

# 集水區展望通訊

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編輯小組

## 水資源永續指標體系建立初探 Preliminary Study of Sustainability Indicators for Water Resources

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### 摘要

本文針對國內現存水資源評價工作所涉及大量數據及指標等，探討傳統水資源管理與永續水資源管理的差異，並採用聯合國永續發展委員會 (United Nation Commission on Sustainable Development, CSD) 所建議之驅動力-狀態-回應 (Driving force-State-Response, DSR) 架構收集整理國內外水資源相關指標。為建立水資源永續指標體系，首先利用專家評估的方式通過問卷的發放，對各水資源指標的重要性進行判別及篩選，並將此調查資料透過因子分析 (Factor analysis) 及考慮資料的可行性建立水資源永續指標體系之架構，初步建議水資源永續指標架構分為四層，第一層為目標層；第二層為準則層，包括 4 個準則；第三層為議題層，包括 11 個議題；第四層為指標層，包括 39 個指標。

**Keyword** : Sustainable development, Sustainable water management, Indicators (General)

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水資源指標體系是一個複雜的大系統，如選用單一指標進行評價工作，則較具局限性，故要建立一個各有側重而又相互關聯的綜合反映水資源利用情形的指標體系是必需的。而水資源評價工作因涉及較廣且需大量數據及進行綜合分析後才能對某一地區水資源進行總體評價，指出其優勢或存在之主要問題，一次評價工作，費時耗力，但作為認識與決策常需及時對地區作出整合性、正確的水資源評價，不僅需定量比較，且可明確各地區水資源之可利用程度與存在問題。以下擬就永續指標體系建構方法與步驟，分別討論如下：

#### (一) 指標評選

本研究蒐集了國內外相關資料，並整理國內、外的相關水資源指標計有 146 個之多，並將指標依水資源基本自然與人文情況架構分為七大類：(1) 水文背景資料；(2) 水資源開發利用；(3) 社會經濟；(4) 水資源質與量；(5) 水資源利用效益；(6) 水資源利用現況；(7) 水資源災害等。以上分類方法係基於水資源系統來考量地區水資源的特點與存在問題，以簡化描述水資源系統問題。為進一步配合經濟部水資局所頒佈之現階段水資源政策綱領之 11 項措施：(1) 有效消滅旱澇災害損失；

(2)加速水資源開發與利用；(3)加強水資源調配；(4)推動節約用水；(5)整體規畫治理並有效管理河川；(6)加強地下水管理與保育；(7)加強集水區治理保育與管理；(8)推動水資源科技與發展；(9)加強推動人力培育與愛護水資源教育；(10)修訂水利法及相關法規；(11)健全水利行政管理機關組織與功能，故將所收集指標再據此 11 項措施予以分類。

為明瞭各指標之屬性，本研究採用聯合國永續發展委員會所建議之驅動力 - 狀態 - 回應 (Driving force-State-Response, DSR) 架構建立各指標的屬性。驅動力 (Driving force) 代表該指標會對永續發展有衝擊性的人類活動、過程與形態，這些指標提供一個永續發展的狀態為正面或負面改變的理由；狀態 (State) 為提供在已知時間或空間的永續發展的情況或其可利用定性或定量的方式予以估算；回應 (Response) 指標指示政策選擇與其他永續發展狀態的改變，其指標代表著永續發展狀態回應的改變其可能是立法、規章、經濟手段等，D-S-R 架構關係如圖一所示。

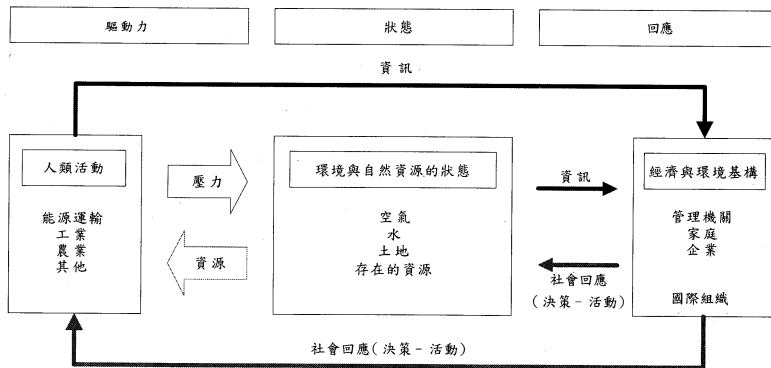
(二) 專家評估

本研究考慮 D-S-R 架構與上述篩選原則及資料可利用程度下先行反覆就此

146 個指標進行篩選工作，初步建議 46 個指標以進一步的篩選工作。為考慮整合各方之意見故再一次經由相關領域專家進一步篩選指標，利用原有之 11 項議題與 46 個指標，並透過專家問卷 (Delphi 法)，在結合產、官、學者間相關領域專家共同參與的方式下進行指標篩選。本研究共發出 92 份問卷給相關領域的機關、民間團體與學校，其中包涵水資源機構主管、工程師、研究員及學者等專業領域的人員，經由 2 個月的發放與回收，共收回 65 份回卷，其中 13 份因為資料填答遺漏，沒有完整地答填資料為無效問卷，真正可供分析問卷資料的有效卷數為 52 份。經由專家問卷刪除了 7 個指標，在第一次專家問卷的結果篩選出 39 個指標作為永續指標架構的初步指標群。

(三) 統計分析

為圖客觀篩選指標及建立指標體系架構，本研究利用 SPSS 統計分析軟體對於 11 個議題與 39 個指標利用因子分析 (Factor analysis) 進行分析，可將 11 個議題經由因子分析得到不同的因子模式矩陣 (Factor pattern matrix) 如表三所示，分析結果顯示可將 11 個議題綜合為 4 個準則，其分別為組織法規、災害防治、水



圖一 D-S-R 指標架構關係圖 (UN, 1997)

資源有效利用與流域經營管理等，故水資源永續指標體系之架構體系初步分為四層，第一層為目標層；第二層為準則層，包括4個準則；第三層為議題層，包括11個議題；第四層為指標層，包括39個指標。

## 結論與建議

### (一) 結論

1. 本研究搜集整理了國內外有關水資源指標與指標體系的建立與篩選原則，初步確立了水資源永續指標體系的篩選原則，以提供未來指標的設計及選擇的依據。
2. 為建立水資源永續指標體系架構，本研究採用驅動力-狀態-回應指標架構，在考量水資源體系之完整性下，探討系統內水資源所受到的驅動力及其對應的回應對水資源狀態的影響，以研擬出水資源永續指標體系架構。
3. 本研究利用專家問卷配合因子分析結果建立了水資源永續指標體系之架構體系，初步建議水資源永續指標架構分為四層，第一層為目標層；第二層為準則層，包括4個準則(組織法規、災害防治、水資源有效利用與流域經營管理)；第三層為議題層，包括11個議題；第四層為指標層，其中包括39個指標。

### (二) 建議

1. 由於水資源永續指標體系架構之建立涉及了社會、經濟與生態環境等複雜因素與國內外之可比性，因此收集的資料愈完整，就愈能建立合理水資源永續指標體系，故日後仍需配合新的資訊與資料不斷地予以修正。
2. 永續指標的所代表之“永續性”，迄今並沒有一致的看法與作法，未來就永續性的定義、選取與水資源指標之間的關聯，希望具有完整性與共同性。

## 參考文獻

1. 何奇峰(1998)，多變量統計在河川水質特性分析之應用，碩士論文，逢甲大學土木及水利工程研究所。
2. 李公哲(1998)，永續指標，環境工程會刊，中華民國環境工程學會，9(4)，24-35。
3. 陳冠榮(1997)，台灣地區環境壓力指標建構之研究，碩士論文，國立台灣大學環境工程學研究所。
4. 游靜秋(1997)，台灣地區環境品質指標建構之研究，碩士論文，國立台灣大學環境工程學研究所。
5. 黃崇益(1998)，河川流域水環境承載容量評量模式之建立，碩士論文，國立中央大學環境工程研究所。
6. 楊益嘉(1997)，區域水資源承载力可靠度分析-以中港流域為域，碩士論文，國立台灣海洋大學河海工程研究所。
7. 盧誌銘等(1995)，全球永續發展的源起與發展，工業技術研究院能源與資源研究所全球資訊網，[http://sd.erl.itri.org.tw/sd\\_sd\\_globe/cont.htm](http://sd.erl.itri.org.tw/sd_sd_globe/cont.htm)(1997/8/25)。
8. DPCSD (1997), Indicators of sustainable development framework and methodologies, Online document, <http://www.un.org/dpcsd/dsd/indi8.htm>(1998/12/17)。
9. SDI Group (1997), Sustainable development indicators, Online document, <http://www.hq.nasa.gov/iwgsdi/welcome.html>(1998/8/18)。



Sustainable Water Resource

## Top 10 Watershed Lessons Learned

### 集水區管理首要十課 -- 美國環保署網際網路資訊介紹

<http://www.epa.gov/owow/watershed/lessons/toc.html>

#### 編輯小組

這個首頁是由美國環保署製作，將過去多年來美國各地發展集水區民眾參與活動的經驗彙整，成為10項首要的學習目標。在每一個課題中，提出清楚的目標與內涵，並輔以若干地方實例，使有志從事集水區保育民眾參與活動的人們，能獲得重要的參考。本刊編輯小組特將網站上重要訊息摘要於下，並將重要標題均附上中文翻譯，以響讀者。更詳細的訊息請參考所附之網站地址。

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#### **Lesson One: The Best Plans Have Clear Visions, Goals, and Action Items**

##### 第一課 最佳的計畫要有清楚的願景、目標與行動方案

Clear visions help watershed groups understand, relate to, and support protection and restoration efforts. And, when framed well, they can also help the general public, elected officials, business, the press, and community leaders understand.

In addition to visions, groups usually develop goals, objectives, and action items. The difference among them is explained below.

- A. Visions - general statements of where the effort wants to go and what it will accomplish over a given time span (usually 5 to 10+ years). Visions should be comprehensive enough to capture the thrust of the effort's overall mission.
- B. Goals - less general than visions, describe what is needed to obtain vision, refer to components of overall effort, sometimes quantifiable.
- C. Objectives - elaboration of goals, describe types of management or activities and are quantifiable where possible.
- D. Action Items - explain who is going to do what, where, and when; they generally articulate how to implement the objectives and should be quantified if possible; benchmarks of existing conditions and/or indicators should be developed for action items.

Many watershed groups go through a facilitated workshop process in which they develop their statements. A facilitator, as a neutral party, can help people reach consensus and avoid getting bogged down in arguing among interests. It is important not to quibble over whether a particular statement becomes a goal or an objective.

## **Lesson Two: Good Leaders are Committed and Empower Others**

### **第二課 好的領導者應能促使大眾有意願並有能力投入**

As for common characteristics of successful watershed leaders, they tend to reflect the values of the community and to know what works there. They generally are good communicators, have the ability to bring about change and set things in motion, and are committed to making their (or a group's) vision a reality. They also tend to know how to engage, respect, and empower others and are able to find new or leverage existing resources.

Because leadership is so important, many seek to encourage and nurture it. Some states offer grants to budding watershed associations. Several nonprofits maintain lists of watershed leaders who are willing to talk to others about their success. Other groups offer training and leadership workshops.

## **Lesson Three: Having a Coordinator at the Watershed Level is desirable**

### **第三課 儘量在集水區內尋求合作者**

Having a coordinator based within the watershed is important because it provides a focal point for the watershed effort and helps to ensure that someone is paying attention to moving group activities along. The coordinator's role generally includes maintaining contact with members of the watershed group; performing liaison with interested parties beyond the group; celebrating success; calling, facilitating, and summarizing meetings; helping to secure funding and training; and ensuring that watershed plans are developed, implemented, and effective in achieving the desired outcomes.

A coordinator may be a volunteer or a part-time or full-time paid staff person. He or she may be housed in government offices, a non-profit organization, or out of someone's basement. In general, they should be from a group that is trusted and that has the power to make a difference. The ideal coordinator is one who can commit to spending enough time to really make a difference. As for funds, many groups have been creative in establishing multiple funding sources to support watershed coordinators.

## **Lesson Four: Environmental, Economic, and Social Values are Compatible**

### **第四課 環境、經濟與社會是可以兼顧的**

Too often in the past, environmental and economic and social issues have polarized people, making it impossible to achieve a common vision of sustainability. For the watershed approach to become a reality, there must be widespread recognition in the community that people and nature can coexist within the watershed. This can pave the way for partnerships of diverse interests to form around a sustainable vision.

### **Lesson Five: Plans Only Succeed if Implemented**

#### 第五課 唯有行動方能成功

Plans are essential in that they represent the consensus achieved among watershed stakeholders. Typical components of a plan include: vision, goals, action items, and time frame (see Watershed Lesson 1). Time frames for plans typically range from 5 to 20 years. The best plans allow for the incorporation of new information, reflect the needs of the watershed, and have the commitment of the community behind them.

The greatest challenge associated with watershed planning is to ensure that the recommendations called for within a plan are implemented and that the plan does not sit on a shelf gathering dust in some office. A key element in implementing a plan is charging an individual or organization with the responsibility to follow through and work with key constituencies to take the actions laid out in the plan (see Watershed Lesson 3). It is also important to break things down to a manageable scale. This often involves a "nested approach" in which broad goals are set for large watersheds but subwatersheds are used to implement and achieve those goals.

### **Lesson Six: Partnerships Equal Power**

#### 第六課 參與者的通力合作

Watershed partnerships come in all shapes and sizes, with each partner having a different interest. Some partnerships are loosely structured, while others are quite formal. Some groups are open, while others are closed. Regardless of how they are structured, making partnerships work is challenging and takes commitment. Common issues that partnerships face include selecting a leader, ensuring that all the right people are involved, and moving beyond any hostility that may exist among members. If a group is able to develop esprit de corps, they can be quite effective. To get past the "forming and storming stages," some groups have set ground rules under which individuals can complain for only a certain amount of time, after which they must move on. Some groups have decided to say that issues that are too divisive are not to be discussed.

Partners can include any one who has an interest in the watershed. This ranges from conservation groups, local elected officials, chambers of commerce, environmental education organizations, local military bases, farm groups, students, senior citizen and religious organizations, financial groups, credit unions, and land developers, among others. The important thing is to include all the key interest groups so that you can tap into their strengths, increase your credibility, reduce duplication of effort, and make optimal use of limited funds.

In terms of lessons learned, experienced watershed practitioners say that one-on-one contact is most effective in eliciting support. Further, building partnerships takes time and

commitment, and once built they need to be nurtured. However, their benefits are clear as they can lead to wider acceptance and quicker implementation of projects.

### **Lesson Seven: Good Tools Are Available**

#### *第七課 採用適當的工具*

Good tools are essential to the success of the watershed approach. Tools are broadly defined to include geographic information systems, "how to" guides, funding sources, regulations (when appropriate), and monitoring and modeling programs. The sources of funds and technical assistance vary widely, from corporate, government, to nonprofit organizations.

In many watersheds, technical advisors are critical to the effort as watershed residents need a sound, scientifically-based understanding of the resource in order to make good decisions. Some studies suggest that one of the biggest challenges for watershed groups is securing funding. Many states have special funds to support watershed groups, but using creativity in finding other sources is always needed. GIS maps have been very helpful to watershed efforts and have served to educate constituency groups such as town councils and landowners. Fortunately, many tools are available to assist watershed groups.

### **Lesson Eight: Measure, Communicate, and Account for Progress**

#### *第八課 評估、溝通並說明行動的進展*

Having systems in place to measure and communicate progress is a critical part of watershed work. Appropriate measures not only keep watershed issues on people's radar screens, but, as they are met, allow stakeholders to share successes and to highlight new challenges to the watershed.

Progress can be measured in many ways and communicated through meetings, brochures, internet sites, annual reports, news releases, and other ways. The important thing is to make sure that the appropriate measures of progress (often referred to as indicators) are selected and that information on these indicators is shared with relevant stakeholders. Measurements of progress should be associated with achieving goals set for the watershed effort (see Watershed Lesson #1). Depending on the goal, groups may choose water quality measurements (e.g., dissolved oxygen, bacteria levels, fecal coliform) or less directly water-quality based results (e.g., number of trees planted, number of watershed groups in a state, pounds of trash collected, number of canoe rentals, number of miles protected from erosion). To make sure that progress does indeed occur, most watershed groups spell out who is responsible for what in their watershed plans. Some go so far as to establish agreements that commit groups to certain actions within certain time frames. Spelling this out can help with accountability.



## **Lesson Nine: Education and Involvement Drive Action**

### **第九課 教育與參與是行動的驅動力**

When it comes to creating awareness in the general public, watershed coordinators have used many different mechanisms, including highway signs, bumper stickers, billboards, awards, field trips, newsletters, and newspaper inserts as well as cutting edge approaches such as the internet. A large number of people have also been reached through public service announcements, license plates, storm drain stenciling, peer to peer communication, and community events.

Educating a community for the purpose of stimulating voluntary action means targeting groups from all walks of life: farmers, businessmen, school children and teachers, local government officials, homeowners, and the like. Well designed education programs can lead to tangible results, especially when they get participants out in the field, are delivered in an effective way, and encourage action and reflection. Some local watershed groups have had a lot of success in awarding small contracts to key constituency groups under which they themselves are charged with carrying out education programs. Such programs have been quite effective in encouraging the voluntary adoption of best management practices.

Watershed practitioners have learned that who delivers the information is important, as well. In general, peer to peer communication or communication by a neutral source is best. Community members, such as students, are often better received than a government official.

## **Lesson Ten: Build on Small Successes**

### **第十課 聚沙成塔，由小小的成功開始**

Small successes fuel future, larger ones. It is important, according to watershed practitioners, to start small and demonstrate success before working on a larger scale. For this reason demonstration projects are often a popular choice in watershed work. In some states, small victories have been instrumental in prompting the implementation of the watershed approach statewide.

Commitment to the watershed is key, and a small group's passion for its improvement can catch fire. Practitioners also say over and over that it's important to "Celebrate Success" as it occurs.



## 網站連結

為提供更多的諮詢管道，並隨時保持與現今活動的密切聯繫，前述網站亦整理其他有關集水區管理的網際資訊，使資訊交流更為便捷。

有心的讀者，不妨按圖索驥，瞭解一下國外各地推動的狀況與經驗，使台灣的集水區民眾參與的推動，有事半功倍的發展！

**Adopt-A-Watershed:**

<http://www.tcoe.trinity.k12.ca.us/aaw/adopt.html>

**American Rivers:**

<http://www.amrivers.org/>

**Anacostia Watershed Society:**

<http://www.gmu.edu/bios/anacosti/aws/>

**Center for Excellence for Sustainable Development:**

<http://www.sustainable.doe.gov/index.html>

**Center for Watershed Protection:**

<http://www.pipeline.com/~mrrunoff/>

**Chesapeake Bay:**

<http://www.epa.gov/r3chespk/>

**EPA:**

<http://www.epa.gov/owow>

**Farm-A-Syst:**

<http://www.wisc.edu/farmasyst>

**Freshwater Imperative:**

<http://www.islandpress.com/books/bookdata/FWimp.html>

**GREEN:**

<http://www.econet.apc.org/green/>

**Groundwater Foundation:**

<http://www.groundwater.org>

**Izaak Walton League:**

<http://www.iwla.org>

**Know Your Watershed:**

<http://ctic.purdue.edu/KYW/KYW.html>

**National Fish and Wildlife Organization:**

<http://www.nfwf.org>

**The Nature Conservancy:**

<http://www.tnc.org>

**Planners Web:**

<http://www.planning.org/books/bookstor.html>

**Project WET:**

<http://www.montana.edu:80/wwwwet/>

**River Network:**

<http://www.teleport.com/~rivernet/rivernet/leader2.htm>

**Surf Your Watershed:**

<http://www.epa.gov/surf>

**Terrene Institute:**

<http://www.terrene.org/cfaward.htm>

**University of Connecticut:**

<http://www.lib.uconn.edu/CANR/ces/Nemo/>

**University of Wisconsin:**

<http://www.uwex.edu/erc>

**Water Environment Federation:**

<http://www.wef.org/wwwboard/watershed/wwwboard.html>

**Watershed '96 On-Line Proceedings:**

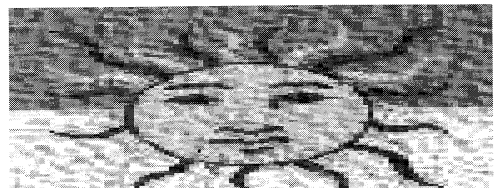
<http://www.epa.gov/OWOW/watershed/Proceed/>

**Western Governor's Association:**

<http://www.westgov.org>

**Wildlife Habitat Council:**

<http://www.wildlifehc.org/index.html>



**WATERSHED 2000**

Vancouver, British Columbia, Canada, 9-12 July 2000

ABSTRACT SUBMITTAL DEADLINE: 15 NOVEMBER 1999

The Water Environment Federation (WEF), the British Columbia Water and Waste Association, and the Western Canada Water and Wastewater Association are sponsoring the international specialty conference WATERSHED 2000, with the support of the International Joint Commission; the U.S. Environmental Protection Agency; Environment Canada; Fisheries and Oceans Canada; the British Columbia Ministry of Environment, Lands and Parks; and the British Columbia Ministry of Forests.

WATERSHED 2000-to be held in the Pacific Northwest-will explore national and international challenges of managing watersheds. The conference will bring together environmental professionals for a showcase on integrated resource management and environmental protection principles using watershed-based approaches.

Topics to be addressed include:

- A.**Sustainable Watershed Protection ; **B.**Multi-Use Watershed Management-Approaches and Steps ; **C.**Voluntary versus Mandatory Approaches ; **D.**Local, Regional, National, and International Jurisdictional Issues ; **E.**Total Maximum Daily Loads and Watershed Pollutant Load Trading ; **F.**Watershed Restoration Activities and Habitat Improvements ; **G.**Effectiveness of Best Management Practices (BMPs) ; **H.**Regulatory, Legislative, and Institutional Issues ; **I.**Forestry, Agricultural, and Mining BMPs and Issues ; **J.**Managing Watersheds to Support Fisheries ; **K.**Coastal and Wetland Issues ; **L.**Water Resource Planning and Source Water Protection ; **M.**Urban Watershed Issues ; **N.**Land Management-Public and Private ; **O.**Geographic Information Systems, Modeling, and Monitoring ; **P.**Use of Environmental Indicators and Standards ; **Q.**Public Education and Stakeholder Involvement ; **R.**Financing BMPs and Watershed Programs ; **S.**Risk-Based Watershed Management Strategies ; **T.**Creative Watershed Programs-Case Studies ; **U.**Balancing Environmental and Economic Issues.

Please submit abstracts for papers on subjects A-U. Deadline is 15 NOVEMBER 1999. Authors will be notified of acceptance of papers in early JANUARY 2000 and must submit a manuscript by 27 MARCH 2000 for inclusion in the Conference Proceedings. For each proposed paper, please submit one copy of both an information sheet (over) and a typed abstract (two pages, single spaced).

For registration information, please provide your complete mailing address to WEF's Member Services Center (Phone: 800.666.0206 or 703.684.2452, E-mail: msc@wef.org).

