企業自然資本的沿革及發展趨勢

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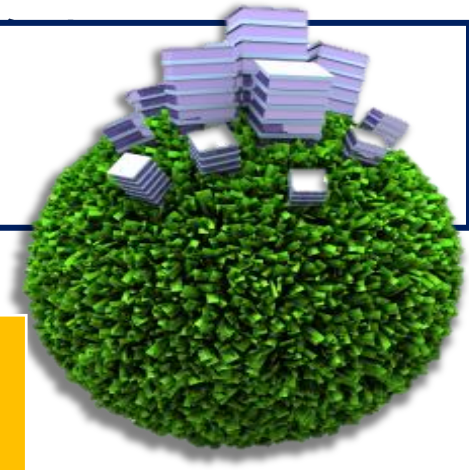
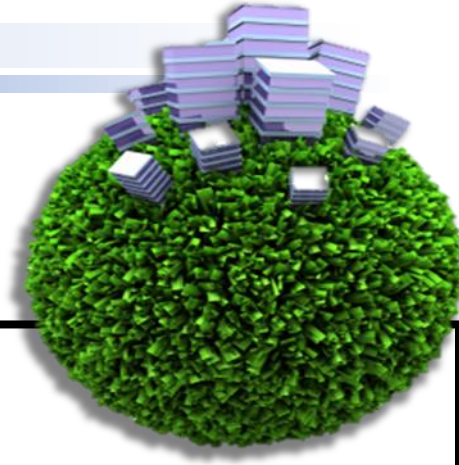
永續創新與評估中心
Sustainability, Innovation and Assessment Center (SIAC)

OUTLINE



- 前言－自然資本及生態系統服務
- 企業自然資本評估及其發展
- 聯合國永續發展目標與自然資本
- 結語—未來展望Netpositve與Handprint



前言－自然資本與生態系統服務

美國羅斯福總統在1937年到蒙他拿州(Montana)時發表的感言，提到了“natural capital”的概念以及 "balancing the budget of our (natural) resources"

INFORMAL, EXTEMPORANEOUS REMARKS
OF THE PRESIDENT, HAVRE, MONTANA,
OCTOBER 3, 1937.

Good morning.

I am glad to be back in Montana after an absence of one week.

I am particularly interested in seeing this part of the country because I have got to plan ahead and you have got to plan ahead and the Congress has got to plan ahead for the use of more water.

I was talking last night with Jim Murray about that problem of water and we agreed that in a drought area like eastern Montana probably the time has come -- and that applies to big sections of other states as well -- the time has come to use our WPA work, not in building any more armories or school stadiums or streets but to put it into the building of dams.

This morning I smiled all the way through breakfast because I happened to see an editorial, not in a paper here but in a Great Falls paper, that talked about "balancing the budget of our resources." That is something that is well worth thinking about. It said that because we have made money in wasting and eroding large human resources and piled up nominal wealth in securities and bank balances, we have lost sight of the fact that the natural resources of our land - our permanent capital - are being converted into those nominal evidences of wealth at a faster rate than our real wealth is being replaced.

That is well worth thinking about. That is the unbalanced budget that is most serious and it is to balance that budget that the great program of conservation and useful public works is being carried out. The success of that form of budget balancing is just as important to the future of America as that of the Treasury, important as that may be.

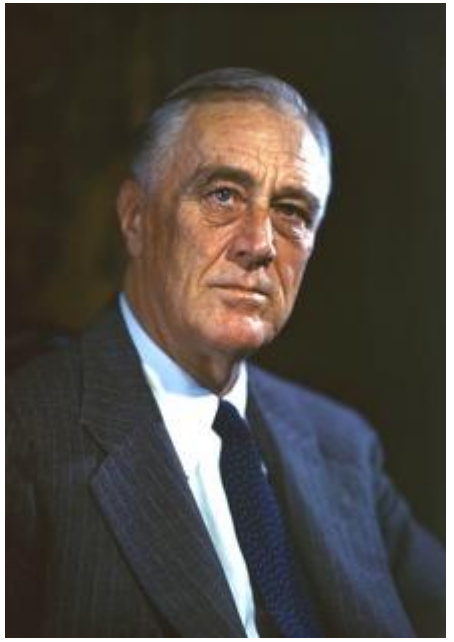
As a matter of fact, the Treasury is all right and we are balancing that budget -- you needn't worry -- but, in addition to it, we are going to use every effort to balance the budget of our human and our natural resources.

I have had a very wonderful trip. I have seen a lot and I have learned a lot. I wish a whole lot of other people from back East and from Washington, D. C., could take trips like this.

I am going on down to Fort Peck to see the largest earth dam in the world. Yesterday I saw the largest concrete dam in the world. All of them are intended to do just what I have been talking about -- to give people a better chance -- and I believe that is what the American people want and are going to get.

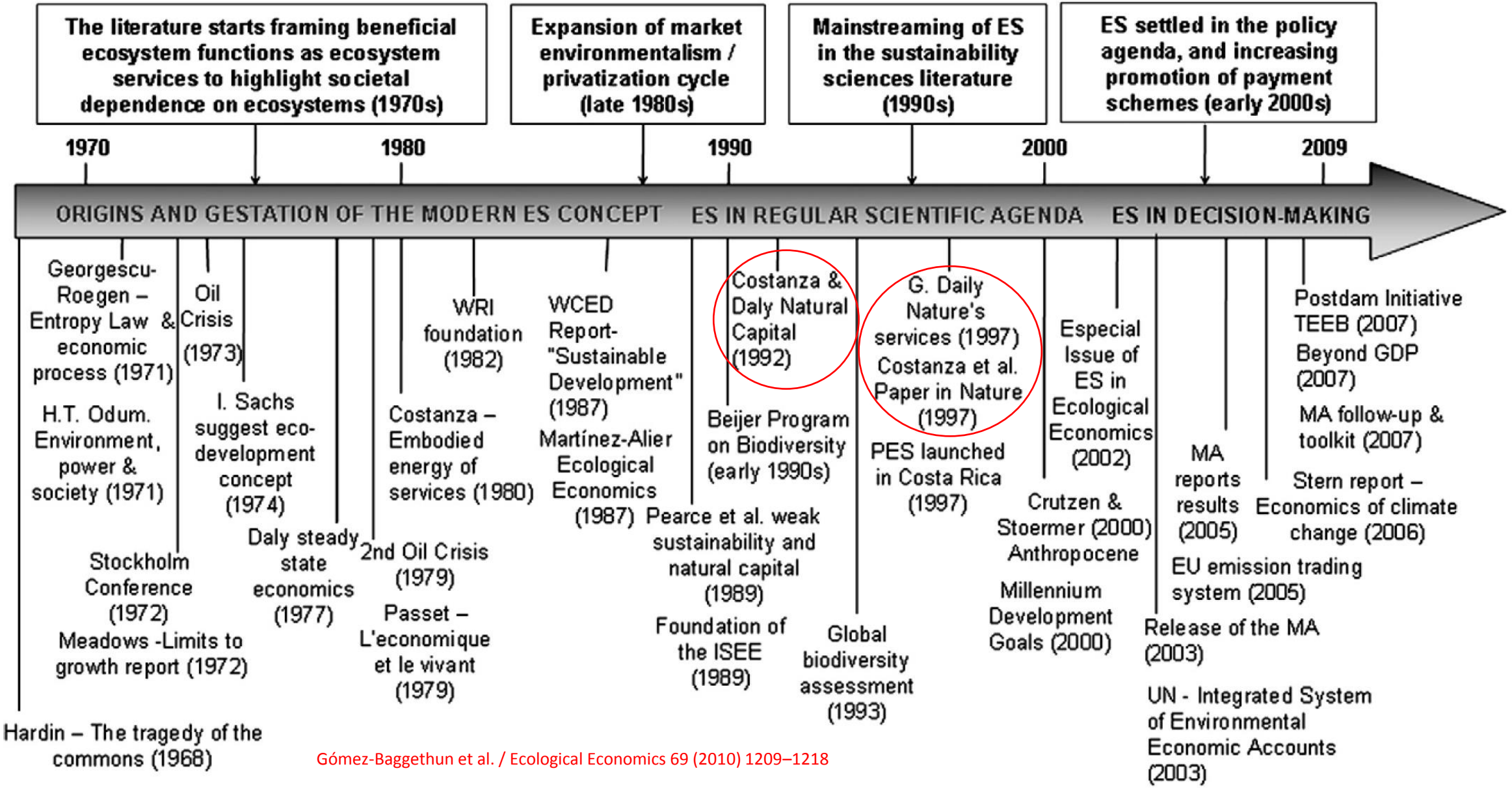
It has been good to see you all this morning. I wish I could stop off longer and see this country. I have been here before, you know. I wish I could go up to Glacier. I wish I could drive in an automobile because I can see more that way than from the rear platform of a train.

I hope to come back and see you again soon.



Franklin D. Roosevelt

Stages in the Modern History of Ecosystem Services



Gómez-Baggethun et al. / Ecological Economics 69 (2010) 1209–1218

自然資本及生態系統服務

有研究指出”natural capital”一詞，最早出現於1973 由德裔英國經濟學家E. F. Schumacher所撰寫之「小即是美」(*Small Is Beautiful*),之後才陸續及廣泛被其他學者採用。

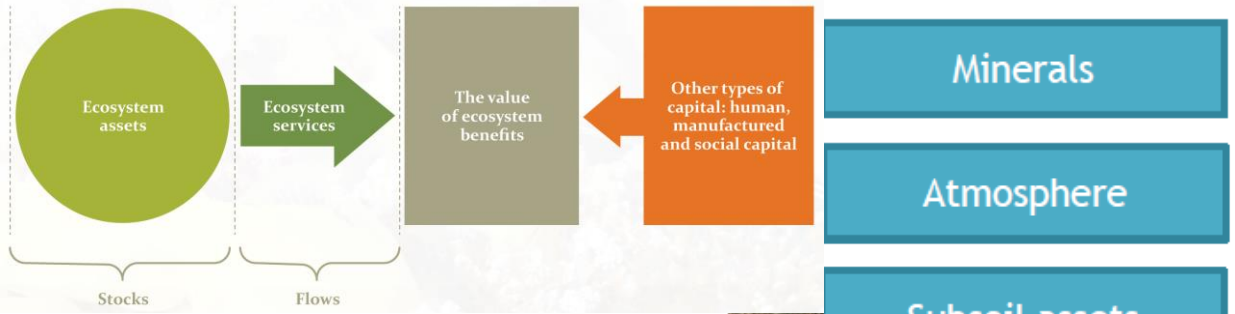
Natural capital
（各種自然生態系統的存量）

Ecological communities

Soils

Freshwaters

Land



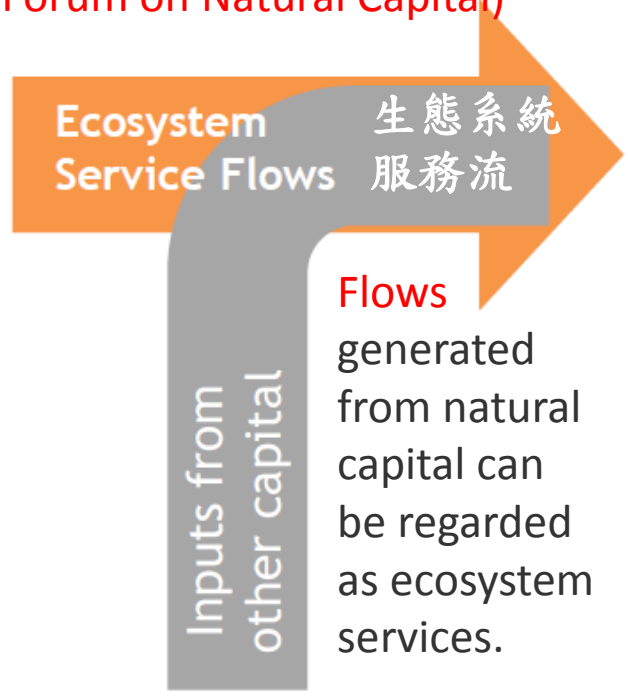
Minerals

Atmosphere

Subsoil assets

Oceans

“Natural Capital is the stock of natural ecosystems on Earth including air, water, land, soil, biodiversity and geological resources. This stock underpins our economy and society by producing value for people, both directly and indirectly.”(World Forum on Natural Capital)



Flows generated from natural capital can be regarded as ecosystem services.

Natural capital benefits

資料來源: Economics for the Environment Consultancy(efetc)

The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#, Shahid Naeem, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶**

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¶¶ *Ecological Economics Research and Applications Inc., PO Box 1589, Solomons, Maryland 20688, USA*

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16–54 trillion ($10^{12}$) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.

Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans in the biosphere. The economies of the Earth would grind to a halt without the services of ecological life-support systems, so in one sense their total value to the economy is infinite. However, it can be instructive to estimate the 'incremental' or 'marginal' value of ecosystem services (the estimated rate of change of value compared with changes in ecosystem services from their current levels). There have been many studies in the past few decades aimed at estimating the value of a wide variety of ecosystem services. We have gathered together this large (but scattered) amount of information and present it here in a form useful for ecologists, economists, policy makers and the general public. From this synthesis, we have estimated values for ecosystem services per unit area by biome, and then multiplied by the total area of each biome and summed over all services and biomes.

Although we acknowledge that there are many conceptual and empirical problems inherent in producing such an estimate, we think this exercise is essential in order to: (1) make the range of potential values of the services of ecosystems more apparent; (2) establish at least a first approximation of the relative magnitude of global ecosystem services; (3) set up a framework for their further analysis; (4) point out those areas most in need of additional research; and (5) stimulate additional research and debate. Most of the problems and uncertainties we encountered indicate that our estimate represents a minimum value, which would probably increase: (1) with additional effort in studying and valuing a broader range of ecosystem services; (2) with the incorporation of more realistic representations of ecosystem dynamics and interdependence; and (3) as ecosystem services become more stressed and 'scarce' in the future.

Ecosystem functions and ecosystem services

Ecosystem functions refer variously to the habitat, biological or system properties or processes of ecosystems. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions. For simplicity, we will refer to ecosystem goods and services together as ecosystem services. A large number of functions and services can be identified[1–4]. Reference 5 provides a recent, detailed compendium on describing, measuring and valuing ecosystem services. For the purposes of this analysis we grouped ecosystem services into 17 major categories. These groups are listed in Table 1. We included only renewable ecosystem services, excluding non-renewable fuels and minerals and the atmosphere. Note that ecosystem services and functions do not necessarily show a one-to-one correspondence. In some cases a single ecosystem service is the product of two or more ecosystem functions whereas in other cases a single ecosystem function contributes to two or more ecosystem services. It is also important to emphasize the interdependent nature of many ecosystem functions. For example, some of the net primary production in an ecosystem ends up as food, the consumption of which generates respiratory products necessary for primary production. Even though these functions and services are interdependent, in many cases they can be added because they represent 'joint products' of the ecosystem, which support human

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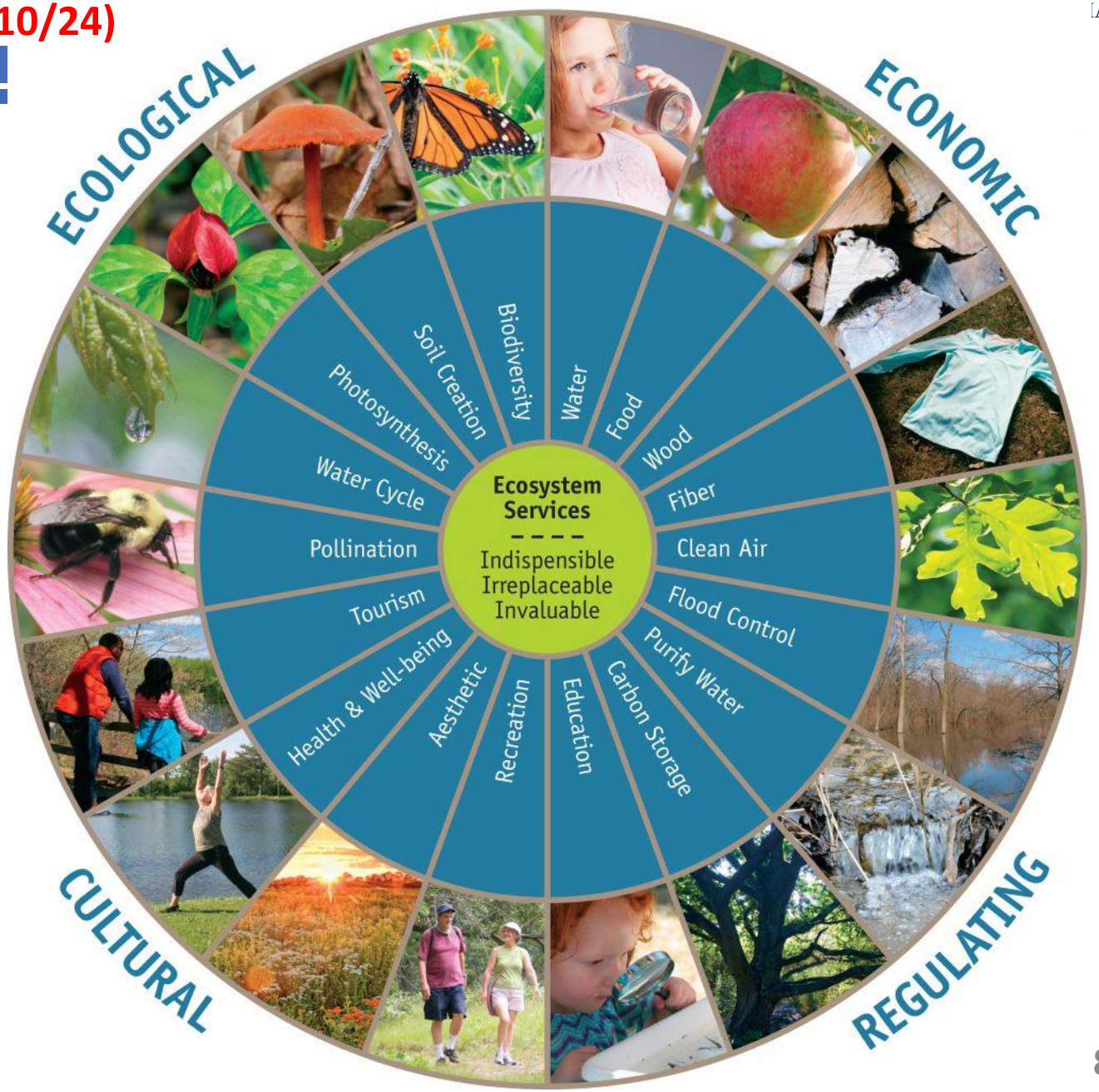
Table 1 Ecosystem services and functions used in this study

Number	Ecosystem service*	Ecosystem functions	Examples
1	Gas regulation	Regulation of atmospheric chemical composition.	CO_2/O_2 balance, O_3 for UVB protection, and SO_x levels.
2	Climate regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels.	Greenhouse gas regulation, DMS production affecting cloud formation.
3	Disturbance regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations.	Storm protection, flood control, drought recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.
4	Water regulation	Regulation of hydrological flows.	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation.
5	Water supply	Storage and retention of water.	Provisioning of water by watersheds, reservoirs and aquifers.
6	Erosion control and sediment retention	Retention of soil within an ecosystem.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of silt in lakes and wetlands.
7	Soil formation	Soil formation processes.	Weathering of rock and the accumulation of organic material.
8	Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients.	Nitrogen fixation, N, P and other elemental or nutrient cycles.
9	Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds.	Waste treatment, pollution control, detoxification.
10	Pollination	Movement of floral gametes.	Provisioning of pollinators for the reproduction of plant populations.
11	Biological control	Trophic-dynamic regulations of populations.	Keystone predator control of prey species, reduction of herbivory by top predators.
12	Refugia	Habitat for resident and transient populations.	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds.
13	Food production	That portion of gross primary production extractable as food.	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming or fishing.
14	Raw materials	That portion of gross primary production extractable as raw materials.	The production of lumber, fuel or fodder.
15	Genetic resources	Sources of unique biological materials and products.	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants).
16	Recreation	Providing opportunities for recreational activities.	Eco-tourism, sport fishing, and other outdoor recreational activities.
17	Cultural	Providing opportunities for non-commercial uses.	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems.

* We include ecosystem 'goods' along with ecosystem services.

The value of the world‘s ecosystem services and natural capital (Costanza, 1997)(迄今已被引用18,568次-2017/10/24)

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16-54 trillion ($10^{12}$) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.



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Changes in the global value of ecosystem services

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ABSTRACT

In 1997, the global value of ecosystem services was estimated to average $33 trillion/yr in 1995 $US ($46 trillion/yr in 2007 $US). In this paper, we provide an updated estimate based on updated unit ecosystem service values and land use change estimates between 1997 and 2011. We also address some of the critiques of the 1997 paper. Using the same methods as in the 1997 paper but with updated data, the estimate for the total global ecosystem services in 2011 is $125 trillion/yr (assuming updated unit values and changes to biome areas) and $145 trillion/yr (assuming only unit values changed), both in 2007 $US. From this we estimated the loss of eco-services from 1997 to 2011 due to land use change at $4.3–20.2 trillion/yr, depending on which unit values are used. Global estimates expressed in monetary accounting units, such as this, are useful to highlight the magnitude of eco-services, but have no specific decision-making context. However, the underlying data and models can be applied at multiple scales to assess changes resulting from various scenarios and policies. We emphasize that valuation of ecoservices (in whatever units) is not the same as commodification or privatization. Many eco-services are best considered public goods or common pool resources, so conventional markets are often not the best institutional frameworks to manage them. However, these services must be (and are being) valued, and we need new, common asset institutions to better take these values into account.

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1. Introduction

Ecosystems provide a range of services that are of fundamental importance to human well-being, health, livelihoods, and survival (Costanza et al., 1997; Millennium Ecosystem Assessment (MEA), 2005; TEEB Foundations, 2010; TEEB Synthesis, 2010). Interest in ecosystem services in both the research and policy communities has grown rapidly (Braat and de Groot, 2012; Costanza and Kubiszewski, 2012). In 1997, the value of global ecosystem services was estimated to be around US$ 33 trillion per year (in 1995 $US), a figure significantly larger than global gross domestic product (GDP) at the time. This admittedly crude underestimate of the welfare benefits of natural capital, and a few other early studies (Daily, 1997; de Groot, 1987; Ehrlich and Ehrlich, 1981; Ehrlich and Mooney, 1983; Odum, 1971; Westman, 1977) stimulated a huge surge in interest in this topic.

In 2005, the concept of ecosystem services gained broader attention when the United Nations published its Millennium Ecosystem Assessment (MEA). The MEA was a four-year, 1300-scientist study for policymakers. Between 2007 and 2010, a second international initiative was undertaken by the UN Environment Programme, called the Economics of Ecosystems and Biodiversity (TEEB) (TEEB Foundations, 2010). The TEEB report was picked up extensively by the mass media, bringing ecosystem services to a broader audience. Ecosystem services have now also entered the consciousness of mainstream media and business. The World Business Council for Sustainable Development has actively supported and developed the concept (WBCSD, 2011, 2012). Hundreds of projects and groups are currently working toward

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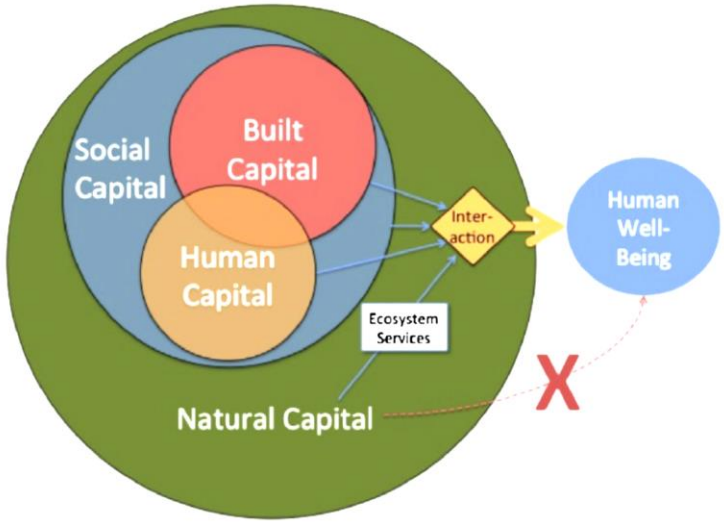
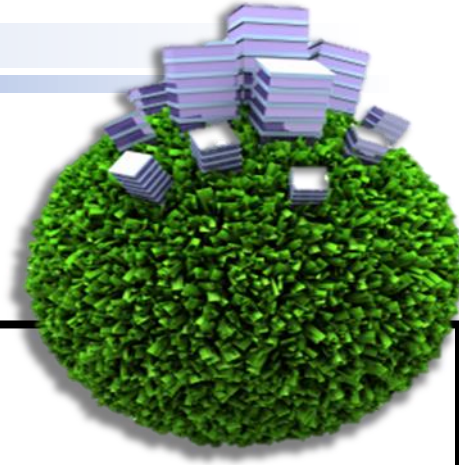


Fig. 1. Interaction between built, social, human and natural capital required to produce human well-being. Built and human capital (the economy) are embedded in society which is embedded in the rest of nature. Ecosystem services are the relative contribution of natural capital to human well-being, they do not flow directly. It is therefore essential to adopt a broad, transdisciplinary perspective in order to address ecosystem services.



企業自然資本評估及其發展

自然資本與經濟價值的損失

全球三分之二的水資源以及土地生態系統被明顯的破壞，目前統計資料顯示全球因為沒有妥善的自然資本管理導致的成本損失高達6.6兆美元(約占全球GDP的11%)，照這趨勢下去，到了2050年將預估高達25兆美元

全球三千大的上市櫃企業估計在2008年造成了2.15兆美元的環境損害

為什麼自然資本需要價值化?

價值化：代表一個估計自然資本在**特定情境與脈絡下的重要性、財富與實用性**。

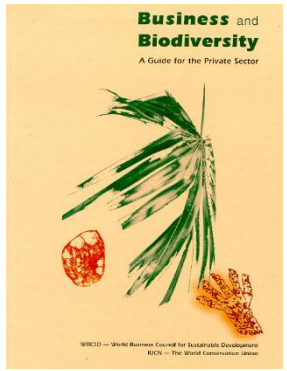
沒有辦法評估價值，則無法進行有效管理	生物多樣性與生態系統常被忽略其價值	生物多樣性與生態系統缺乏明確的產權定義
企業造成的環境外部性與日俱增	價值化有助於企業將自然資本議題納入決策之中	價值化外部性也有助於與外部利害關係人溝通

企業開始重視自然資本及其評估之重要倡議及活動

生態系統服務價值的省思-生物圈2號(Biosphere 2)

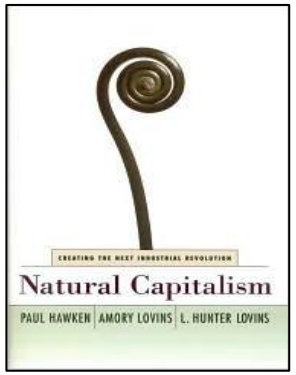
1991-1993, 1994

企業與生物多樣性



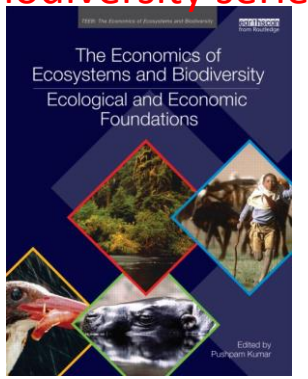
WBCSD (1997)

自然資本主義



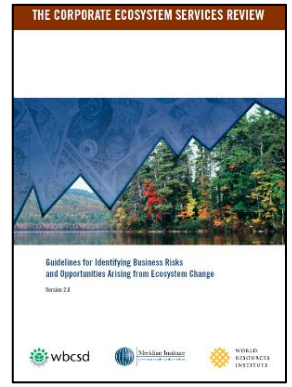
Hawken(1999)

The Economics of Ecosystems and Biodiversity series



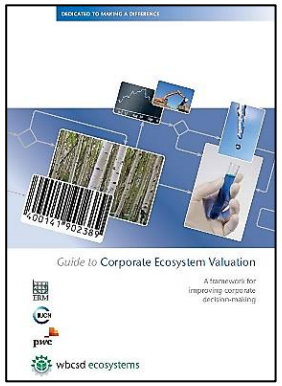
TEEB全球倡議(2007)

The Corporate Ecosystem Services



WBCSD(2008, 2012)

Guide to Corporate Ecosystem Valuation

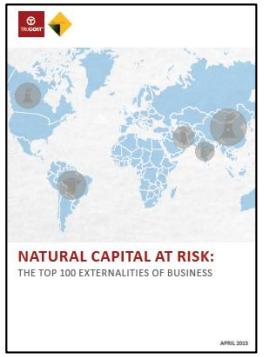


WBCSD(2011)

EP&L方法論

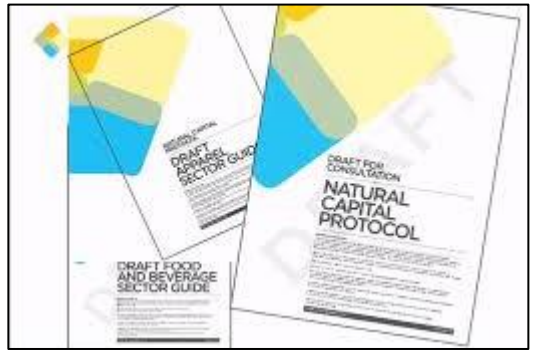
Puma(2011)

TEEB for Business Coalition(2012)



TEEB for Business Coalition(2013)

Natural Capital Coalition(2014)

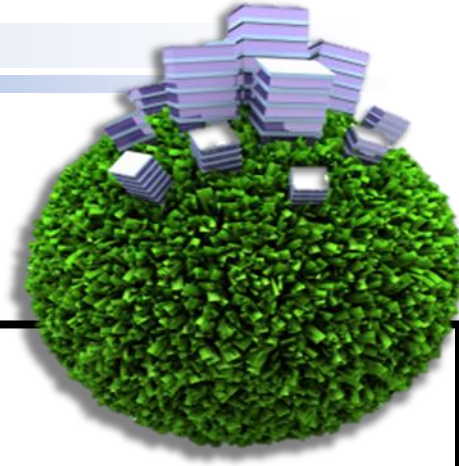


Natural Capital Protocol(2016)

列入題項評估(2017)

綠色(自然)資本主義的四種策略

1. 資源生產力的大幅提升(Radical Resource Productivity)
2. 生物模擬(Biomimicry)
3. 服務與流動經濟(Service and Flow Economy)
4. 對綠色資本的投資(Investing in Natural Capital)



聯合國永續發展目標與自然資本

重點摘要：

1. **了解聯合國永續發展目標與自然資本關聯的重要項目**
2. **了解全球因應聯合國永續發展目標的現況**

聯合國永續發展目標(UN SDGs)

In the context of the UN Sustainable Development Goals (SDGs), impact measurement is becoming increasingly relevant: both companies and investors want to understand both the positive and negative externalities (DJSI, 2017)

目標2、3、6、7、11至15，與自然資本息息相關

UN SDGs與自然資本評估的關聯

- 糧食問題與土地等自然資源有高度相關，特別是食物生產商。

- 減少污染物造成死亡與損害
- 全球因家庭空氣污染導致約430萬人死亡，而環境空氣污染導致約300萬人死亡

- 改善水質、減少污染物影響水質、減少水量的使用。
- 全球超過20億人生活在用水極度緊張的國家。
- 實現普遍獲得基本的環境衛生和消除露天排便的不安全做法，將需要大大加速在中亞和南亞、東亞和東南亞以及撒哈拉以南非洲農村地區取得的進展

UN SDGs與自然資本評估的關聯

- 確保穩定與負擔的起的能源是企業營運的關鍵；
- 投資或採購再生能源是目前企業達成碳脫鉤的關鍵作為。
- 可再生能源的份額在2012至2014年略有增長，從17.9%增至18.3%。

- 強化城市的韌性以及減少都市對於環境的有害影響
- 固體廢物的安全清除和管理是最重要的城市環境服務之一。
- 2014年，90%的城市居民呼吸著不符合世衛組織安全標準的空氣。

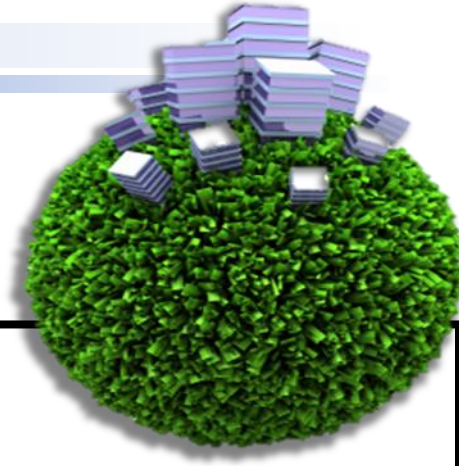
- 減少消費端的資源浪費以及足跡的產生；下游端因服務與產品創造出的正面效益
- 經濟增長與自然資源利用脫鉤，是永續發展的基礎。
- 全球資料顯示趨勢正在日益惡化：從2000年到2010年，每單位國內生產總值的國內材料消費從1.2公斤增加到1.3公斤

UN SDGs與自然資本評估的關聯

- 本目標主要關注如何提升任何組織對於氣候變遷調適能力；
- 自然災害造成的死亡人數繼續上升。從1990年到2015年，有160多萬人死於國際上報告的自然災害

- 正視海洋資源對其營運的重要，特別是仰賴海洋的產業部門。
- 污染和優養化導致沿海水域持續惡化。16%的生態系統處於沿海優氧化的高或最高風險類別。這些生態系統主要位於西歐、南亞、東亞和墨西哥灣
- 過度捕撈減少生物多樣性。世界海洋魚類處於生物學永續狀態的比例已從1974年的90%降至2013年的68.6%並趨於穩定。

- 注重陸地生態系統的維護，包含森林、生物多樣性等議題
- 從2010年到2015年，全球森林面積年淨喪失量不到1990年代的一半。
- 通過永續土地管理來扭轉土地退化和荒漠化的影響。
- 根據紅色名錄指數，生物多樣性的喪失仍在以驚人的速度發生。



企業自然資本的發展趨勢

重點摘要：

1. **為何企業需要進行自然資本評估**
2. **DJSI對於價值化衝擊的要求**

DJSI的需求：Valuing impact

- DJSI的題目需企業提供價值化衝擊的題項
- 衝擊的種類包含環境與社會

Question Layout:

Does your company measure its environmental and/or social profit and loss (SEP&L) i.e. do you estimate the monetary value of your positive and/or negative externalized impacts? Ideally, a comprehensive environmental P&L includes or three or more environmental externalities and a social P&L includes two or more social impacts, but all valued impacts are welcome. Please refer to the information text for more details and examples. Please provide supporting evidence.

- Reference Link: _____

  Yes, we conduct an environmental and/or a social profit & loss analysis. Please provide a description and the number of externalities measured.

Number of environmental externalities (positive or negative)	
Number of social externalities (positive or negative)	

- Reference Link: _____

  We value our environmental and/or social impacts qualitatively or quantitatively, but they are not converted into monetary values. Please describe:

DJSI期待看到的數據

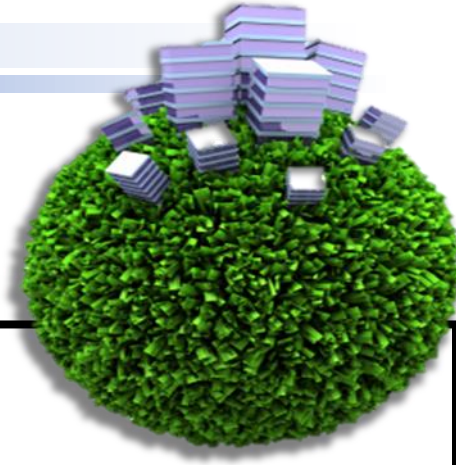
For this question, we expect companies to provide:

- Information that is active and current 資訊能夠反應出現況
- An indication that coverage is company-wide, not limited to a single product, location, or business unit 非局限於產品而是能夠涵蓋整體企業
- 1 (or more) externality has been identified and valued 一種或多種的外部性予以價值化
- An indication that some form of impact valuation (monetary, qualitative, quantitative) was conducted, going beyond units of output 一種或多種的外部性予以價值化
- An explanation of the methodology or results of the analysis 方法學的解釋或結果的分析
- For companies that indicated that they were in the process of developing impact measurement tools, we expected companies to provide a clear description of the methodology being used or developed, as well as a clear indication that testing of the methodology has begun as well as an expected roll-out date of the valuation framework. 正在開發衝擊量測工具的企業，DJSI期待企業能夠說明方法學，同時清楚的指出方法學已經開始進行測試。

目前DJSI接受的範例

Some examples of things we accepted include:

- Social/environmental profit loss statements that measured *outcomes* and estimated social and environmental costs, rather than only input costs or costs using current market prices (e.g., carbon price based on European Union's Emission Trading System instead of the *social cost* of carbon)
- Application of existing methodologies such as True Value, TIMM, etc.
- Pilot testing of frameworks like the Natural Capital Protocol → NCP的先期測試
- Positive externalities (e.g. quality of life improvements from access to medication, improved social cohesion due to redevelopment of dilapidated buildings, increase in earning potential from skills training, improved ecosystems through restoration and rehabilitation)
- Negative externalities (e.g. environmental and health impacts caused by GHG or other air emissions, soil and groundwater pollution from landfilling waste, reduction in wellbeing due to injury or illness, decline in health from overconsumption of products containing sugar)
- Environmental / social return on investment methodologies, where the outcomes were based on estimated social and environmental benefits instead of current market prices



結語—未來展望Netpositve與Handprint

重點摘要：

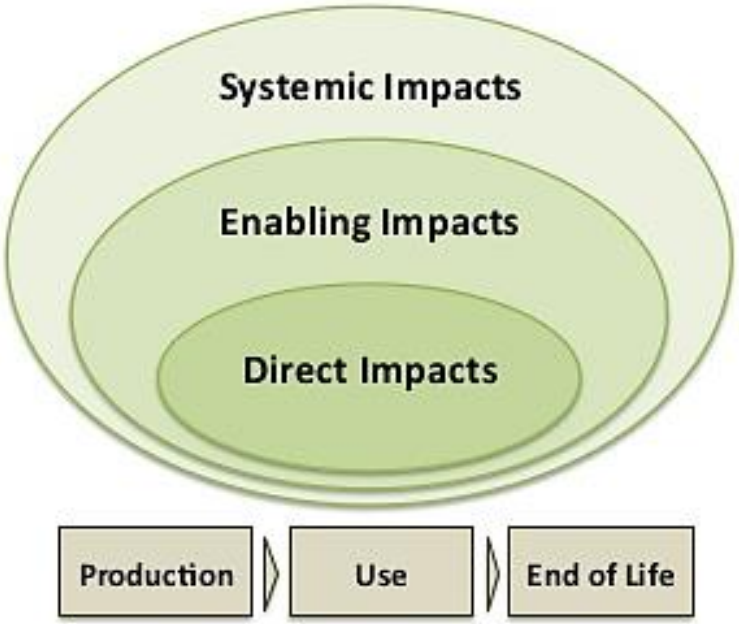
1. **介紹net positive與handprint的概念**
2. **自然資本評估應用於net positive的潛在能力**

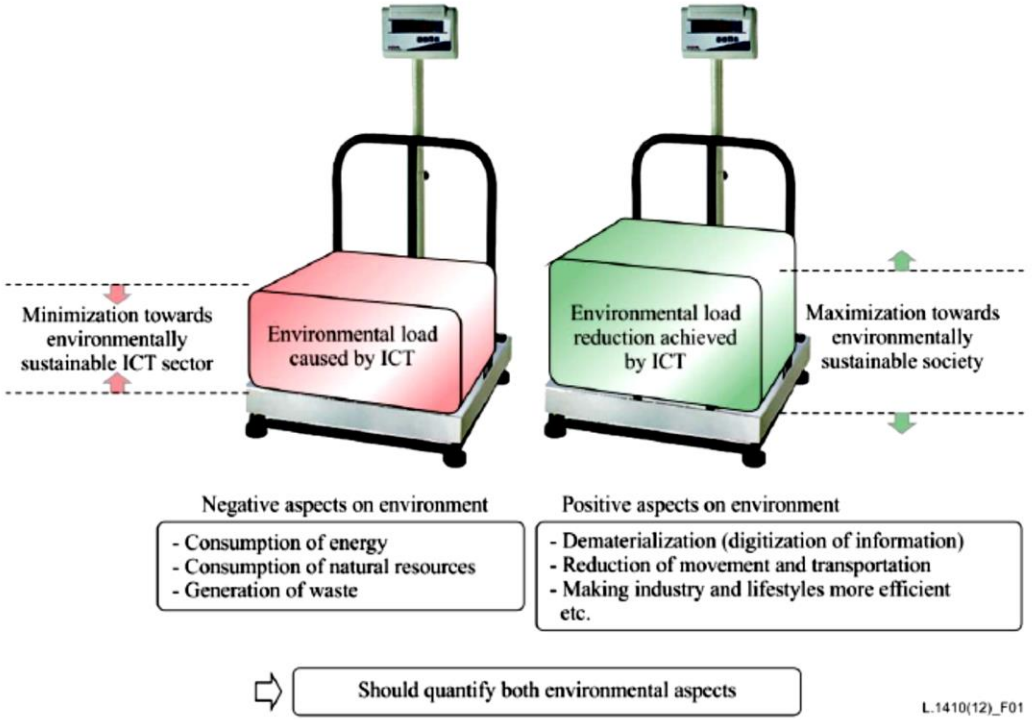
環境衝擊評估的新概念—淨正衝擊(Net Positive)

Environmental Impacts

II. ICT Impacts on the Environment

There are three analytical levels in the interaction between ICT and the natural environment: Direct impacts (first order), enabling impacts (second order) and systemic impacts (third order)





Net Positive的新觀念!!

手印(handprints)的概念

目的

- 創造正面效益

定義

- 相較於BAU情境下，產品或服務過程中能創造出多少正面影響

於2007年國際環境教育會議(Fourth International Conference on Environmental Education)首次提出

手印與足跡的差異

Handprint		Footprint
產生的益處	⟷	造成的危害
無限潛在	⟷	有限資源
再生/還原	⟷	減少使用/物盡其用/回收
激勵	⟷	警告
成就價值	⟷	計算的數量
提倡保護	⟷	抵制破壞

積極思考

消極思考

創造手印方法(Norris, 2015)

減少足跡的產生

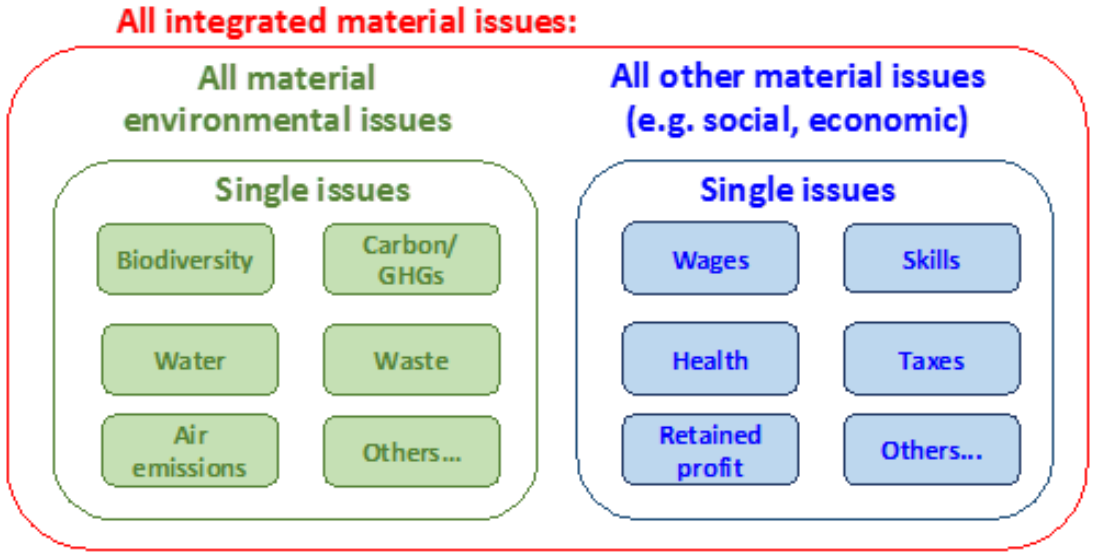
- 透過節能減少外購電力的碳排放
- 透過清潔生產的導入，節省資源與能源的投入

創造正面的影響

- 被污染的土地透過復育方式使其恢復原有的生態系統
- 透過教育供應商新方法的採用，以低衝擊的方式生產原物料
- 透過新的產品與服務，減少下游端外部環境衝擊的產生

淨正面效益的概念

定義(Noriis, 2015)：經由角色互換，再藉由生命週期的評估方式，重新定義一套新的思考方向，使手印＞足跡，進而創造出積極正面的形象

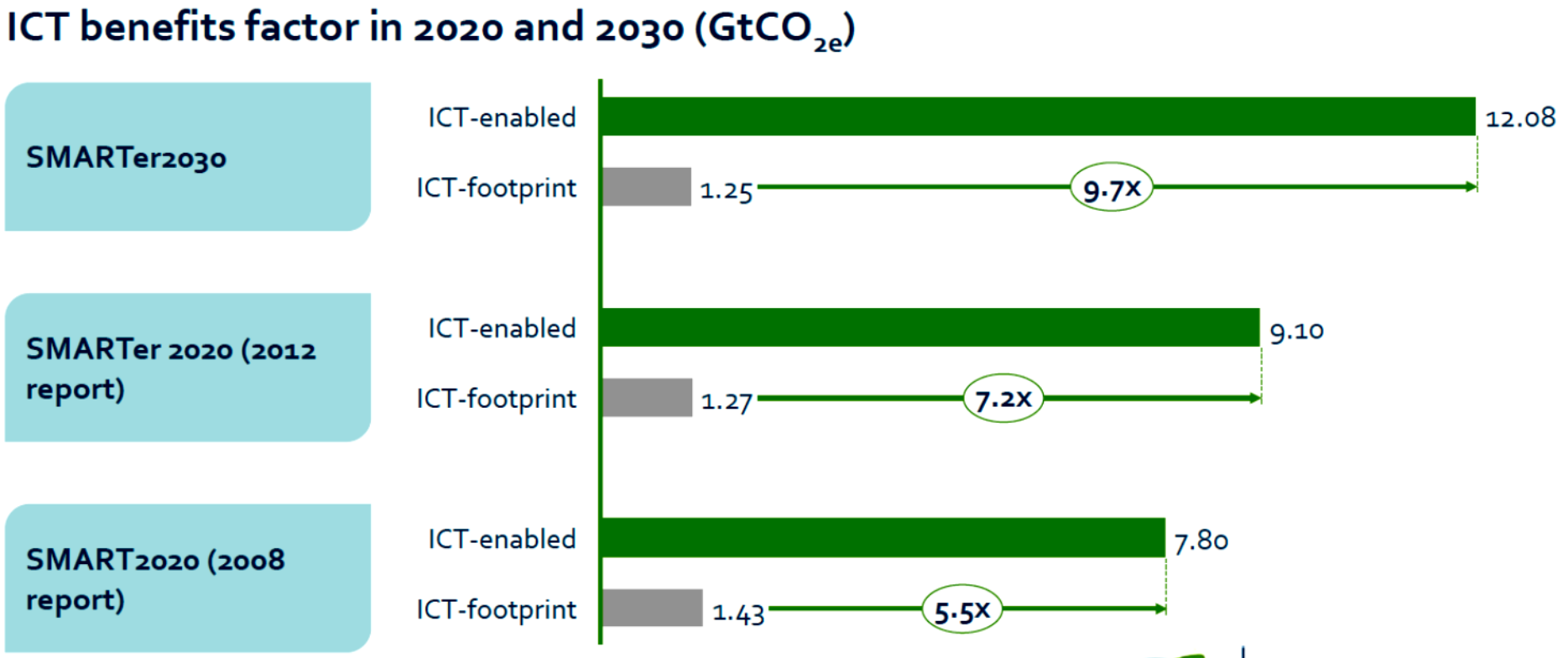


Ambition	Outcome	Related terms
Net Positive Goal	Net gain	Net positive Net positive gain Net positive impact Total contribution
Net Neutral Goal	Net neutral	Net zero No net loss Carbon/water neutral Zeronaughts
Improvement Goal	Net loss	Less bad Incremental reduction Minimising impacts

歐盟討論 (Spurgeon, J.P.G, 2016)：針對與net positive相關的字彙，包含net impact、net neutral 等項目

案例：ICT對永續發展最主要的貢獻表現在促使其他產業更環保節能及永續—Enabler, Enabling Technology

ICT could realize a benefit 9.7 times higher than its own emissions in 2030, while its own footprint is expected to fall



Source: Source: WRI, IPCC, GeSI, SMARTer2020, Accenture analysis & CO2 models

GeSI
GLOBAL e-SUSTAINABILITY INITIATIVE

Net Positive 與自然資本評估的鏈結

- Net positive的邏輯與方法可以協助企業與永續目標結合
- 自然資本評估在環境面的net positive過程中，可以扮演一項評估與量化的工具；而NCP可以扮演一個標準化的評估架構
- 彈藥完善這些方法與機制，仍需要政府、企業以及金融部門的共同配合與發展
- 一個具備標準化的自然資本評估的邏輯，將有助於企業進行完整的Net positive 評估

NCA for business approach		Description	Link to net impact	Maturity of methods	Explanation
Decision-making					
1	Dependency	Determines the nature and extent to which companies depend on natural capital (NC).	**Weak links**	**Medium**	A net impact assessment approach can be applied to evaluating both a 'with' and 'without' the dependency scenario in order to value the company dependency.
2	Impacts	Determines the nature and extent to which companies impact NC.	**Potential strong links**	**Medium/ High**	By definition, this approach has direct links. Methods to assess such impacts are fairly well developed.
3	Risk/ opportunity & materiality	Involves identifying & quantifying NC related risks and opportunities. Potential materiality may also be assessed.	**Potential strong links**	**Low/ Medium**	A net impact approach can be used to help identify and evaluate risks and opportunities.
4	Valuation (full cost accounting)	Involves valuing the importance of NC and other environmental costs and benefits to society & the company. Form of full cost accounting for management decisions.	**Potential strong links**	**Medium/ High**	There can be strong links here, with considerable experience of applying cost-benefit analysis and net present value calculations to determine net monetary value impacts.

Thank you for your attention