecosystem services need a functional definition within the context of the ecological and economic systems. As noted in Section 3.3, the system as it *is* lacks a common definition for ecosystem services. This is a primary obstacle for stakeholders to communicate their sustainability needs and express values (Boyd and Banzhaf, 2007).

For this text, natural capital outputs and outcomes will be defined separately as ecosystem goods *and* ecosystem services and will be referred to as ***eco-services*** to differentiate this definition from other terms. *Eco-services* will be based on the definition used by Daily (1997) and Brown et al. (2007). In this context, *eco-services* are defined in the traditional economic sense of a service being an intangible, time-dependent process often associated with a location or site conditions. *Eco-goods* are defined in the traditional economic sense of a good as a tangible, consumable item.

This definition is inclusive relative to the other important attributes associated with human needs, spatial connections, and economic indicators. Since these eco-services are accounted for within a geo-referenced, index-based platform, it can adopt the service providing unit (Luck et al., 2003) concept to address location-specific values. This same accounting structure could create the connection to the broader economic metrics promoted by Boyd and Banzhaf (2007) and include FEGS and BRI values. From the perspective of the MEA definition, eco-services would capture the definition of *regulating* ecosystem services.

These eco-services become a *geo-referenced index package* and are referred to as a natural capital unit (NCU). The NCU acts as a commodified natural capital asset to simplify measurement, ownership, valuation, and transactional processes. The NCU commodifies the management of ecosystems as place-based outcome.

7.3.1.3 Natural capital units

NCUs are the tradable units of eco-services. They are calculated using indices applied to a natural capital cell (NCC), a specific area of land. The

NCU represents the functions and processes within the NCC. The NCU, an index calculation and location, becomes the unit of eco-service ownership. This is a key feature to enable trade and commerce to support agricultural landscape sustainability. The NCU *converts* what is typically and traditionally viewed as a nonexcludable and nonrival public good into an excludable and rival private good, or an excludable and nonrival club good. This conversion is further explained in Chapter 9.

Once ownership is established for NCUs, the value of eco-services will be based on the interaction and negotiation between an NCU buyer and seller. A person or entity may be interested in purchasing NCUs to substantiate a sustainability claim, to promote a level of landscape sustainability, or to achieve some of their sustainability objectives for a watershed or a particular product. Regardless of the motivation, NCUs are generated within the context of landscape data and how the landscape is managed.

7.3.2 *Mapping earth's factory floor*

NCUs express the viability of earth's *factory floor*: its landscape and its capacity to generate outcomes and outputs of natural capital. Costanza et al. (2014) estimated the value of the earth's natural capital outcomes and outputs for oceans and terrestrial environments at $124 trillion/year (Table 7.2). This value exceeds the global gross domestic product (GDP) of $75 trillion. These estimates include values from two marine biomes:

Table 7.2 Natural capital values (in US$) produced each year relative to biomes (in trillions of US$) and hectares

Biome	**Area**	**Values**	
	ha e6	**$T**	**$/ha/yr**
Marine	36,302	49.7	1,369
Open ocean	33,200	21.9	660
Coastal	3,102	27.8	8,962
Terrestrial	15,323	75.1	4,901
Forest	4,261	16.2	3,802
Grass/rangelands	4,418	18.4	4,165
Wetlands	188	26.4	140,426
Lakes/rivers	200	2.5	12,500
Desert	2,159	–	–
Tundra	433	–	–
Ice/rock	1,640	–	–
Cropland	1,672	9.3	5,562
Urban	352	2.3	6,534
Total	51,625	124.8	

open ocean and coastal waters with hectare values of $660/yr and $8,962/yr, respectively. The nine terrestrial biomes averaged $4,901/ha/yr with wetland eco-services valued the highest at $140,426/ha/yr and the low range of forests at $3,802/ha/yr. Insufficient data were available to estimate desert, tundra, and ice/rock biomes.

Some of this total is already included in GDP as marketed goods and services. But much of it is not captured in GDP because not all eco-services are marketed or fully captured in marketed products and services. Costanza et al. (2014) estimates that these eco-services (i.e., storm protection, climate regulation, etc.) are much larger in relative magnitude than the sum of marketed goods and services. This is possible as not all human benefits, economically and otherwise, are included in the GDP.

7.3.2.1 Natural capital values and GDP

For any economic value to be recognized at the national and global scale, it must be measured within the accounting system of the nation. The System of National Accounts (SNA) is a conceptual framework that sets the international statistical standard for the measurement of the market economy. It is published jointly by the United Nations, the Commission of the European Communities, the International Monetary Fund, the Organization for Economic Co-operation and Development, and the World Bank. The SNA consists of an integrated set of macroeconomic accounts, balance sheets, and tables based on internationally agreed concepts, definitions, classifications, and accounting rules. Together, these principles provide a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for purposes of economic analysis, decision making, and policy making (UNSD, 2015).

Conventional measures of economic activity include GDP and net domestic product (NDP). Conventionally, GDP is constructed as a measure of the output of the market sector. In this manner, GDP has serious deficiencies in regard to natural resource stocks, whose use contributes to current income flows (Harrison, 1989). Although the “environment” is not completely invisible in national accounting, its treatment produces some curious results. Wright (1990) states that it often appears better, economically speaking, to cause environmental damage and then repair it than to avoid causing the damage in the first place; this is hardly an efficient form of economic growth.

The NDP equals GDP minus depreciation on a country’s capital goods. NDP accounts for capital that has been consumed over the year in the form of housing, vehicle, or machinery deterioration. The depreciation accounted for represents the amount of capital that would be needed to replace those depreciated assets. If the country is not able to replace the capital stock lost through depreciation, then GDP will fall, unless the capital lost is natural capital.

A commonly cited example of the inappropriateness of the GDP to measure the value of the economic system is the Exxon Valdez oil spill of March 24, 1989, where 40.9 million liters of crude oil were spilled into the sea, covering 28,000 km^2 of ocean. Thousands of animals died immediately, including an estimated 500,000 seabirds, 1,000 sea otters, 300 harbor seals, 250 bald eagles, and 22 orcas, as well as the destruction of billions of salmon and herring eggs. Oil can still be found on the beaches of Prince William Sound today. Economically speaking, the accident generated an estimated US$5 billion in additional economic activity, much more than the straight delivery of the cargo would have produced (Jefferies, 2016).

In a more general statement, the shortfalls of GDP were clearly articulated by Repetto (1988) who stated that a country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife to extinction, but measured income would rise steadily as these assets disappeared.

Harrison (1989) notes that GDP is "gross" meaning that it does not consider the depreciation of capital stock, such as the factories and infrastructure that produced the goods or the depreciation of natural capital. She states that first it may seem counterintuitive that the degradation of permanent resources leads to an increase in GDP. This reflects the common lack of awareness that the "gross" in GDP means before allowance has been made for consumption of capital.

This perspective gives a sense that the GDP is not a perverse system as it relates to natural capital. But the challenge still remains to have an NDP accounting system that can generate an economic allowance when the consumption, degradation, or improvement in the capacity of natural capital occurs.

7.3.2.2 Agricultural NCC values

To include natural capital values into the GDP or NDP, the NCUs must reflect natural capital appreciation or degradation at the landscape relative to the overall economy. Stoneham (2009) states this valuation is one-sided. If a landowner excludes livestock from part of the farm to allow habitat to regenerate, GDP will fall because the reduction in livestock production will be accounted for, but not the production of eco-services and/or the increase in the capacity of natural capital. Harrison (1989) states natural capital degradation and appreciation can be captured as annual changes and measured with air and water quality indexes.

To include these values at both local and global scales, the NCC is designed as a 9 m × 9 m land unit. It is at this scale that the production of small diverse farm operations can be captured as well as precision farming techniques and output from farms with thousands of hectares.

A 9 m × 9 m NCC is also small enough to delineate various-sized landscape features such as streams and wetlands. Digitizing the entire earth's surface using these 9 m × 9 m units yields approximately 6.4 trillion NCCs. Table 7.3 identifies the approximately 1.37 trillion NCCs covering the terrestrial biomes excluding desert, tundra, and rock/ice biomes. The average NCC value for each biome and the total value of each biome are listed. Agriculture would include the cropland and the grass/rangeland biomes for a total of 751 billion NCCs with a value of US$27.7T.

These totals include both marketed goods (food and raw materials) and nonmarketed goods and eco-services. For example, the value of a typical corn crop in an Iowa cornfield yielding 13.5 tons/hectare (200 bushels/acre) at US$ 178/ton (US$5/bushel) creates an approximate value of US$30 of corn per NCC. This compares to the estimated average value (Costanza et al., 2014) of the cropland NCC value of US$45.06/year in Table 7.3. In this simple calculation estimation, the nonmarketed eco-service value would be US$15 (US$45.06–US$30) per NCC or 33% of the total NCC value. In this case, the corn and perhaps the stover would be the marketable commodities, and the NCUs may consist of water, soil, carbon, and habitat values depending on the management activities.

It should be noted that Costanza et al. (2014) emphasized that valuation of eco-services is not the same as commodification or privatization and conventional markets are often not the best institutional frameworks to manage them. However, Costanza et al. (2014) state eco-services must be (and are being) valued, and new, common asset institutions are needed to better take these values into account.

Table 7.3 Terrestrial biome types, number of natural capital cells (NCCs) per biome (in millions), value in US$/NCC, and total biome values (in US$ millions)

Biome	**NCCs e6**	**$/NCC/yr**	**Total value e6**
Forest	526,049	30.80	16,200,891
Grass/rangelands	545,432	33.74	18,401,012
Wetlands	23,210	1,137.51	26,401,452
Lakes/rivers	24,691	101.26	2,500,137
Cropland	206,420	45.06	9,300,511
Urban	43,457	52.93	2,300,126
Total	1,369,259		75,104,131

Source: Costanza R. et al., *Global Environmental Change*, 26 (2014), 152–158, 2014, doi:10.1016/j.gloenvcha.2014.04.002.

Note: Total NCCs in the six biomes listed are approximately 1.4 trillion. Total market value is US$75.1T.

7.3.3 Disruption toward harmonization

The creation of a new NCU landscape language to communicate sustainability goals and to be used as an accounting and valuation platform for eco-services at local and global scales is a *disruptive innovation* strategy. Disruptive innovation is a term from Christensen's (1997): *The Innovator's Dilemma* describing a market force that occurs due to the introduction of a new process, technology, and/or product that appeals to a new customer base enabling them to approach an issue with a different set of values and strategies. Disruptive innovation can and does occur in many fields and sectors.

Kara Hurst, former CEO of The Sustainability Consortium, recognizing their sustainability vision remained largely unrealized, stated at the 2014 Green Biz forum that for sustainability to reach the next plateau *disruptive innovation* must occur (Hurst, 2014). To introduce disruptive innovations and achieve this goal, The Sustainability Consortium has developed science-based tools and methodologies to identify ways businesses can improve products and help companies answer the question of how businesses can hone in on where the real impacts are, and where they should collectively focus to make these improvements.

In many respects, the disparate stakeholder efforts in Chapter 4 and the case studies used to describe a transdisciplinary solution in Chapter 6 are examples of disruptive innovation strategies: the introduction of a new process, technology, and/or product that appeals to a new customer base enabling the innovators to approach an issue with a different set of values. Within the context of the NCU strategy, three global disruptive innovative strategies are reviewed: a global environmental mechanism (GEM) (Esty and Ivanova, 2002), a global environmental asset portfolio (GEAP) (Costanza et al., 2000), and developing a harmonized natural capital protocol (Maxwell et al., 2014).

7.3.3.1 Global environmental mechanism

Esty and Ivanova (2002) envision a GEM that draws on modern information technologies and networks to promote cooperation in a faster and more effective manner than traditional institutions. This network-based GEM would build on the functioning elements of existing institutions and create new structures where gaps exist. This global institutional mechanism would grow organically as consensus develops on issues and needs, but not as a new international bureaucracy.

Esty and Ivanova (2002) postulate a GEM would contain a data collection mechanism that calculates sustainability indicators and benchmarks. It could be used as a repository for information to provide continuous and transparent reporting effort. This data set could be used to assess environmental processes and trends, and assist forecasting long-term trends and environmental risks. It would have a means to facilitate transactions related to environmental issues in return for payment or achieving policy objectives. This mechanism could be used to establish policy guidelines for global commons and shared natural resources and provide businesses and NGOs the means to directly participate in problem identification and policy analysis. A finance mechanism could mobilize public and private resources to promote the best options suited to national and local solutions in coordination across all sectors.

Through these capacities, the GEM would contribute to addressing three institutional gaps: the jurisdictional gap, the information gap, and the implementation gap. Simply put, data can make the invisible visible, the intangible tangible, and the complex manageable. It is a re-engineering aiming for a new, forward-looking, and more efficient architecture that will better promote the environment while also serving governmental, public, and business needs. Its logic is based on a globalizing world requiring better and more modern ways to manage ecological interdependence (Esty and Ivanova, 2002).

7.3.3.2 Global environmental asset portfolio

The concept of a GEAP emerged in 2000 from a roundtable gathering of global experts. The discussion moved beyond the "environment as a debate" by focusing on the common view that the environment is a productive asset shared by all of humanity (Costanza et al., 2000). The roundtable suggested humans need to manage these assets at least as wisely as individual investors manage their stock portfolios, but recognized the fundamental problem with environmental management is that no effective institutions exist at the appropriate scale. An institution is needed for managing humanity's collective behavior and its common global environmental portfolio, rather than managing the earth assets as small, independent subunits, none of which had to account to any other for the resources it used.

The roundtable experts promoted the use of strategies by financial managers that work on a broad range of complex assets. The first rule of asset management is to protect the stock of assets that create wealth. In the context of the environment, the natural capital must be protected so that the flow of eco-services from the stock continues. The second rule is to hedge your investments, often referred to as "don't put all of your eggs in one basket." Relying on technology to solve all environmental problems is risky. Ecosystem preservation is a hedge against the possibility that technology alone will be unable to provide humans and their economy with adequate resources and eco-services. The third rule is insuring the asset. Insuring an environmental asset means one should not degrade its capacity to produce the goods and services humans rely on and should protect oneself against the worst-case scenario.

To manage the environment as an asset, Costanza et al. (2000) recommend an institutional framework for sustainable governance. This framework would promote responsibility for those with access to environmental resources; it would be able to match the scale(s) of the environmental issue to the relevant decision makers and enable adaptive management strategies. This framework would identify environmental costs and benefits and ensure they are appropriately allocated, and all relevant stakeholders would be engaged in the formulation and implementation of decisions concerning environmental resources.

7.3.3.3 Harmonizing natural capital valuation

The Natural Capital Coalition (NCC) is a global network of corporations, governments, and NGOs calling for a harmonization of natural capital valuation. It views the growing number of fragmented natural capital activities as a jigsaw puzzle with some of the pieces in place, but mostly disconnected and gaps needing to be filled. This is causing confusion for businesses and investors trying to make informed decisions on risk mitigation, securing resource supply, creating long-term value, resilience, and profitability (Maxwell et al., 2014).

The NCC seeks ways to fill technical gaps relating to natural capital indicators, data, and classification systems to facilitate the mainstreaming of natural capital valuation and emerging environmental economic accounting metrics. The framework would incorporate harmonized principles for what should be measured and valued, and how. This would include clarity on types of capital and the connections between natural, financial, manufactured, societal, human, and intellectual capitals. The NCC state market push and pull factors are needed to motivate behavior change to integrate natural capital and transform business models (NCC, 2015). At the November 2015 World Forum on Natural Capital in Edinburgh, the NCC launched the draft Natural Capital Protocol and accompanying sector guides. The purpose of the draft protocol and guides is to help businesses systematically integrate their relationship with nature into their strategy and operations. In 2016, the NCC participants will provide feedback on how well the categorization scheme works for disparate entities relative to indirect impacts on natural capital and the direct impacts of supply chains.

7.4 Imagining a common landscape language

Each of the three global approaches requires a new, fundamental language of sorts to communicate resource concerns, transmit and compile data, and exchange values among sectors and entities at local and global scales. It is this daunting scenario that perhaps convinced Hurst to state the system as it *is* requires disruptive innovation to move it to the next plateau. Brown (2010) states that the ingredient needed to transcend the existing system of landscape sustainability is *imagination*.

Esty and Ivanova (2002) imagined a networked GEM, while Costanza et al. (2000) envisioned an institutional framework to manage the complexity of an environmental portfolio; the NCC participants are imagining an accounting system for their natural capital impacts. Imagining an index-based language based on a digitized earth-scape consisting of 6.4 trillion NCCs is a step toward a potential transdisciplinary solution. This global, index-based language could address Conklin's (2006) issue of fragmentation, referring to the multiple perspectives, understandings, and intentions of sustainability stakeholders.

This fragmentation results in a lack of adherence to ensuring scientific principles (Naeem et al., 2015). Of 118 payment-for-ecosystem (PES) projects examined by 45 scientists and practitioners from government, nongovernment, academic, and finance institutions, only 40% met the four principles to ensure scientific integrity. Naeem et al. in the March 2015 *Science* issue stated baseline data, monitoring of key environmental factors, and services, recognizing that ecosystems are dynamic, and inclusion of metrics are key to ensure the success of sustainability projects.

Brown (2010) stated that as a wicked problem, it is highly unlikely that the many interests involved would be willing or able to work together. These interests need an open-ended and collective framework that stretches their imagination to include the contributions of each other. This collective framework consists of land management indices as the basis for the form and content (the words and intelligence) of a landscape language. These new terms within the context of a digitized landscape support the use of NCUs as potential *market marvels*. Similar to how *price* aligns market participants, indices can align governance actors and market participants.

Aligning the sustainability conversations is a necessary step to begin the alignment of the stakeholder activities that contribute to and achieve common sustainability objectives. The following chapter illustrates how organizations, in their sustainability efforts, are becoming more inclusive in their conversations, their sustainability activities, and their organizational governance styles. This trend can be accelerated with a common landscape language.