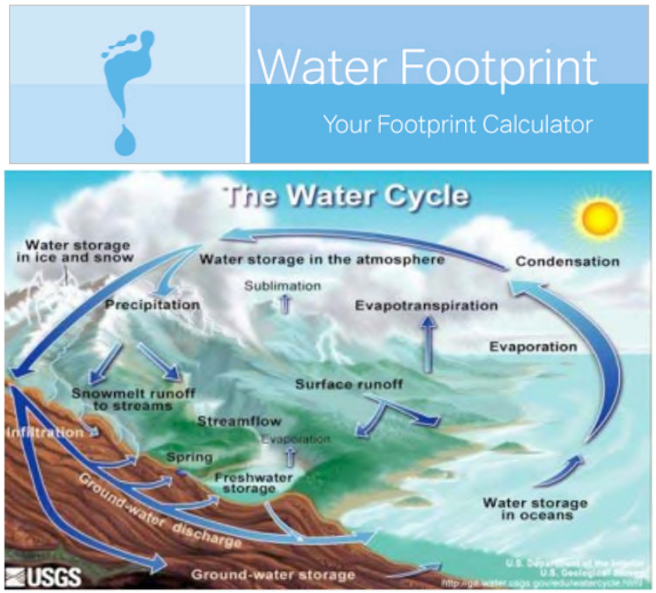

產業用水管理新趨勢-水足跡

SGS Taiwan

台灣檢驗科技股份有限公司

國際驗證服務部

鮑柏宇 Stephen Pao

全球永續產品發展經理

07/18/2014

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OUTLINE

全球水資源使用現況

國際水足跡及水資源管理發展趨勢

企業與產品水足跡管理及LCA介紹

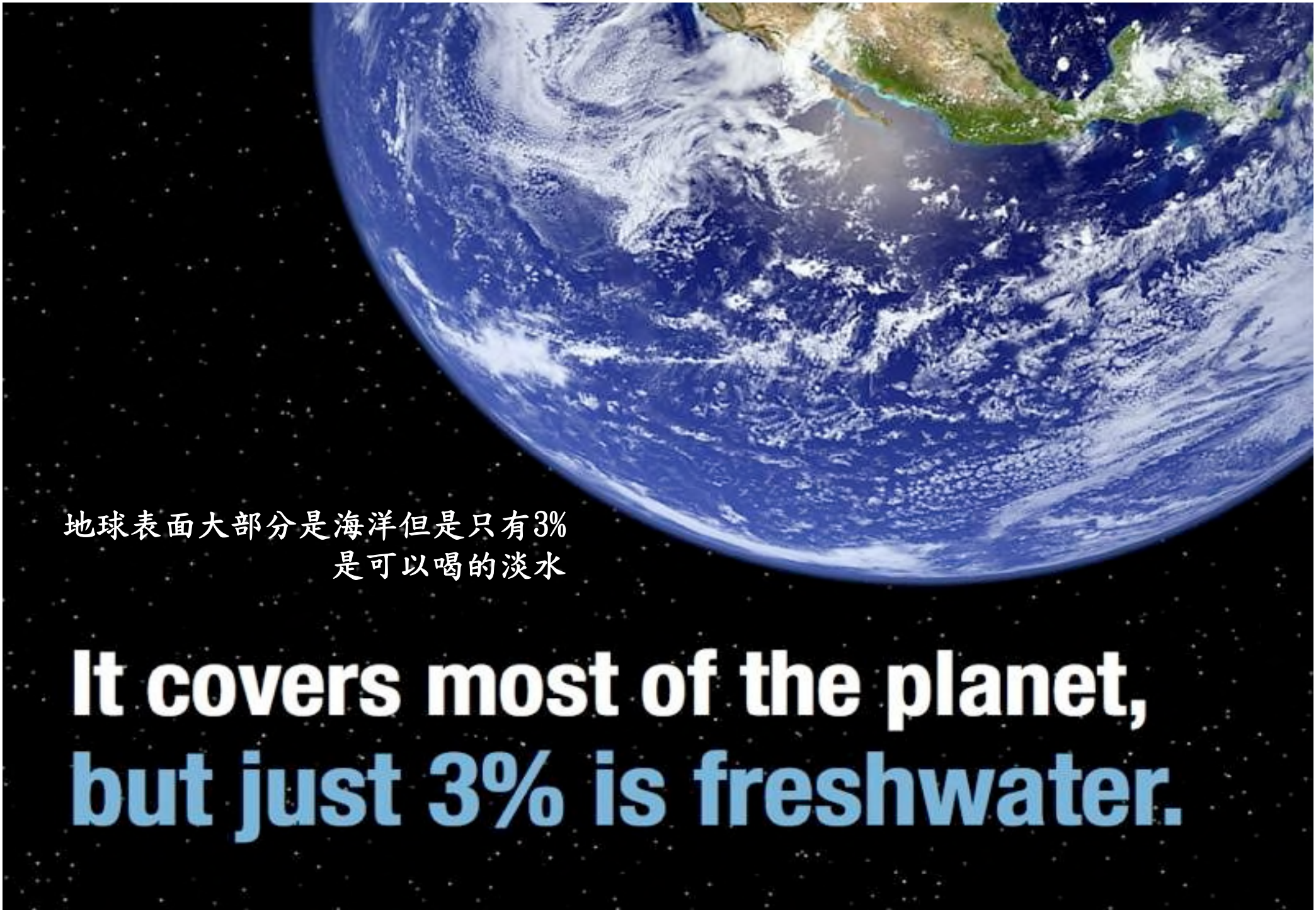
產品水足跡量化

產品水足跡查證流程說明

Q&A

全球水資源使用現況

今天我們看到的水在幾十億年前就已經存在這地球上了


地球表面大部分是海洋但是只有3%
是可以喝的淡水
It covers most of the planet,
but just 3% is freshwater.


而這3%的淡水卻大部分是冰天雪地
(and most of that is ice)

Less than 1% of all freshwater is readily accessible for human use.

人類可以隨便取用的淡水不到1%


Less than 0.007%
of all the water on Earth
is available
to drink.
地球表面上所有的水
只有不到千分之七是
我們可以拿來喝的

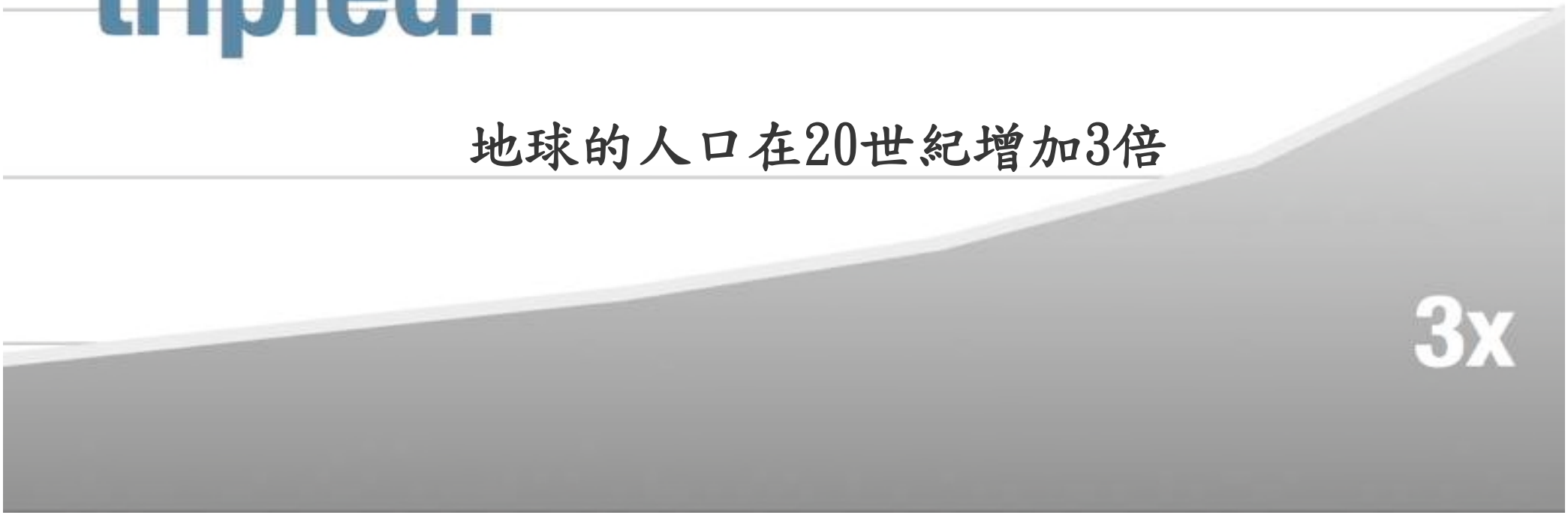

用水危機已經迫在眉睫
A water crisis is looming.

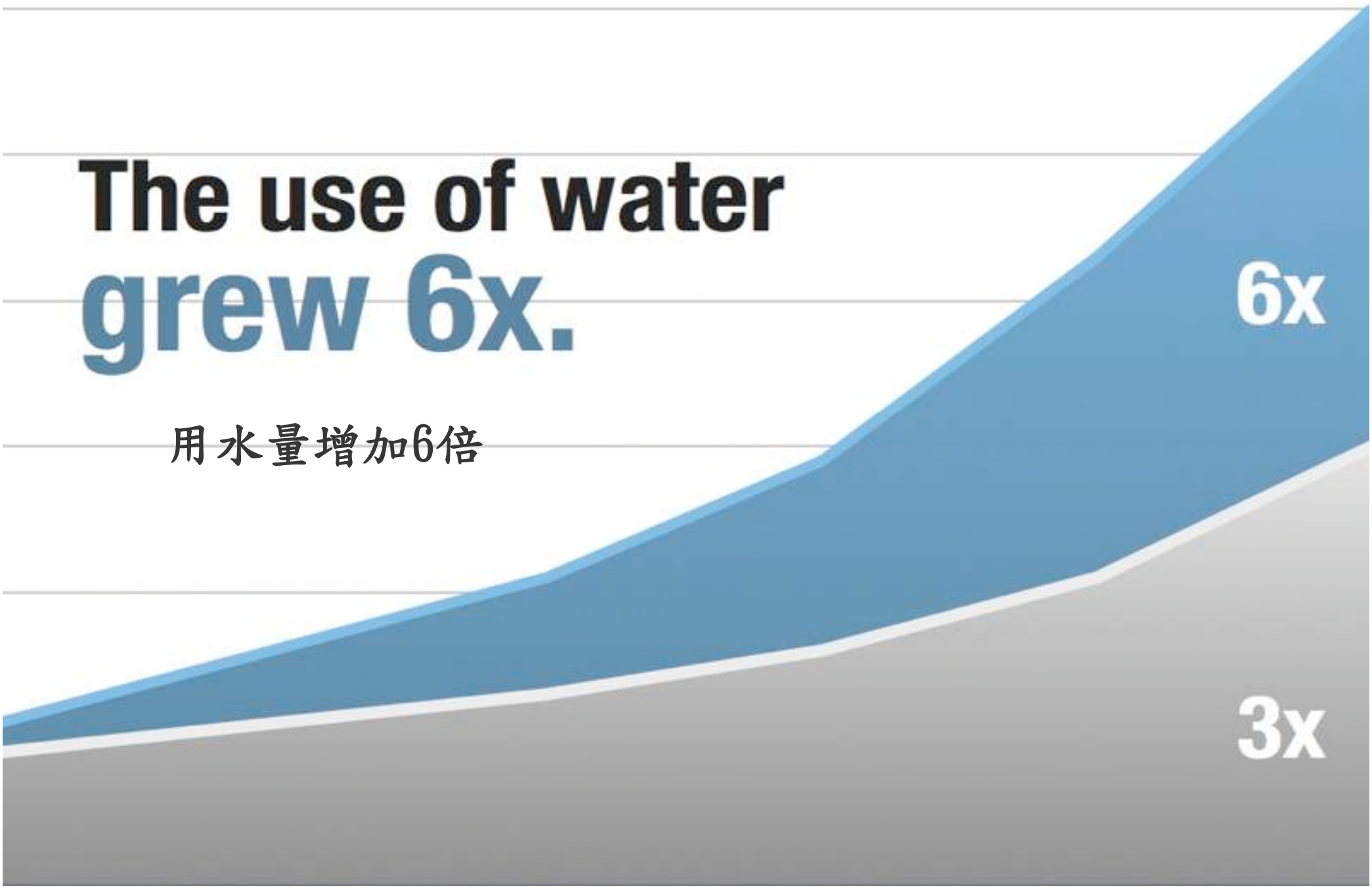
Our water sources
are under pressure.

我們的水資源已經捉襟見肘

In the 20th century
the world's population
tripled.

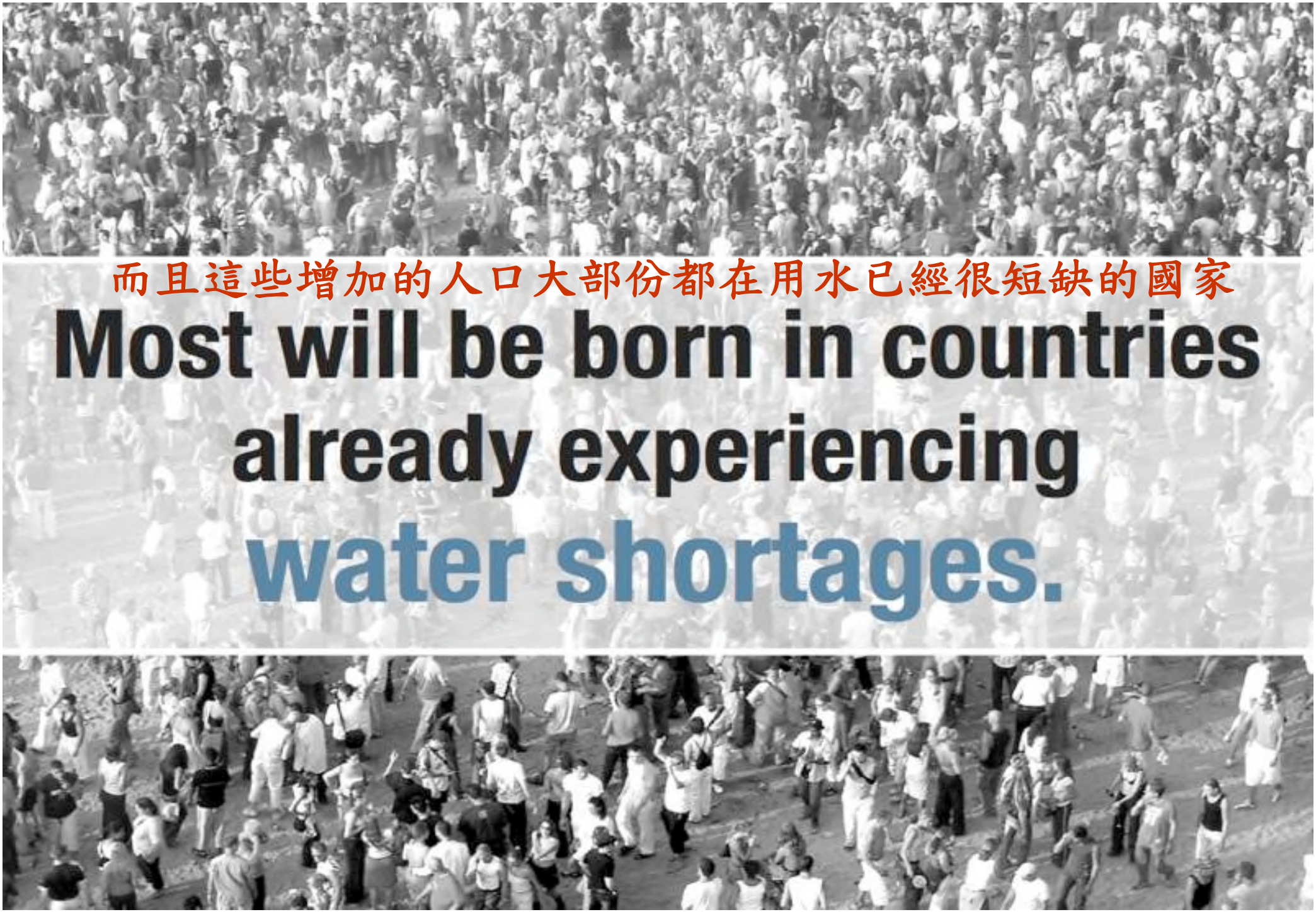
地球的人口在20世紀增加3倍





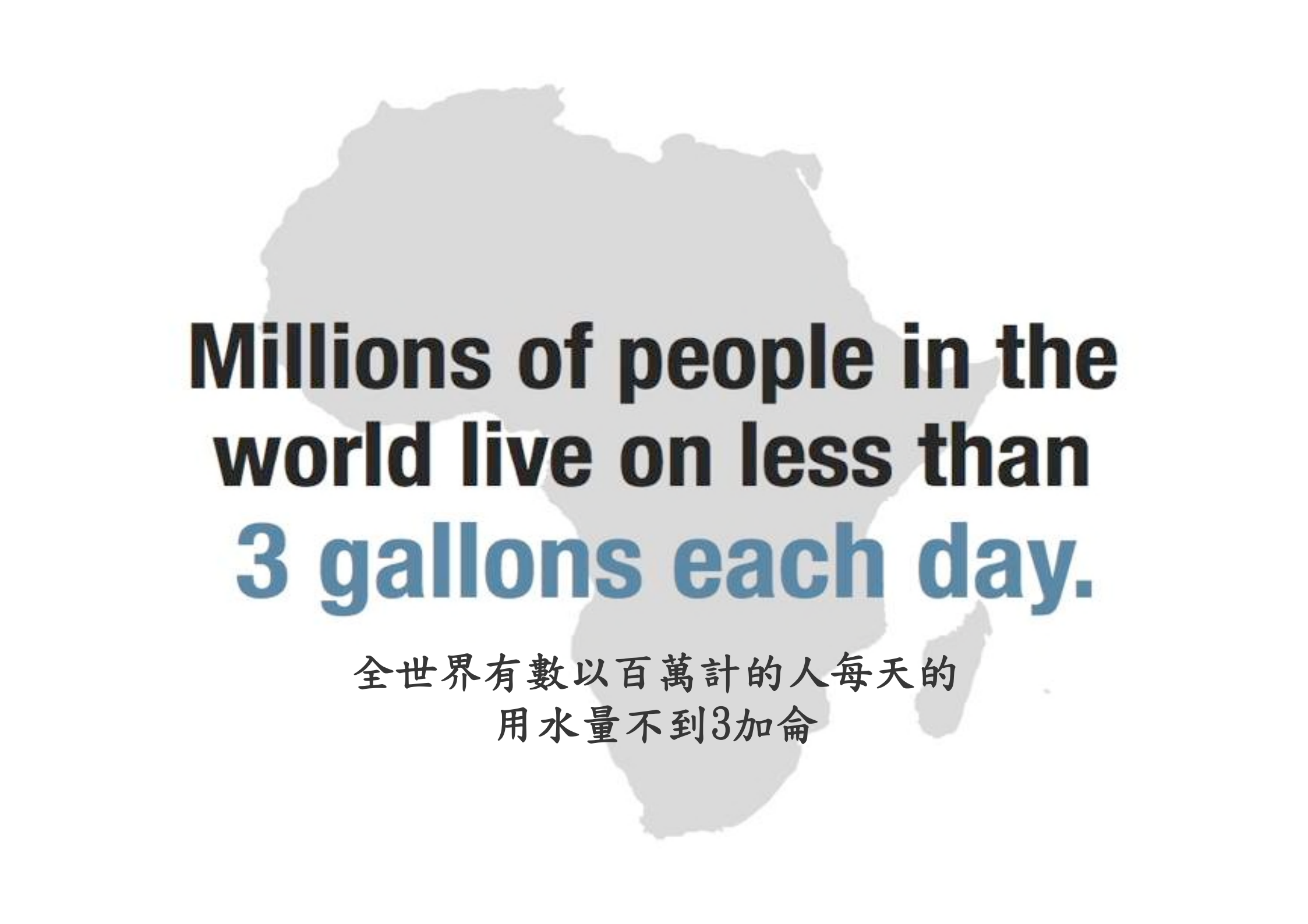
用水量增加6倍


到這個世紀中葉地球人口會再增加30億
By mid-century,
there will be an additional
3 billion people.


而且這些增加的人口大部份都在用水已經很短缺的國家
Most will be born in countries
already experiencing
water shortages.

DID YOU KNOW

你知道嗎 ？



全世界有數以百萬計的人每天的
用水量不到3加侖

25 million refugees were displaced by contaminated rivers last year.

去年有二千五百萬人
因為河川污染而被迫搬遷

這個數目比逃離
戰爭地區的人數還要多


1 in 3 people
lack access to
adequate sanitation.
世界上每三人就有一人享受不到衛生設備

1 in 5

don't have access to safe drinking water.

每五人就有一人沒有安全的飲用水

According to the U.N., a child dies from a water-related disease every 15 seconds.

根據聯合國的統計每15秒鐘
就有一個小孩死於水污染引起的疾病


The emerging worldwide
water shortage is serious.
我們面臨的世界性的水源短缺是非常嚴重的

有人說我們可能在
石油耗盡之前先耗盡水源

It's been said,
we're going to
run out of water
before we run out of oil.

Due to over-pumping, the groundwater in several countries is almost gone.

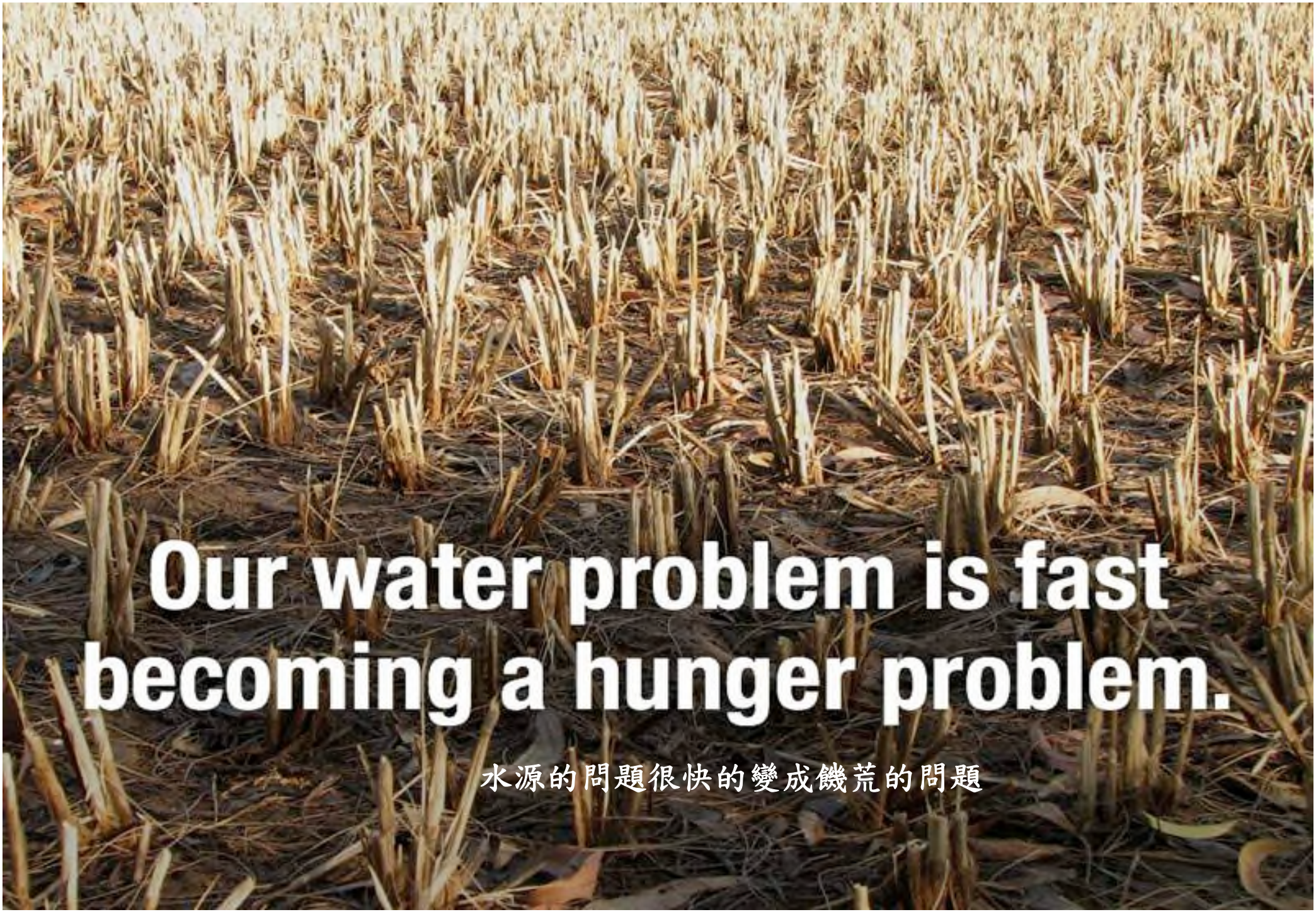
由於過度抽取
很多國家幾乎已經找不到地下水

含水地層的耗損也導致穀物的歉收

Depleted aquifers lead to cutbacks in grain harvests…

因而導致食物短缺以及穀價高漲

...which lead to more food shortages and higher prices.


Our water problem is fast
becoming a hunger problem.
水源的問題很快的變成饑荒的問題

So what does it all mean?

所以
它代表什麼意義呢？

It's a thirsty world.

我們的地球是一個枯渴的世界

Industry is thirsty…

工業是枯渴的

Agriculture is thirsty…

農業是枯渴的

We are thirsty...

我們是枯渴的


What will be
the straw that
breaks the
camel's back?
最後壓倒駱駝的那一根稻草是什麼呢 ？


It's time to give water
a second thought.
現在是我們對水這樣東西重新思考的時候了


少用水
多存水
不斷地提倡這種觀念
Use less.
Save more.
Advocate always.


NOW YOU KNOW
現在你終於明白……


THIRST
什麼叫做枯渴了吧！

人類水資源消費

生產活動

人類活動

manufacture goods

cleaning

cleaning

consume

cleaning

central ingredient

cooling

process raw materials

http://citebook5106.pixnet.net/album/photo/112515316

水、能源與氣候變遷議題(1/2)

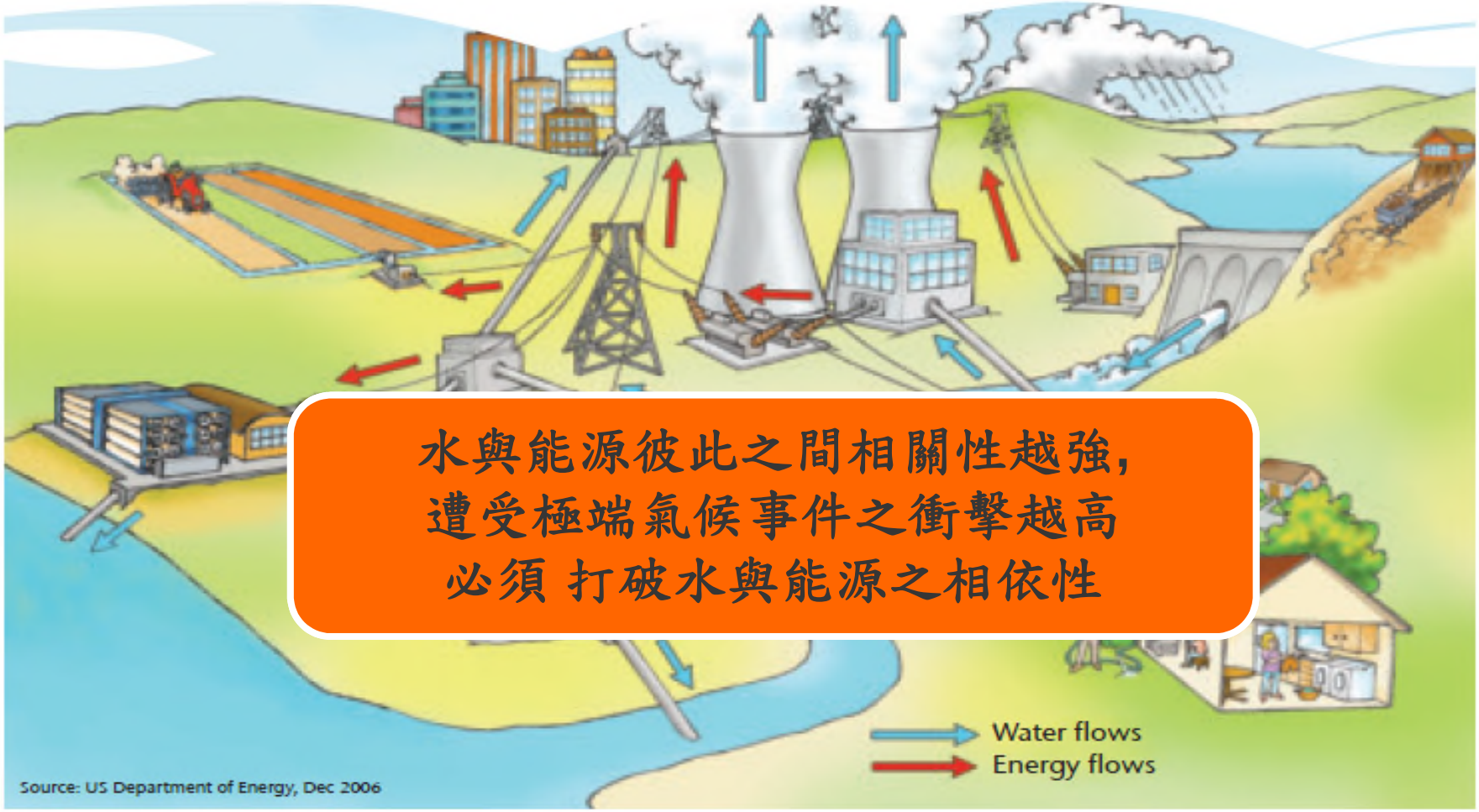
(1)水與能源對人類的重要性：social equity社會公平, ecosystem integrity 生態完整性, economic sustainability 經濟持續性
(2)水也被用來供應能源, 能源被用來供應
(3)水與能源都被用做生產人類生活所需之住行育樂活動

- 人類必須確保水源可永續供應人類需求, 包含工業農業活動
- 要重視水, 能源, 生態足跡三者間之連結性, 避免因其中一項失衡而導致人類生活危機

Inextric… linke… | increasing… | …ecosyst… | …hip …cy

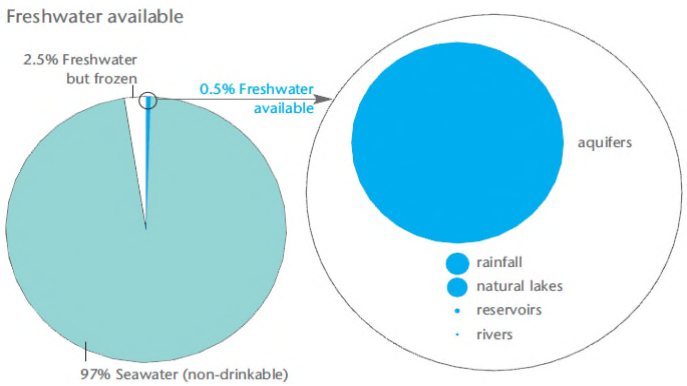
Water is used to generate energy; energy is used to provide water.	people use more energy and water for refrigerators, swimming pools, transport, watering and cooling that meet their new lifestyle and diet needs.	Water, energy and ecological footprints cannot be addressed in isolation. (日本福島核能電廠事件)	The appropriate and sustainable use of water and energy resources locally.	Technology, innovation, a sense of shared responsibility and political will are factors that bring real solutions as we strive to keep pace with increasing needs from a growing population
			Becoming better able to cope with an uncertain future	

水、能源與氣候變遷議題(2/2)
Water, Energy and Climate Change Issues



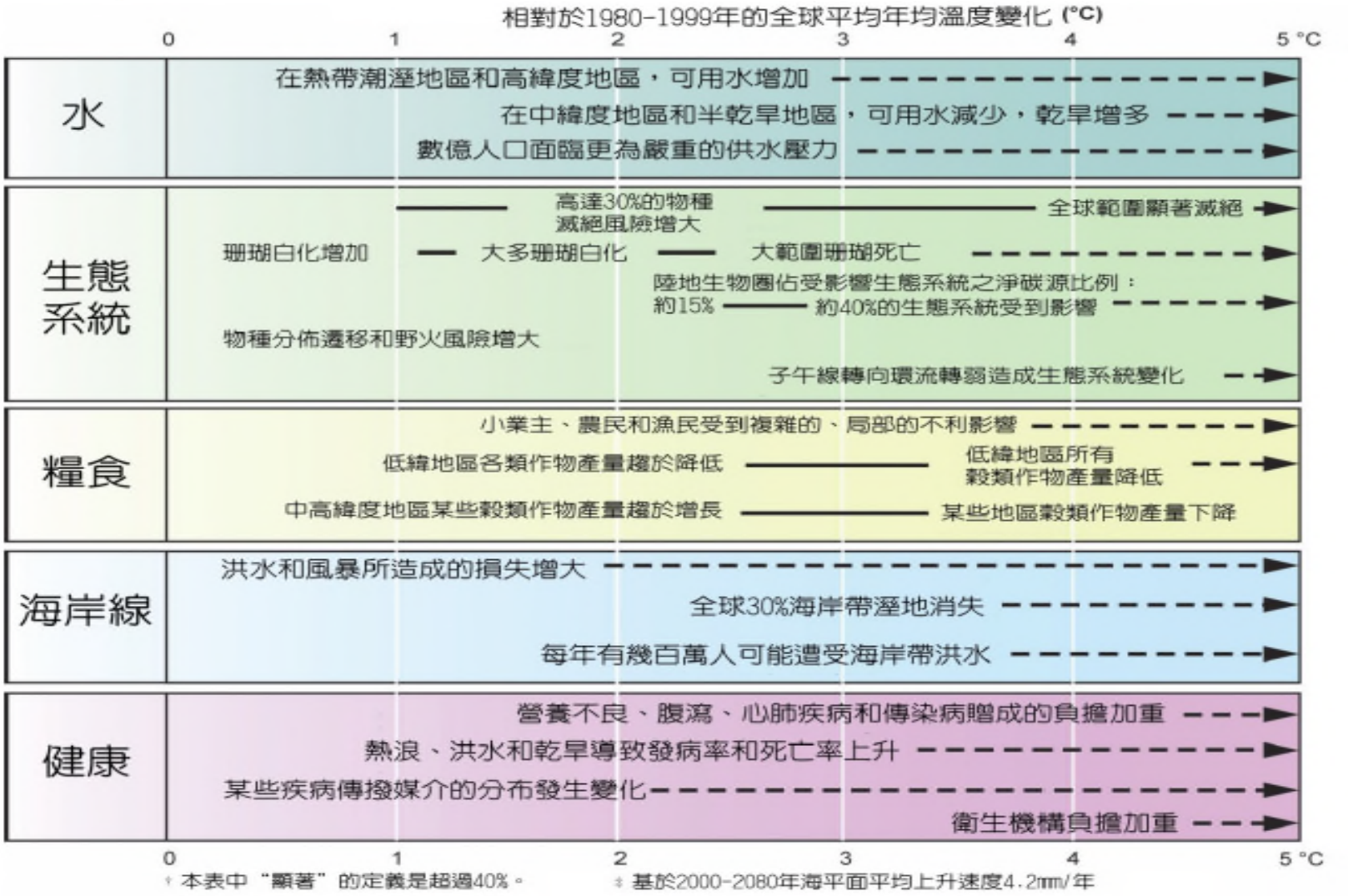
國際永續水資源管理 – 全球水資源現況

- 全球水資源狀況
  - 地球可用水資源 < 3 % (97 %以上為無法直接利用之海水或靜止水)
  - 可用水3 %中，2.5 %位於南北極冰川及地底
  - 人類可用之水資源：< 0.5 %
- 地球之水資源不會用盡、但並非永續可供人類「隨意使用」
- 氣候及全球各地季節極端異象，造成之乾旱及洪水事件等影響人類之食物及生活模式，投入災後成本也相對提高
- 水資源不當管理造成水資源短缺



Source : Business in the world of **water (**WBCSD, August 2006)

重要衝擊與全球平均溫度增幅之關係



(衝擊將隨調適程度、溫度改變速率及社經發展途徑而異)

全球水文極端事件

降雨呈現暴雨及乾旱的極端變化

- 根據監測資料顯示，1970年代開始由於高溫和降雨減少導致乾旱發生的頻率增加，特別是熱帶和副熱帶地區強度大，延時長的乾旱頻率更為增加
- 1900~2005年南北美東部、歐洲北部、亞洲中北部年降水量顯著增加，但地中海、南亞及南非則變乾。
- 許多陸地區域豪大雨頻次增加此與暖化帶來的大氣層水汽含量增加有關。
  (暴雨衝擊)

TABLE 2. List of top five ranked drought events for each continent in terms of duration and maximum spatial extent. The duration (months) and extent (millions km^2) are given in brackets after the time period of each event.

Region	Duration (months)	Spatial extent (10^6 km^2)
Africa	1982–84 (19)	1982–84 (11.3)
	1973–74 (14)	1990–91 (8.4)
	1991–92 (14)	1984–85 (7.9)
	1985–86 (14)	1991–92 (6.9)
	1994–95 (11)	1985–86 (6.7)
Asia	1984–88 (49)	1997–98 (8.2)
	1974–77 (37)	1999/2000 (7.5)
	1978–80 (27)	1972–73 (5.0)
	1981–83 (24)	1964–65 (4.9)
	1950–52 (23)	1982 (4.7)
Europe	1959–61 (20)	1950 (4.3)
	1976–77 (12)	1953–54 (4.0)
	1975–76 (12)	1975–76 (4.0)
	1951–52 (12)	1959 (3.9)
	1995–96 (11)	1951–52 (3.8)
North America	1950–53 (44)	1954–57 (8.2)
	1954–57 (39)	1952–53 (7.6)
	1999–2000 (20)	1976–77 (6.3)
	1958–59 (13)	1988/89 (6.0)
	1976–77 (13)	1953–54 (5.7)
Oceania	1951–52 (12)	1965 (6.5)
	1977 (11)	1961–62 (5.1)
	1965 (11)	1957 (5.0)
	1961–62 (11)	1951–52 (4.8)
	1985 (9)	1986 (4.7)
South America	1958–59 (16)	1963–64 (9.0)
	1982–83 (15)	1961 (6.5)
	1963–64 (14)	1968 (6.3)
	1965–66 (12)	1951 (5.1)
	1991–92 (11)	1997–98 (5.0)

全球水文極端事件

- **氣候變遷&降雨變化預測 (IPCC AR4)**
  - 熱帶區域以及熱帶太平洋的降水增加
  - 亞熱帶地區，降水減少
  - 高緯度地區的降水增加
  - 全球平均的水氣量、蒸發量、與降雨量增加，但平均降雨量的增加幅度比水氣量的增加幅度小。 極端降雨現象增加
  - 豪大雨頻率會增加
  - 連續不降雨天數會變得長
  - 夏季的大區域陸地中有逐漸變乾的趨勢，未來該區域發生乾旱的機率大增

全球水文極端事件記錄

- 美國西南部、東南亞、東南美洲、澳洲西部、南歐，以及非洲南部和北部等地，50年內可能會發生無法逆轉的乾旱（即永久沙漠化）
- 中國北方地區，10米深[illegible]田間出現。水的使用[illegible]，未來10年內，[illegible]環境難民
- 巴西亞馬遜州的[illegible]創紀錄的水位高漲，才剛剛在[illegible]歷史性洪水，如今卻已經因[illegible]而[illegible]立，坐船再也到達不了，只能靠徒步[illegible]森林
- 伊拉克、中國、查德、澳洲、蒙古、非洲的薩赫勒地區（Sahel）在內的地方，在2010年都遭受乾旱之苦
- 英國氣候越來越熱，夏季越來越乾燥，河流水量已減少 80%，可能導致極端的缺水情況

乾旱 & 水災
Drought & Flooding

- 巴基斯坦洪災： 該國歷史上最嚴重的大洪水，導致兩千多人死亡，兩千多[illegible]受傷或無家可歸，五分之一的國[illegible]在水中
- [illegible]4月和6月，也發生了極[illegible]數百人死亡
- [illegible]月，遭受了幾十年來
- [illegible]2010年6月經歷百年來最[illegible]重的[illegible]，暴雨襲擊，重大災[illegible]陸續傳出
- 澳洲布里斯班經歷百年一遇最嚴重水災，市中心商業區斷電猶如死城，造成國內生產總值（GDP）減少約130億澳元
- 台灣2009年8月「莫拉克」風災災情 / 台灣地區暴雨襲擊事件頻率增高

台灣地區水資源狀況

- 台灣屬海島，四面環海，亞熱帶季風區氣候，年平均雨量達2,510公釐，
- 台灣水資源之主要來源：雨水，約為世界平均值之2.6倍
- 台灣雨水豐沛，水資源仍短缺？
  1) 地狹人稠，每人每年所分配雨量僅及世界平均值之七分之一，高居國際缺水排行榜第18名
  2) 雨量在時間及空間上之分佈極不均勻，五月至十月之雨量即佔全年之78%，枯水期長達六個月，河川坡陡流急、腹地狹隘，逕流量被攔蓄僅18%，其餘均奔流入海。
  3) 台灣水庫密度相當高，約40座但庫容不大，有效容量為20.51億立方公尺。

經濟部水利署 http://www.wra.gov.tw/ct.asp?xItem=11733&ctNode=2314&comefrom=lp

台灣地區水資源問題(1/3)

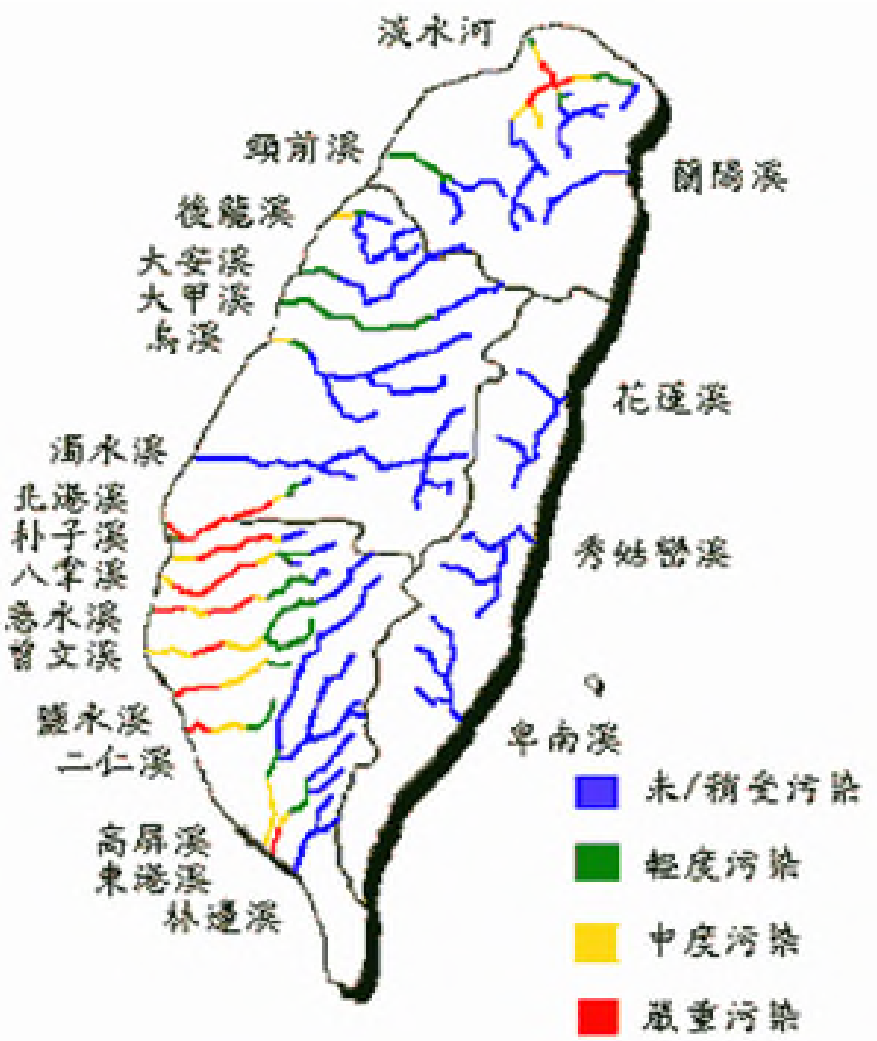
水資源利用率分析表

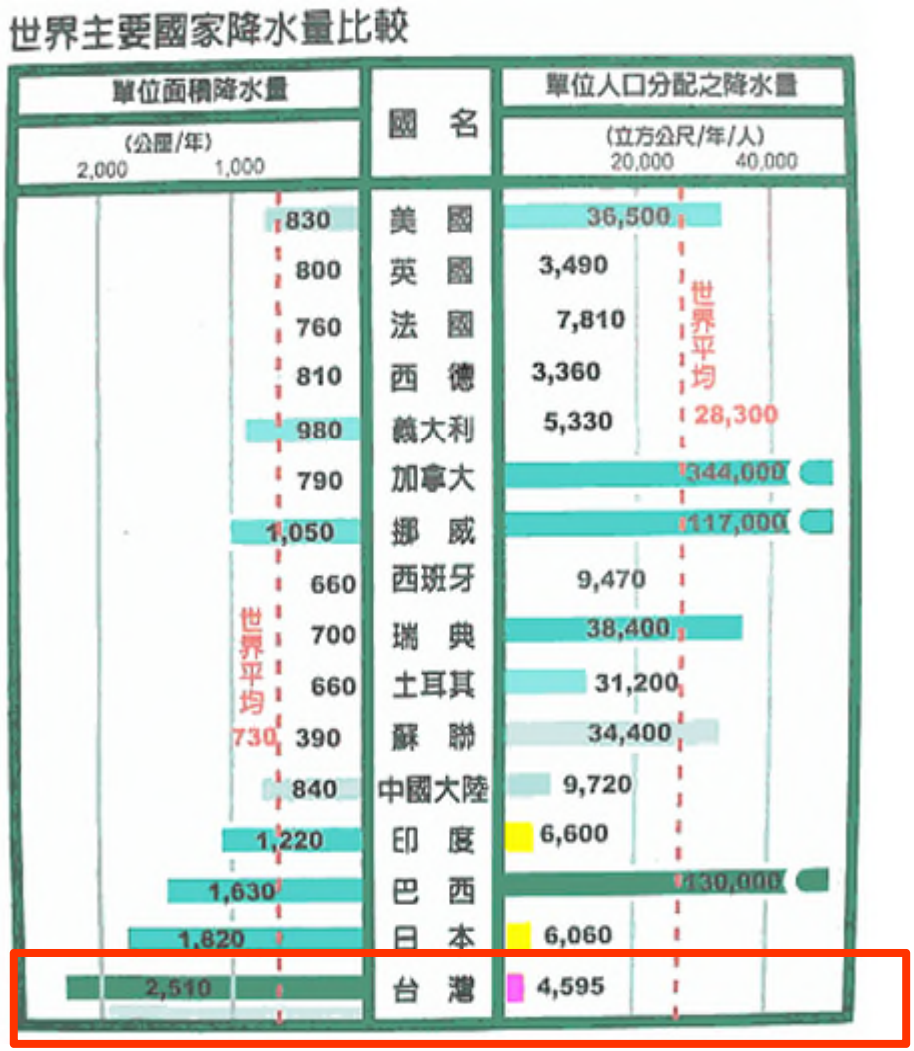
水	水資源利用量（億立方公尺）	占年平均逕流量百分比	占河川最下游水文流量站以上面積之年平均逕流量百分比	占水庫集水區及攔河堰控制面積之年平均逕流量百分比
近十年地面水 利用量	120	120/668 =18%	120/450 =27%	120/314 =38%
目標年110年 地面水利用量	**160**	**160/668 =24%**	**160/450 =36%**	**160/314 =51%**

- 具水文不確定性
- 人口成長快速
- 生活及工業用水增加快速
- 蓄水設施抗旱能力不足
- 水土保持不良影響集水區涵蓄水資源能力
- 水質污染降低水資源供應量
- 水資源管理問題
  1) 健全水權用水秩序
  2) 自來水系統管網連結調配及管漏問題

經濟部水利署 http://www.wra.gov.tw/ct.asp?xItem=11733&ctNode=2314&comefrom=lp

台灣地區水資源問題(2/3)





台灣地區水資源問題(3/3)

SPECIFIC WATER CONSUMPTION 2008
IN LITRES / CAPITA / DAY

- 全球每日人均用水量170公升
- 台灣2008Y人均用量為全球平均兩倍

COUNTRY	CITY	HOUSEHOLD AND SMALL BUSINESS	AVERAGE TOTAL	AVERAGE HOUSEHOLD	AVERAGE TOTAL
AUSTRIA	Graz	125	54	125	189
	Innsbruck	125	88		
	Linz	12	05		
BELGIUM					193
BULGARIA		1	171	114	165
	Burgas	108	200		
	Pleven	94	124		
	Razgrad	84	84		
	Stara Zagora	110	246		
CHINA	Beijing	142	210	178	366
	Shanghai	244	528		
	Tianjin	119	274		
	Shenzhen	206	452		
CHINESE HONG KONG	Hong Kong	220	375	220	375
CHINESE TAIWAN	Taipei	340	414	306	530
	Kaohsiung	272	646		
CYPRUS	Larnaca	119	144	112	138
	Lefkosia	90	110		
	Lemesos	120	140		
	Paphos	117	156		

台灣用水習慣＆基礎
設施建構較偏浪費

國際水足跡及水資源管理發展趨勢

國際永續水資源管理策略(1/2)
Sustainable Water Management Strategy

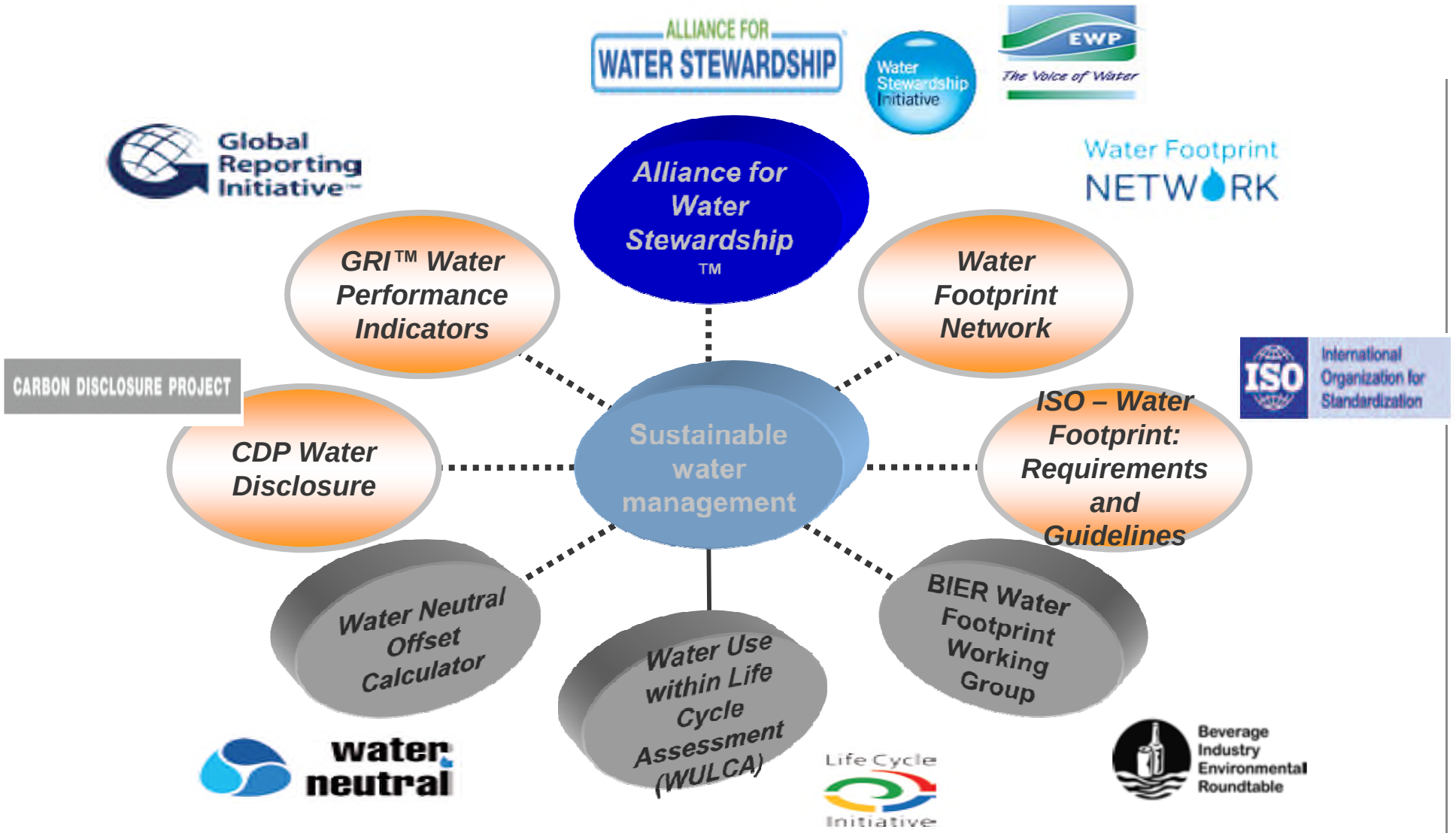
Key focus of the initiative

- Identify and assess water-related risks (鑑別評估與水相關的風險)
- Measure water use and assess water related impacts (測量水用途及評估水相關衝擊)
- Develop response options and/or risk mitigation strategies (發展對應及風險減緩策略)

國際永續水資源管理策略(2/2)
Sustainable Water Management Strategy

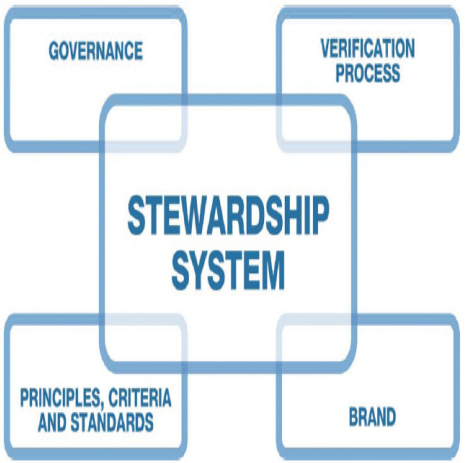
Direction	Action		Notes
Identify Risk 風險鑑別	• Collecting the Drops: A Water Sustainability Planner • Strategic Water Management in the Minerals Industry • Water Brief for Business • WBCSD Global Water Tool		**Policy**
Measurement 量測管理及工具	• Aquawareness • Alliance for Water Stewardship™ • BIER Water Footprint Working Group • Corporate Water Gauge™ • GRI™ Water Performance Indicators • Water Stewardship Initiative	• ISO – Water Footprint: Requirements and Guidelines • Strategic Water Management in the Minerals Industry • Water Footprint Network • Water Use within Life Cycle Assessment (WULCA) • Water Footprint, Neutrality and Efficiency Umbrella Project	**Water Footprint**
Sustainable Response 永續管理及責任	• Aquawareness • Alliance for Water Stewardship™ • CDP Water Disclosure • GRI™ Water Performance Indicators • Water Neutral Offset Calculator • WaterSense ProgramR	• ISO – Water Footprint: Requirements and Guidelines • UK Federation House Commitment to Water Efficiency • UN CEO Water Mandate • Water Stewardship Initiative	**Water Stewardship Standard**

國際水足跡/永續水資源管理推動組織



水資源管理聯盟
Alliance for Water Stewardship Program

- 促進淡水使用責任，益於社會及環境永續，制定水資源管理標準
- 建立全球適用之水管理標準，大量用水者可透過此標準顯示用水效能及社會、環境及經濟永續達成程度促進淡水使用責任，益於社會及環境永續



- **International standards** with a focus on impacts of direct and indirect water use at the watershed level
- **Verification** to determine whether these standards have been met
- **Global brand** to allow users to demonstrate compliance
- **Training and education** to promote achievement of water stewardship
- **Pilot testing** and technical studies to refine the program through an iterativeprocess

- **AWS International Water Stewardship Standard is currently under development**

水資源管理聯盟
Alliance for Water Stewardship Program

- Water footprinting
- CEO water Mandate【企業執行長水資源管理使命】
- WBCSD【企業永續發展協會】
- GRI【全球永續性報告推動計畫】
- Management system approaches
- Others…

水資源管理聯盟
Alliance for Water Stewardship Program

The Nature Conservancy

Water Witness International

The Water Stewardship Initiative

Water Environment Federation®

Pacific Institute

European Water Partnership

World Wildlife Fund

International Water Management Institute

- 建構水資源管理標準 (Water Stewardship Standard, WSS)
  - 幫助企業處理與水相關的風險並且發掘企業對水的依賴性長期策略
- 企業參與水資源管理之關鍵焦點
  - 鑑別估計企業與水議題相關之風險
  - 企業應測量水用途及估計水資源利用之衝擊
  - 發展水資源風險應對及減緩策略
- 水資源管理系統執行架構
  - 環境管理系統(ISO 14001)
  - Plan-Do-Check-Act 概念
  - 生命週期評估方法 (WFN development)
  - 建構水資源永續管理目標

CDP – Water Disclosure 水揭露計劃

https://www.cdproject.net/en-US/Programmes/Pages/cdp-water-disclosure.aspx

CARBON DISCLOSURE PROJECT

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CDP Water Disclosure

Watch the CDP Global Water Forum video to understand how companies are exposed to water related risks, hear about new business opportunities and learn more about why water stewardship should be at the heart of every business' strategy

> About us

> Case studies

> Search responses

> Read the 2011 report

Stay up-to-date

12 March
The CDP Water Disclosure 2011 South Africa Report was launched in Johannesburg in conjunction with our South African partner, National Business Initiative. Click here to read the report.

01 February
The disclosure process has begun. CEOs will receive the CDP Water Disclosure information request in the mail shortly. Click here to see if your company has been asked to respond.

Quick links

CDP Water Disclosure 2012 information request
English Japanese

Investors
Our signatories
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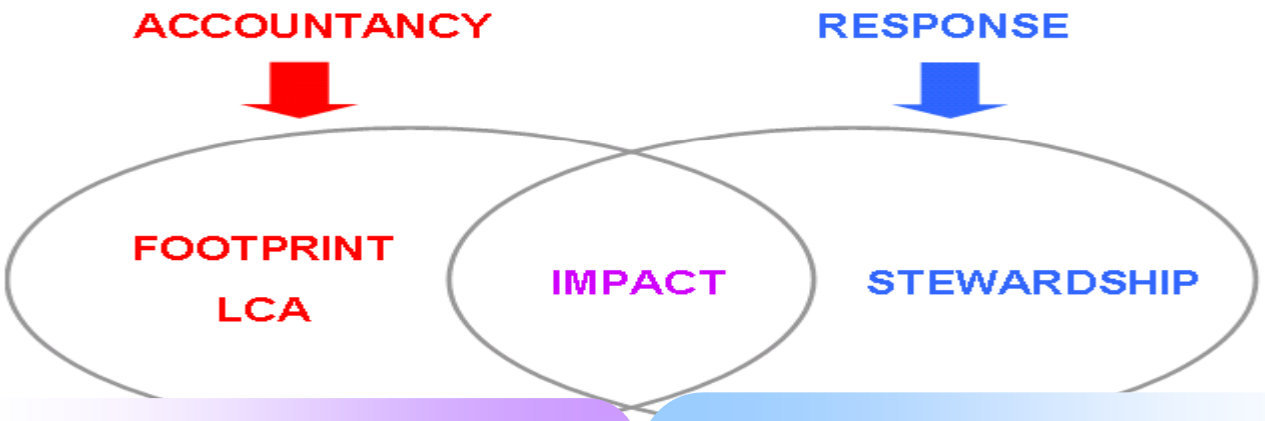
CDP -水揭露計劃_Information Request

Water management and governance	• Policy, Strategy or Plan • Targets and Goals • Specific actions
Risks & Opportunities	• Risk indicators : Operations and Supply Chain • Risk assessment: Operations and Supply Chain • Impacts to business • Opportunities • Managing trade-offs between water and carbon emissions
Water Accounting	• Withdrawals and recycling • Discharges • Water intensity

企業與產品水足跡管理及LCA介紹

企業水足跡及水資源管理工具

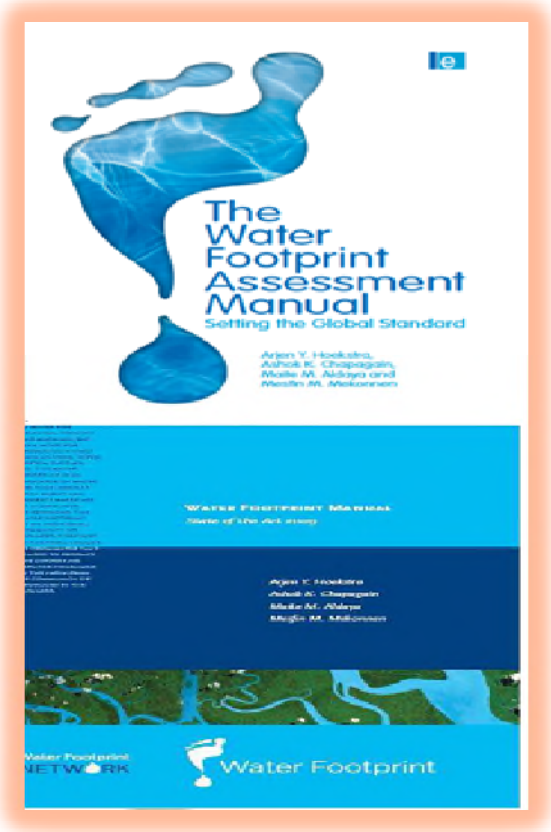
- 水資源管理工具將可協助企業掌控:
  - 透過工具反應企業用水與環境、社會及經濟層面的衝擊性(量化)
  - 掌握及維護能承受的水風險管理(永續水資源管理)



水足跡計算
Water Footprint Network (WFN) / WFP Assessment Manual

水資源管理系統
Alliance for water stewardship (AWS) / International Water Stewardship Standard

企業與產品水足跡管理 - WFAM



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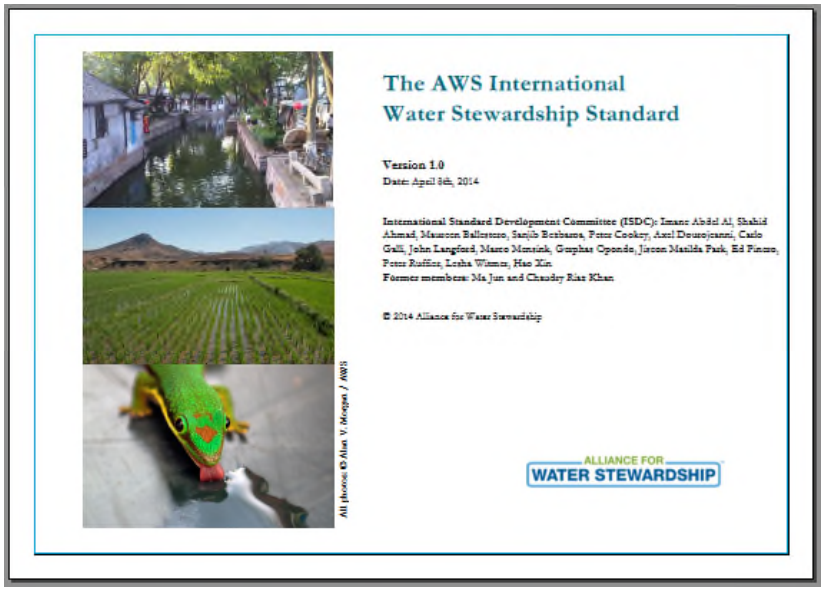
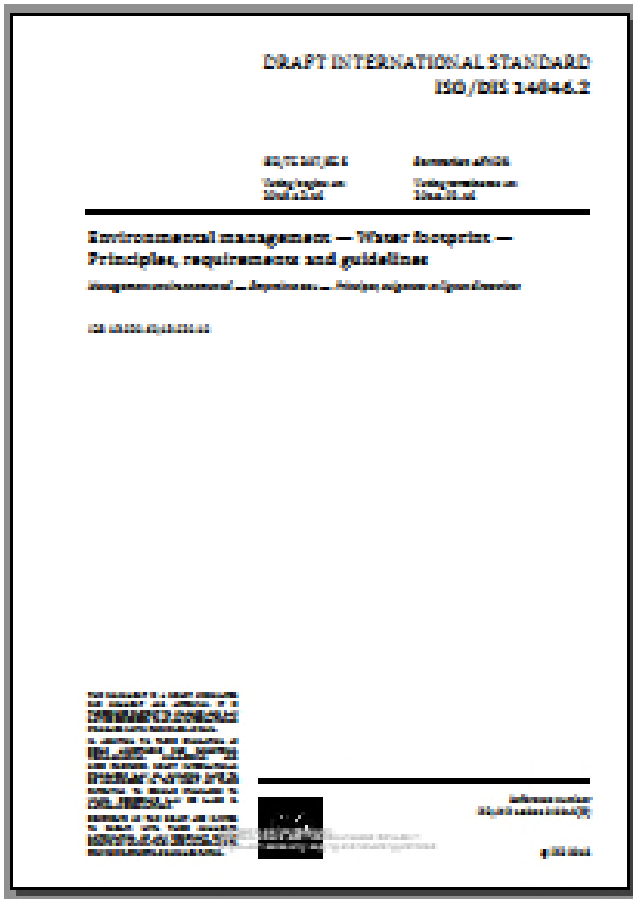
- 水足跡計量重點
  - water volumes consumed (evaporated or otherwise not returned)
  - polluted per unit of time
- 水足跡評估類別:
  - Product 產品型水足跡
  - Consumer or group of consumers 消費型水足跡
  - Business企業(組織)型水足跡

企業與產品水資源管理 - IWSS



- IWSS (International Water Stewardship Standard)也稱為AWS standard
- 該標準於2014年4月8日正式公告
- 以風險評估為基礎,管理系統之概念運作
- 共分為六個步驟:
  - Commit
  - Gather & understand
  - Plan
  - Implement
  - Evaluate
  - Communicate & disclose
- 同步發展驗證機制

企業與產品水足跡管理 – ISO 14046



DRAFT INTERNATIONAL STANDARD
ISO/DIS 14046.2

Environmental management — Water footprint — Principles, requirements and guidelines

- ISO 14046 - Environmental management -- Water footprint -- Principles, requirements and guidelines
- 目前標準已發展至 stage 50.20,預計一年內正式國際標準可正式公告
- This International Standard specifies requirements and guidelines to assess and report water footprint based on LCA
  - Methodology and reference
  - Product level : ISO 14040/44
  - Organization level：ISO 14064
  - Communication issues

生命週期評估技術介紹(1/3)

- **生命週期**
  - 自然資源取得(原物料產生)至最終處置之過程
- **生命週期評估定義(ISO 14040)**
  - 產品自始至終之生命週期中，投入與產出及潛在環境衝擊之彙整與評估
- **評估方式**
  - 投入產出盤查清單
  - 環境衝擊點
  - 衝擊強度與作業目標之闡釋
- **助益**
  - 鑑別產品環境衝擊點改善機會
  - 決策分析
  - 環境績效指標設定
  - 市場行銷

生命週期評估技術介紹(2/3)

~1997Y

ISO 14040:1997
原則與架構

ISO 14041:1998
目的、範疇與盤查分析

ISO 14042:2000
生命週期衝擊評估

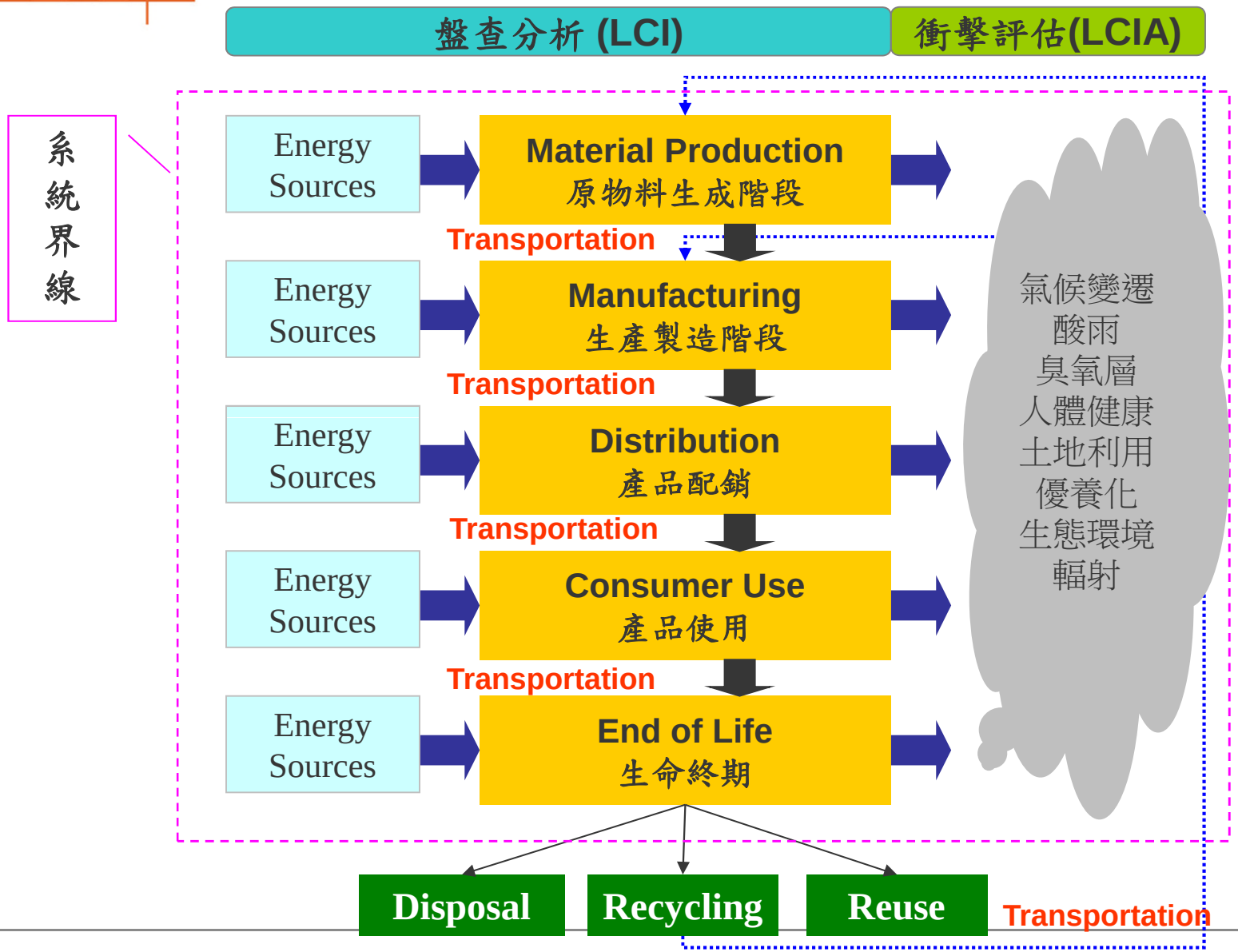
ISO 14043:2000
生命週期闡釋

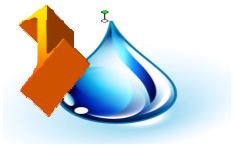
2006Y~

ISO 14040:2006
LCA-原則與架構

ISO 14044:2006
LCA-要求事項與指導綱要

生命週期評估技術介紹(3/3)





產品水足跡量化

What is “Water Footprint”?

- The water footprint is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer.
- The Concept of “water footprint” was introduced by Hoekstra in 2002.
- The water footprint is a geographically explicit indicator, not only showing volumes of water use and pollution, but also the locations.

水足跡發展沿革

1980年：以色列經濟學家Gideon Fishelson提出通過糧食進口來減少國內水資源消耗，以緩解國內水壓力之物化水概念

1993年：英國倫敦大學John Anthony Allan首次提出虛擬水(virtual *water)*一詞，將虛擬水定義為生產農產品所需要的水資源量

2002年：聯合國科教文組織荷蘭國際水文和環境工程研究所(UNESCO-IHE)的Hoekstra教授在虛擬水研究的基礎上，進一步提出了水足跡(water footprint)概念

2008年：Hoekstra與Chapagiain教授根據水足跡概念，提出藍水足跡、綠水足跡與灰水足跡之計算定義

水足跡(water footprint)

Major determinants of a water footprint

- **Consumption characteristics (消耗的特性)**
  - Consumption volume (消耗量)
  - Consumption pattern (消耗特性)
- **Production circumstances (生產狀況)**
  - Climate: evaporative demand at place of production
  - Agricultural practice: water use efficiency

水足跡適用範圍

• 特性：

– 以水資源消費為基礎，反應消費者或生產者直接與間接水資源總使用量的用水指標

– 與虛擬水概念密切相關，考量產品對生產地水資源的耗用與環境衝擊

• 研析對象/尺度：

– 產品、消費者(個人)、生產者(企業體)、族群、國家

Tools for Water Accounting

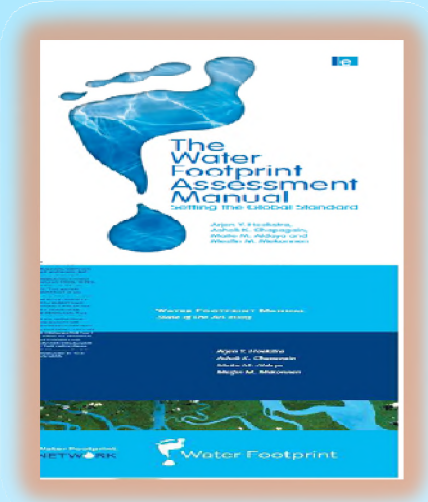
	WFN Water Footprinting	Life Cycle Assessment	WBCSD Global Water Tool	GEMI Water Sustainability Tools
General Strengths	•Good tool for "big picture" strategic planning purposes •Easily understood by non-technical audiences •Best for volume assessments, as opposed to water quality	•Uniquely well-suited for cross-media environmental assessments •Mature science-based methods for assessing water quality impacts	•Good first-tier risk screen •Inexpensive, fast, and does not require company expertise •Simple inventory for companies to compile their water data	•Useful for companies just beginning to think about water stewardship •Inexpensive, fast, does not require expertise
General Weaknesses	•Generic, aggregated blue-green-grey WF figures are misleading •Grey WF deemed ineffective by companies	•No universally accepted method of assessing water use impacts •Results can be difficult to communicate to nontechnical audiences	•Does not address water quality/discharge-related risks •Does not address impacts •Assessments provide only rough estimates of risk	•Rudimentary assessment of relative risks •No quantified results

資料來源 : The Yangtze Corporate Sub-forum presentation slides_Corporate Water Accounting & Water Stewardship in China_by 劉俊國教授 (北京林業大學)

Definition of “Product Water Footprint”
何謂產品水足跡？

- **The water footprint of a product is defined as the total volume of fresh water that is used directly or indirectly to produce the product. (Water footprint network)**
- The water footprint of a product (good or service) is the total volume of fresh water used to produce the product, summed over the various steps of the production chain. (Water Stewardship Standard)

“產品水足跡(water footprint)評估主要為量測產品生產鏈中，因直接及間接生產活動累積之淡水耗用量“



Activities	Product
individuals populations governments companies organizations processes industry sectors	Good & Service

Definition of "Business Water Footprint"
何謂企業(組織)水足跡？

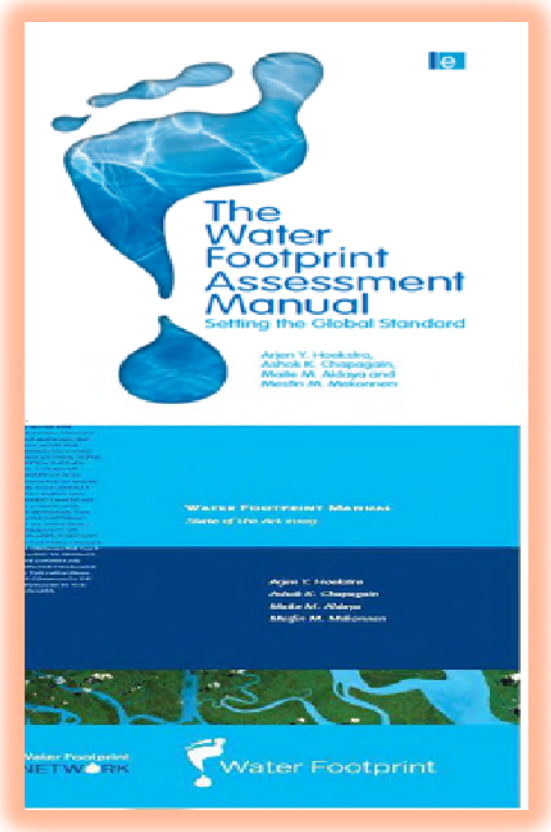
- **The water footprint of a business is defined as the total volume of freshwater that is used directly or indirectly to run and support the business. (Water footprint network)**

- The total volume of fresh water that is used directly and indirectly to run and support a business. The water footprint of a business consists of two components: the direct water use by the producer, for producing/manufacturing and supporting activities, and the indirect water use, i.e. the water use in the producer's supply chain. **(Water Stewardship Standard)**

- **Business water footprint = Corporate water footprint = Organizational water footprint**

"企業(組織)水足跡(Business water footprint)評估主要為量測企業活動鏈中，因直接及間接生產活動累積之淡水耗用量"

企業與產品水足跡管理



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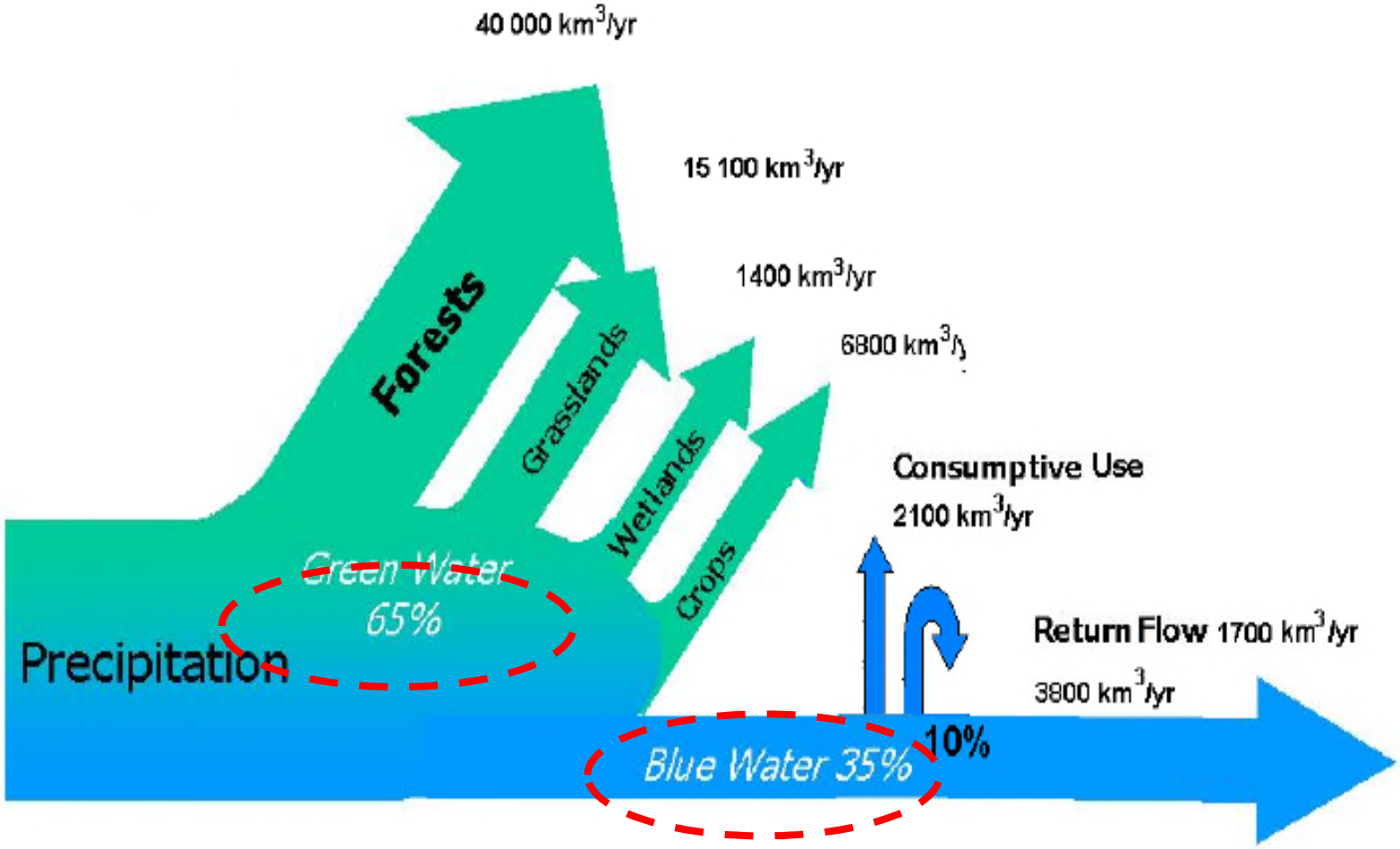
  - Business企業(組織)型水足跡

各類別水足跡定義

藍水 **BLUE WATER FOOOTPRINT**	產品或服務生產流程中消耗之表面水/地下水之水量 **Volume of surface and groundwater consumed as a result of the production of a good or service.**
綠水 **GREEN WATER FOOOTPRINT**	生產流程中消耗來自雨水的土壤含水消耗量 **Volume of rainwater consumed during the production process.** (Green water refers to the precipitation on land that does not run off or recharge the groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation.)
灰水 **GREY WATER FOOOTPRINT**	放流至承受水體標準時所消耗的稀釋水量 **defined as the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards.**

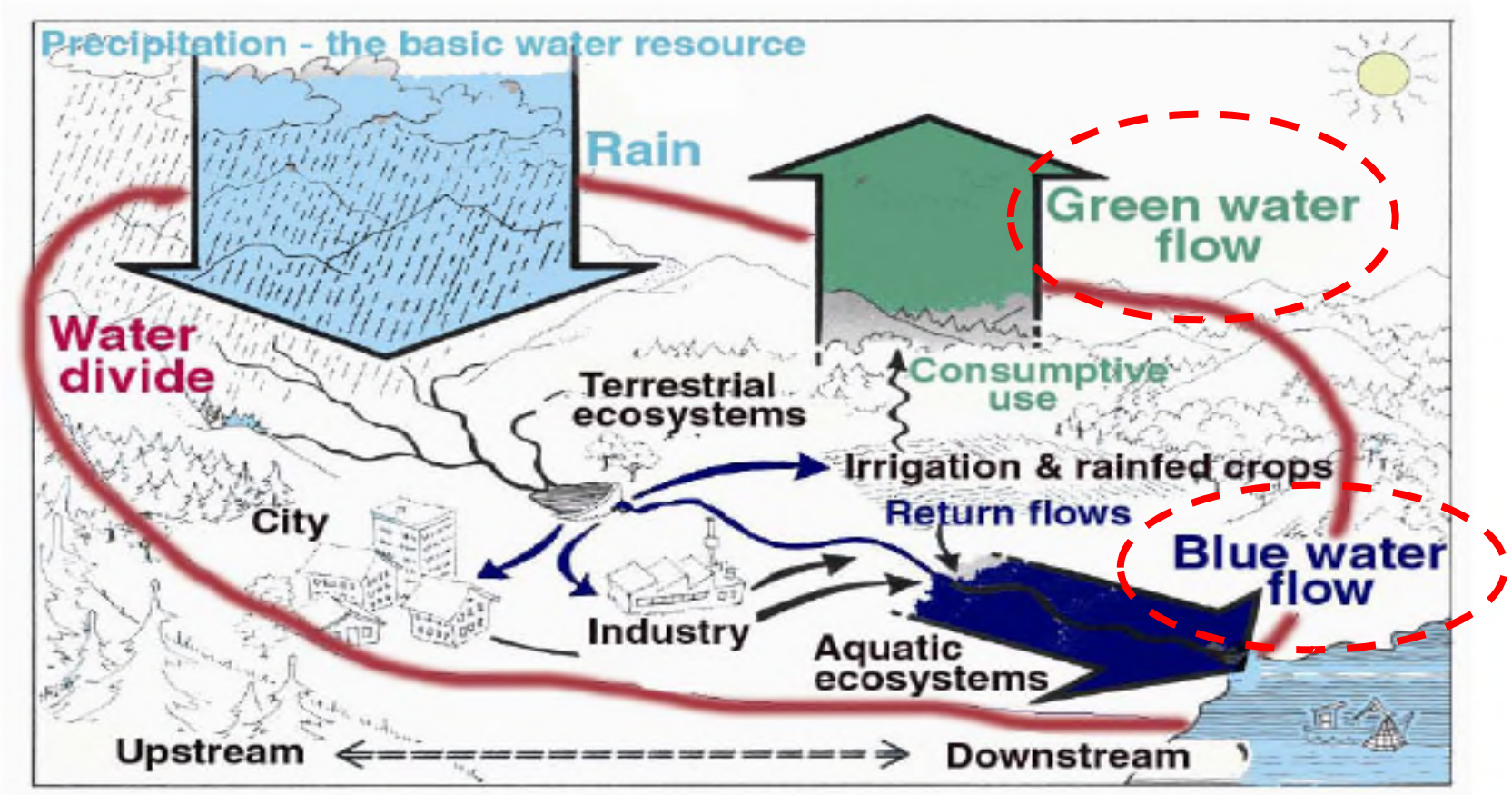
各類別水足跡定義



Holger Hoff

各類別水足跡定義

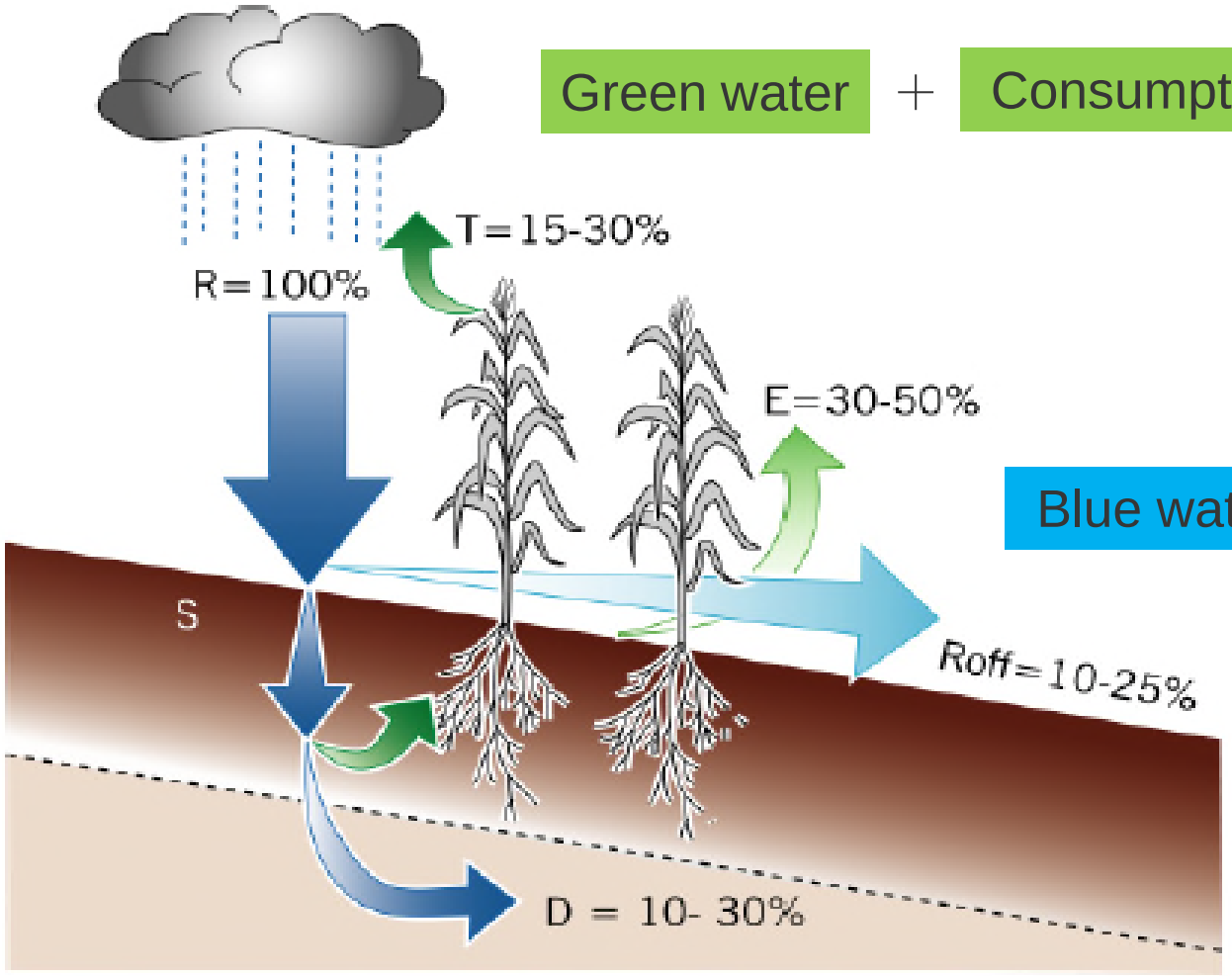
Green and blue water



Falkenmark & Rockström

各類別水足跡定義 (藍水/綠水)

Input

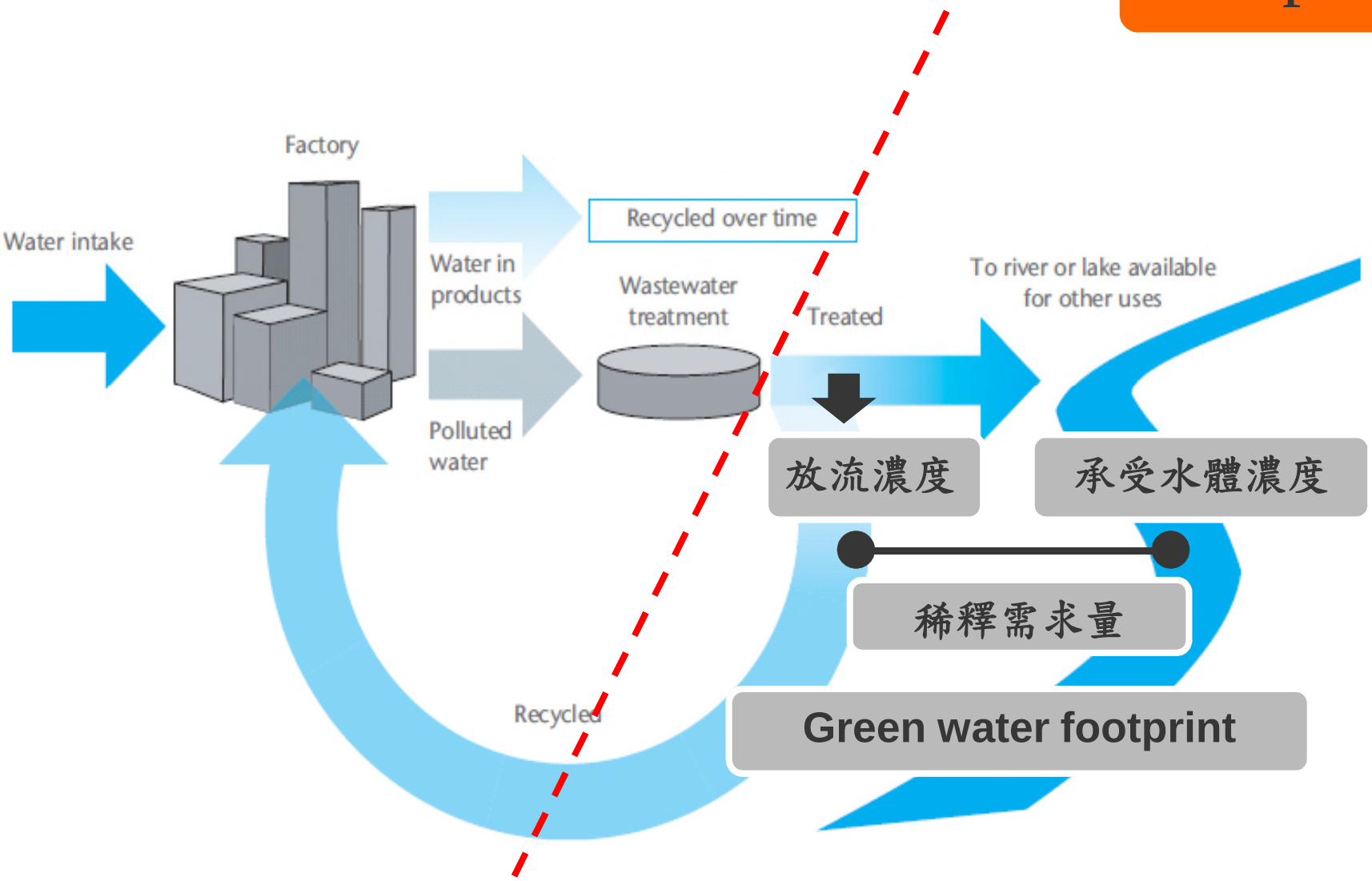


Green water + Consumption = Green water footprint

Blue water + Consumption = Blue water footprint

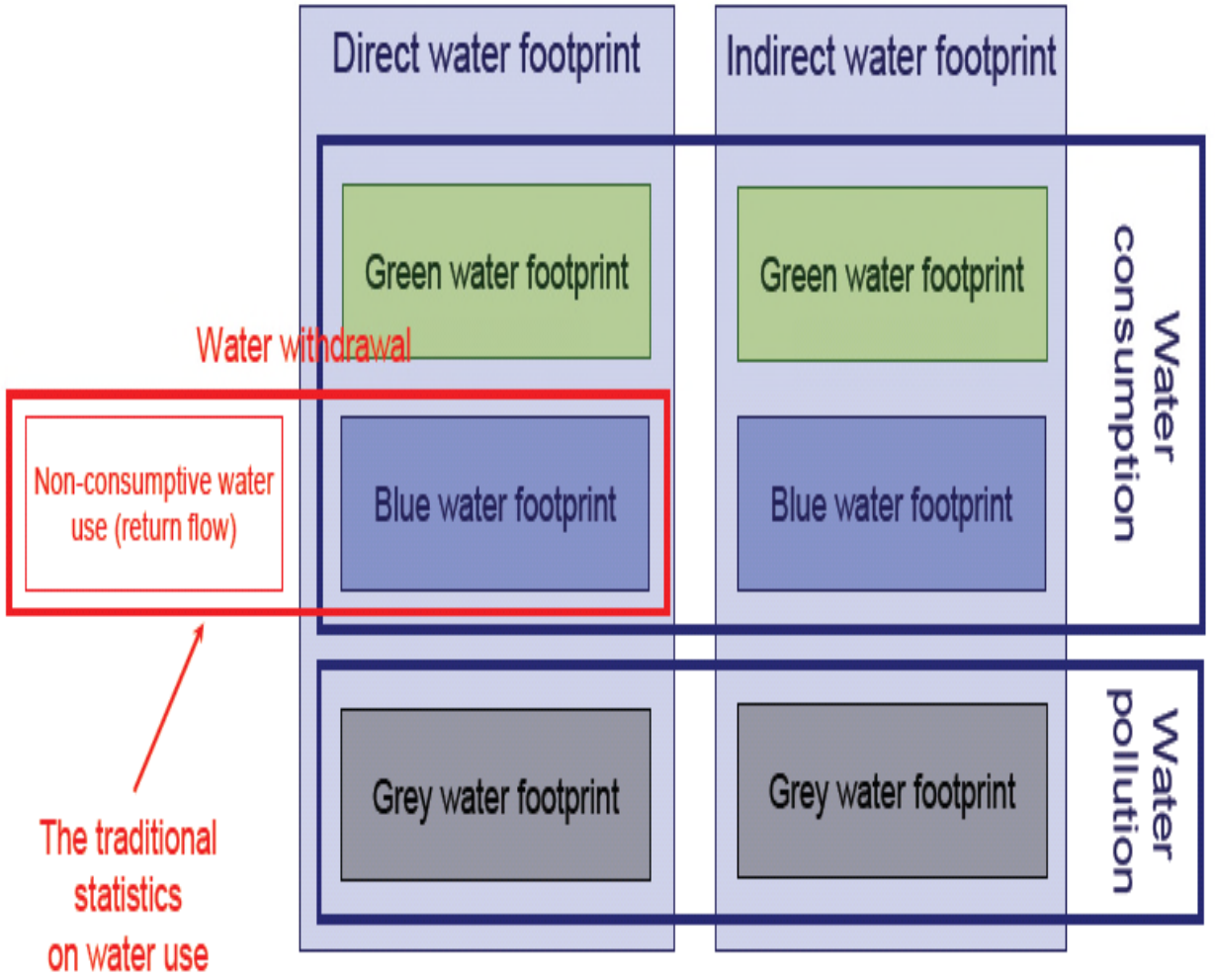
各類別水足跡定義 (灰水)

Output



Water Footprint Assessment Manual

1. Setting goals and scope
2. Water footprint accounting
3. Water footprint sustainability assessment
4. Water footprint response formulation



水足跡計算量化

Scope	Green / Blue / Grey water footprint
Truncation	Significant: larger than 1% or 10% or…etc
Spatiotemporal	

Level	Spatial	Temporal
Level A	Global average	Annual
Level B	National, regional or Catchment specific	Annual or monthly
Level C	**Locally, site and field specific**	**Monthly or daily**

Period of data	Year / specific years
Direct / indirect	direct footprinting Indirect footprinting

水足跡量化公式

WFproduct = WF blue +WF green + WF grey

WF blue 藍水足跡 (地表水/地下水)

WFproc,blue = Evaporation + Incorporation + Lost Return flow

WF green 綠水足跡 (雨水)

WFproc,green = Evaporation +Incorporation

掌握表土特性(土壤含水率) 水份流通量
ex. NIEA S280.61C
植物水份蒸散率 / 吸水率

WF grey 灰水足跡 (污水稀釋耗用水)

WFproc,grey = L / (C max — C nat)

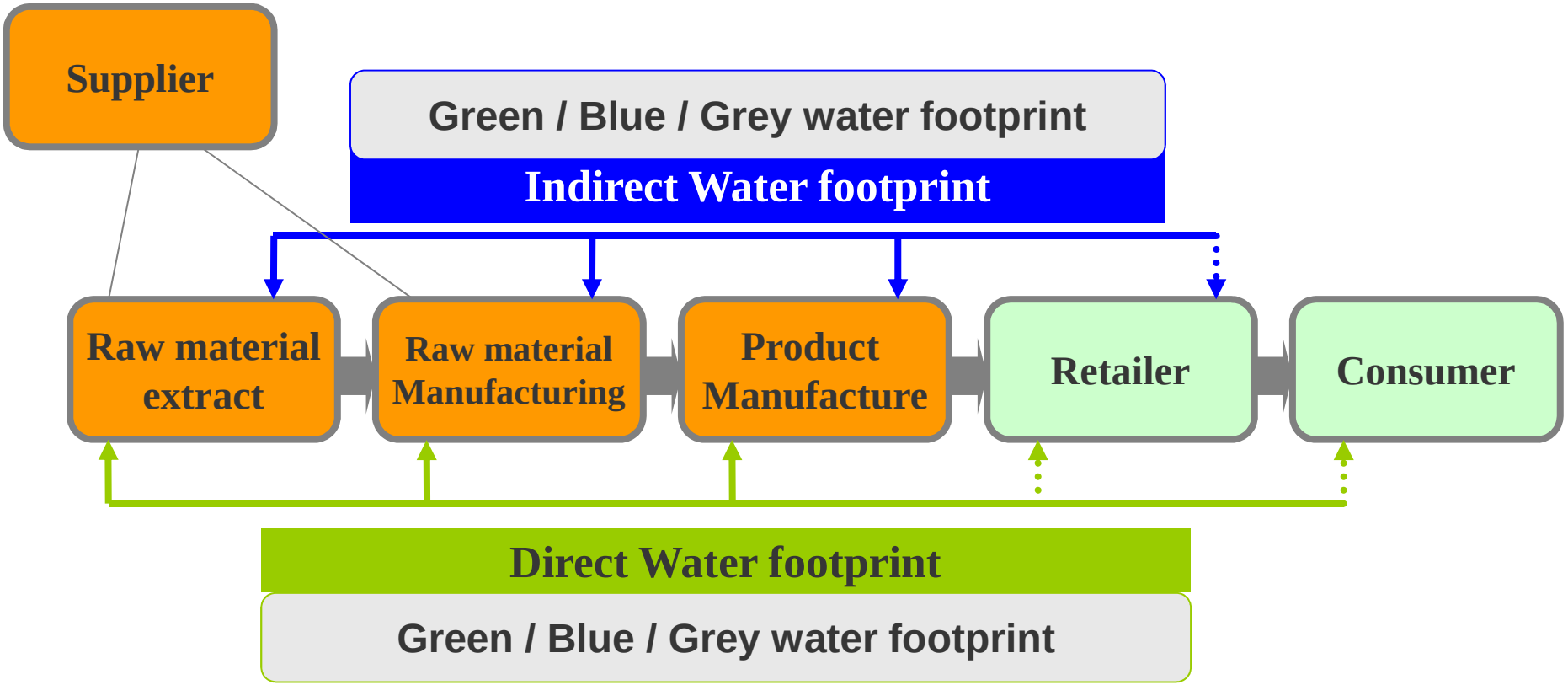
WFproc,grey = E ffl × C ffl / C max

WFproc,grey = Effl × △T effl — △T max

- L : pollutant load
- Cmax : ambient water quality standard, maximum acceptable concentration (水質標準)
- Cnat : natural concentration in the receiving water body (自然界容許濃度)
- Effl : effluent volume (流量)
- Ceffl : concentration of the pollutant in the effluent (濃度)

水足跡計算－生命週期邊界概念

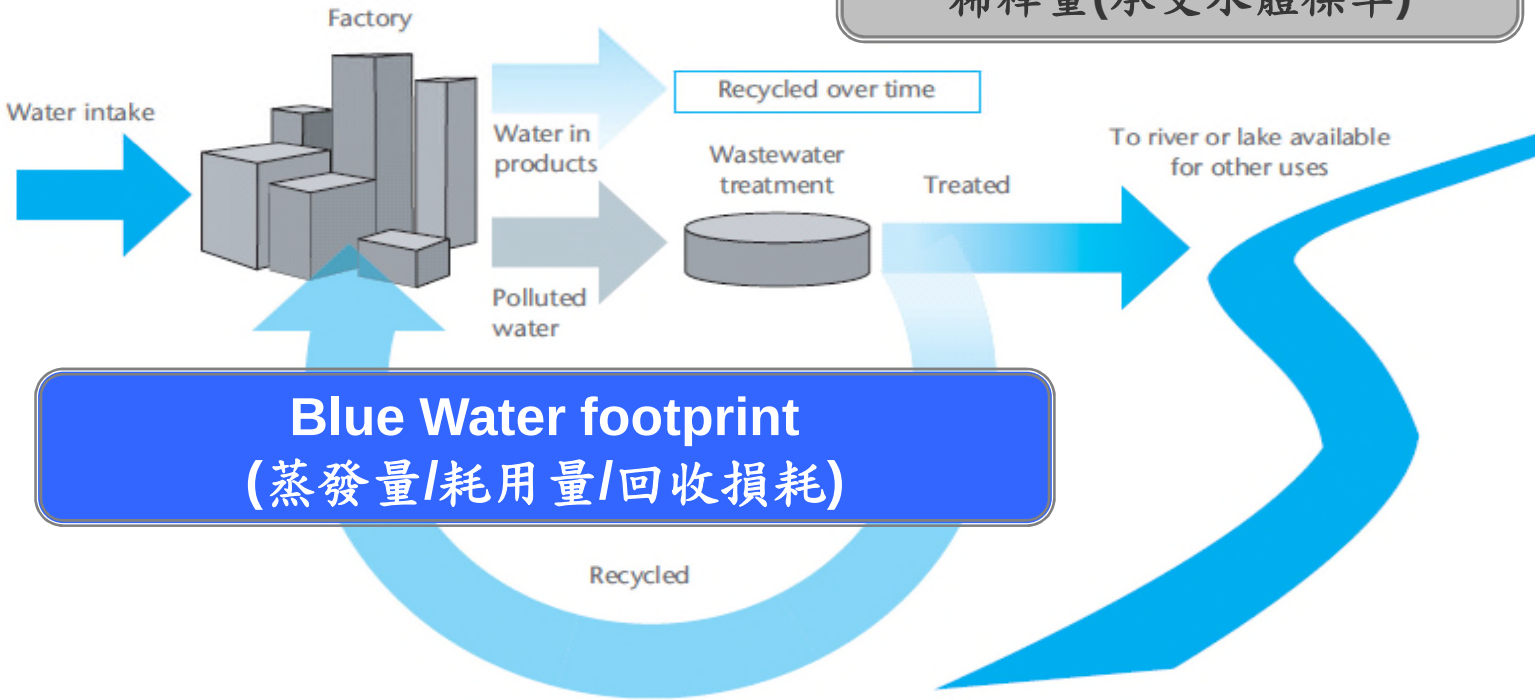
- The water footprint of a product



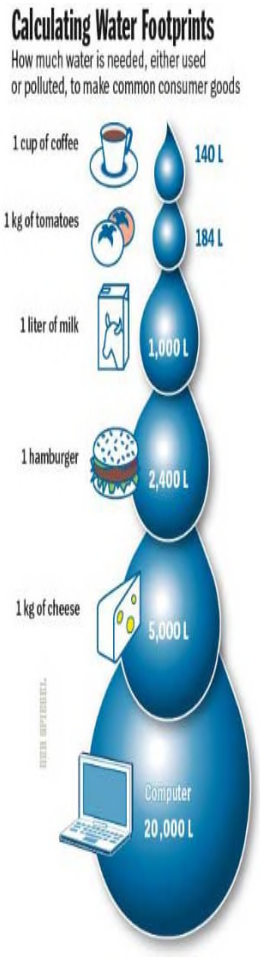
水足跡平衡量化示意圖

Green Water footprint
(蒸發量/耗用量)

Grey Water footprint
稀釋量(承受水體標準)



Blue Water footprint
(蒸發量/耗用量/回收損耗)



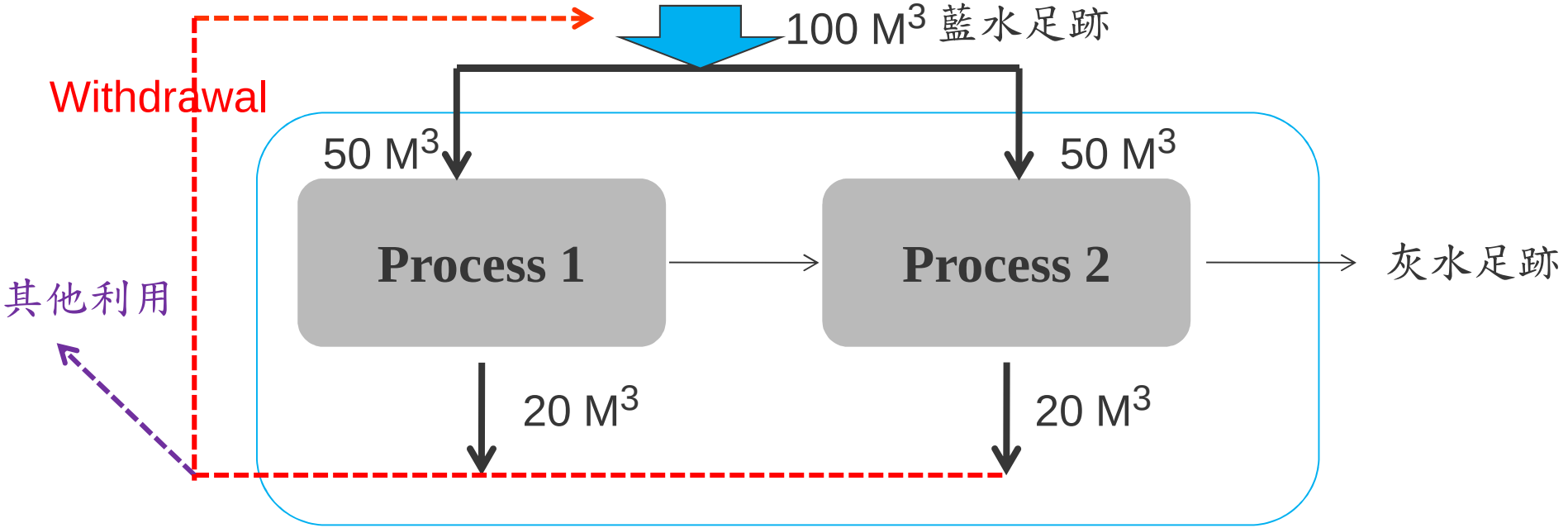
theredmullet.blogspot.com/2009/08/water-footp...

產品層級之水足跡

Definitions	■ The total volume of fresh water that is used directly or indirectly to produce the product. ■ Also Known as Virtual-water content of the product or the product's embedded, embodied, exogenous or shadow water ■ It is estimated by considering water consumption and pollution in all steps of the production chain
Boundary	Schematization of production system into process steps
Product Types	Agricultural Industrial Service sector
Unit to express	m^3/ton,litres/kg (countable agricultural products),m^3/US$ (industrial products), volume/kcal (food products in the context of diets), water volume/joule (electricity or fules), or water volume per piece.

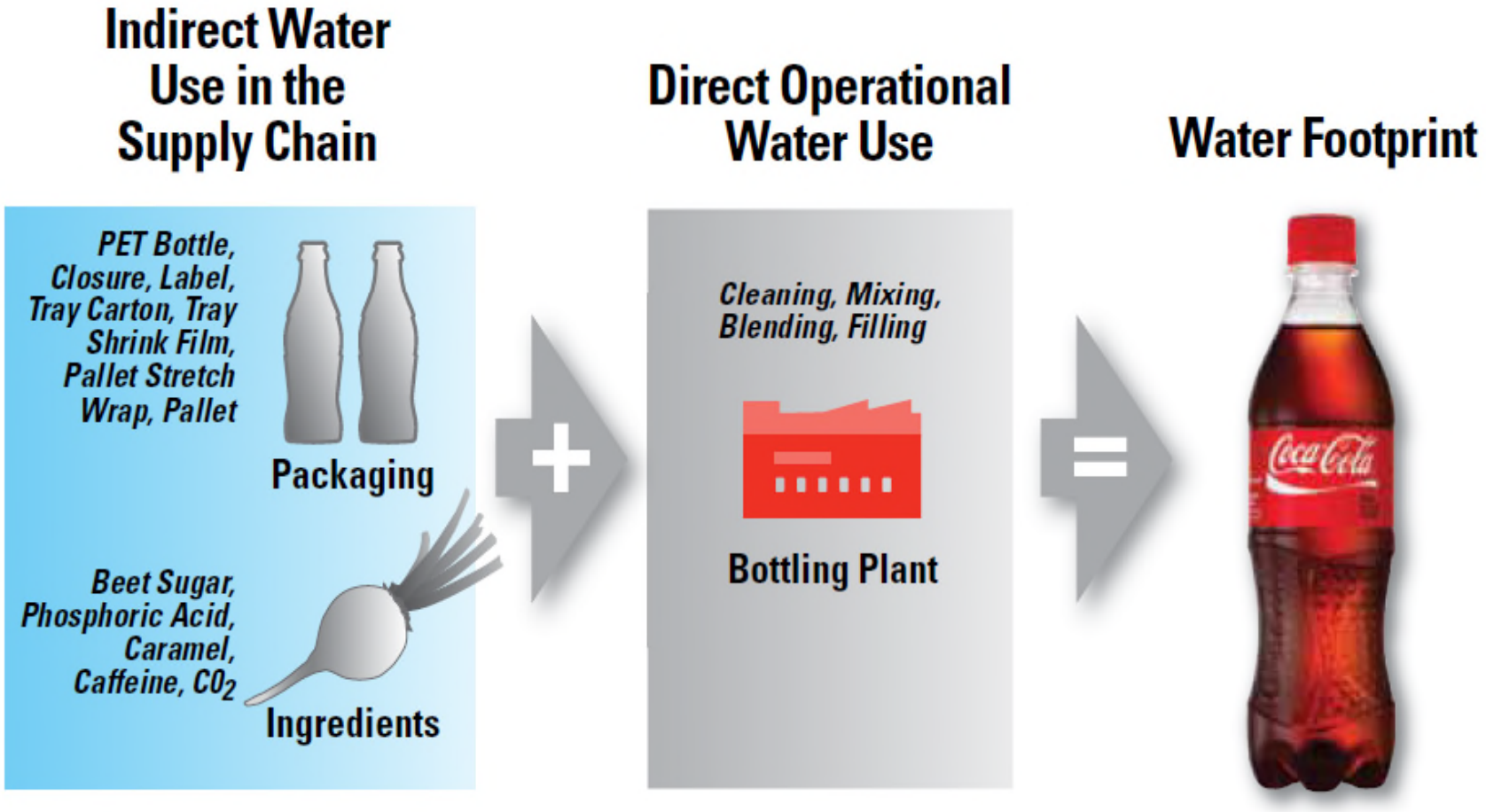
產品層級之水足跡計算概念

- The chain-summation approach (鏈型模擬法)
- The step-wise accumulative approach (分段累進法)
- 不論採用哪一種方法計算, 兩者計算結果應一致
- 延伸思考 →進流水量-排出水量=實際消耗量?



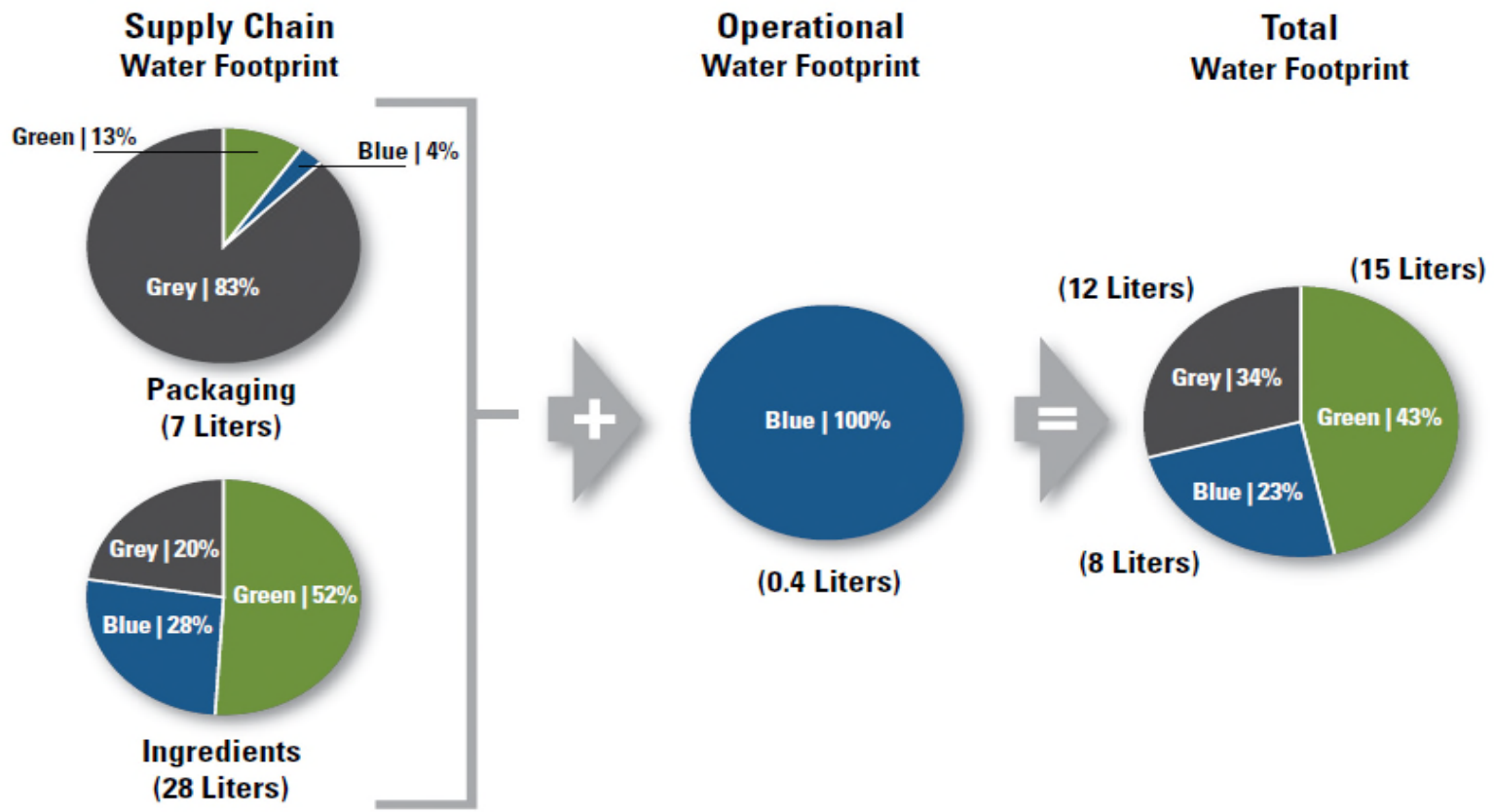
產品水足跡量化案例-可口可樂

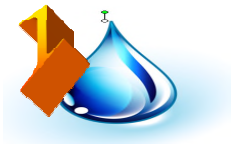
Indirect and Direct Water Footprint Components



水足跡量化案例-可口可樂

Water Footprint of a 0.5 liter of Coca-Cola in Dongen, the Netherlands





水足跡查證流程

SGS 水足跡查證流程

客戶查證需求
Contract review

選擇水足跡揭露範疇

水足跡類型
(產品/消費使用/企業)

水足跡性質
(Green/Blue/Grey)

初始審查
Strategic Review/ Risk Analysis

評估邊界(貢獻度決定)、保證等級、實質性(合理/有限)、水平衡圖、產品功能單位、產品生產流程、供應鏈範疇

標準符合性評估
Compliance Audit

揭露足跡計算規則符合性評估
(WFN-water footprint manual)

現場拜訪/查證
Verification

評估邊界水足跡量化過程及數據查證
數據品質規範、樣本、分配方法學、數據蒐集流程、代表性.etc.

技術審查
Technical Review

發現事項結案提報技術審查 / 查證意見出具

水足跡查證聲明
Water Footprint Statement

自行查證 → 3rd party (第三者查證) → Accredited verification (認證層級查證)

低 → 符合性品質等級 → 高

SGS 查證重點

- **初始審查**
  - 確認水足跡查證系統邊界-製程地圖(包含/排除之說明)
  - 確認水足跡計算方法(一級數據及二級數據引用原則)
  - 包含大於5%貢獻度之水足跡應被納入系統邊界
- **數據查證及抽樣原則**
  - 主要數據來源(各階段水資源耗用情形)
  - 一級數據/二級數據
  - 抽樣比例至少涵蓋70%水足跡耗用量
  - 數據查證應考慮包括用水平衡圖;空間、時間說明以及功能單位水資源耗用量計算之正確性

水足跡建置疑義

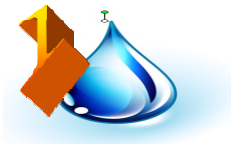
- **產品水足跡系統邊界設定**
  - 如何定義產品生產鏈之流程
  - 是否以生命週期概念考慮間接產生之水足跡
- **藍水足跡計算方法**
  - 藍水足跡的盤查方法
  - 回收水循環利用之途徑
- **灰水計算方法與量化限制**
  - 直接/間接灰水足跡資料來源
  - 直接/間接灰水產生地點及最終承受水體
- **廠內人員對於水足跡議題熟悉度及配合度**
- **數據取得之可行性**

水足跡建置疑義

灰水計算規則

$$WF_{proc,grey} = \frac{L}{c_{max} - c_{nat}} = \frac{Effl \times c_{effl} - Abstr \times c_{act}}{c_{max} - c_{nat}}$$

L	pollutant load (*L*, in mass/time)	污染負荷程度
Cmax	the ambient water quality standard for that pollutant (the maximum acceptable concentration Cmax, in mass/volume)	**承受水體標準最大容許濃度** 依各河川分類水體標準 (甲乙丙丁戊五大類)
Cnat	natural concentration in the receiving water body (C*nat*, in mass/volume).	**承受水體自然濃度** 考量順序: 1. 若有河川監測濃度值，優先使用該監測數值，若監測濃度值＞承受水體濃度, 則Cnat =0 2. 若監測濃度值<承受水體濃度, 則Cnat=監測濃度 3. 若無河川監測濃度值，則可假設Cnat =0 4. Cnat 選擇結果應在報告書中說明



未來查驗證趨勢 – 碳水足跡整合查證及永續水資源管理標準驗證

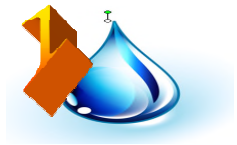
水足跡 vs. 碳足跡

Items	Product Water Footprint	Product Carbon Footprint
時間、空間	spatial and temporal dimension	no spatial / temporal dimension
價值特性	actual, locally specific values	global average values
供應鏈	always referring to full supply-chain	supply-chain included only in ‘scope 3 carbon accounting’
目標	focus on reducing own water footprint (water use units are not interchangeable)	many efforts focused on offsetting (carbon emission units are interchangeable)
方法學	Life cycle assessment	Life cycle assessment

Water footprint and carbon footprint are “complementary” tools.

SGS 產品水足跡與碳足跡整合查證

	碳足跡聲明/協議	水足跡聲明/協議
客戶查證需求 Contract review	設定之標的產品聲明 (PAS/ISO/環保署...)	水足跡類型 (產品/消費使用/企業)
初始審查 Strategic Review/ Risk Analysis	評估邊界(貢獻度決定)、保證等級、實質性(合理/有限)、 水平衡圖、產品功能單位、產品生產流程、供應鏈範疇	
符合性評估 Compliance Audit	PAS 2050:2011 ISO/CD 14067 產品與服務碳足跡查證技術指引	WFN-Water Footprint Assessment Manual
現場拜訪/查證 Verification	評估邊界水足跡量化過程及數據查證數據品質規範 、樣本、分配方法學、數據蒐集流程、代表性.etc.	
技術審查 Technical Review	發現事項結案提報技術審查 / 查證意見出具	
查證聲明 Verification Statement	符合性評估可二者合併/數據查證必須分開進行	



Q&A

THANKS FOR YOUR ATTENTION

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