行政院及所屬各機關出國報告
（出國類別：出席國際會議）

出席「二十一世紀土壤沖蝕研究國際研討會」報告書

服務機關：國立屏東科技大學
出國人職　稱：教授
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出國地區：美國夏威夷州
出國期間：90.1.2－90.1.7
報告日期：90.1.20

目次

一、目的：

本次出席「二十一世紀土壤沖蝕研究國際研討會」之目的有二：其一為發表研究論文兩篇，其二為主持並擔任本次國際研討會中「土壤沖蝕量化」委員討論會（panel discussion）及該委員會主席（panel chair）。發表論文共計兩篇，題目分別為「Effect of slope steepness on soil loss for steep slopes （坡度因子對陡坡地土壤流失量之影響）」及「Surface-cover subfactor for gravel-rich surfaces(礫石地之地表敷蓋次因子）」。此次出國參加並主持國際學術研討會，承蒙教育部給予補助，甚感榮幸，核定補助文號：台(89)文(二)八九一四四二八三號。

二、過程：

- 90.1.2.– 啟程前往美國夏威夷。

- 90.1.2. – 抵達美國夏威夷會議地點、辦理報到並參加會前委員會協調會議。委員協調會議的主要目的，在對於即將召開的國際研討會各組工作做進一步的確認，同時，協調各委員討論會的中心議題與執行方式。

- 90.1.3. –「二十一世紀土壤沖蝕研究國際研討會」於上午 8:00 開幕，本次國際會議與會人數達 217 人，分別來自世界十個國家。開幕式中安排三位專家進行專題演講，其演講的重點針對目前風蝕研究與模擬、水蝕研究與模擬及土壤沖蝕量化等三大主題，提出土壤沖蝕研究在二十一世紀中仍需要努力的方向。

  本次國際會議由美國農業工程學會（American Society of Agricul-tural Engineers; ASAE）主辦，協辦單位則包括有中華水土保持學會（Chinese Soil & Water Conservation Society; CSWCS, TAIWAN）、行政院農業委員會（Council of Agriculture; COA, TAIWAN）、美國農藝學會（American Society of Agronomy; ASA）、歐洲水土保持學會（European Society of Soil Conservation; ESSC）、國際土壤沖蝕控制協會（International Erosion Control Association; IECA）、國際土壤科學聯盟（International Union of Soil Science; IUSS）、美國土壤科學學會（Soil Science Society of America; SSSA）、水土保持學會（Soil & Water Conservation Society; SWCS）、美國農業部農業研究署（USDA-ARS）、美國農業部合作研究教育推廣署（USDA-CSREES）、美國農業部林業署

（USDA-FS）、美國農業部自然資源保育署（USDA-NRCS）及世界水土保持協會（World Association of Soil & Water Conservation; WASWC）。

本次國際土壤沖蝕研究研討會的進行方式，乃是採分組討論分不同場地同步進行。與會人士可依其興趣與所需，自由穿梭於會場間。分組討論的議題包括：土壤沖蝕機制之試驗研究（Experimental soil erosion process research）、土壤沖蝕控制技術（Erosion control practices）、土壤沖蝕之場內場外衝擊（On-site and off-site impacts of soil erosion）、氣候水文及土壤沖蝕機制之模擬（Modeling of climatic, hydrologic, and soil erosion processes）、土壤沖蝕模式於農業與非農業用地之應用（Applications of soil erosion models to agricultural and non-agricultural lands）、土壤沖蝕研究之量測技術（Measurement techniques in soil erosion research）、水蝕研究（Water erosion research）、風蝕研究（Wind erosion research）及泥砂輸送模擬（Sediment transport modeling）等。

- 90.1.3. – 發表第一篇研究論文「Effect of slope steepness on soil loss for steep slopes （坡度因子對陡坡地土壤流失量之影響）」，論文文稿如本報告之附件一。

  參加當天晚間自 7:00 開始至 10:00 結束的非正式討論會（informal rap session）。該討論會的目的在交換不同國家在土壤沖蝕研究上所遭遇的問題，同時並對目前土壤流失量估算技術的推廣與教育經驗，進行相互交談。

- 90.1.4. – 上午主持委員討論會（panel discussion）。本委員討論會的討論議題為「土壤沖蝕的量化（Quantification of soil erosion by wind and water）」。參與本組討論會的與會人士共計 75 人，其專長包含有風蝕研究、水蝕研究、輸砂研究、社會經濟學研究、生態學研究及工程顧問公司等具有現場實務或研究經驗之專家與學者。

  本次國際會議籌備委員會，為了整合國際土壤沖蝕研究的人力資源，特別安排三個委員討論會，分別為風蝕之機制、模擬與控制（Erosion by wind : processes, modeling and control），水蝕之機制、模擬與控制（Erosion by water : processes, modeling and control）及土壤沖蝕的量化（Quantification of soil erosion by wind and water）。委員討論會的主要目的在檢討目前土壤沖蝕研究及土壤流

失量估算模擬技術上的缺失，並提出今後應努力的方向及土壤沖蝕研究在二十一世紀未來十年內的工作重點。

- 90.1.4. – 上午 11:00 發表第二篇研究論文「Surface-cover subfactor for gravel-rich surfaces（礫石地之地表敷蓋次因子）」，論文文稿如本報告之附件二。下午參加本次國際研討會特別安排的野外參觀活動。參觀之重點包括：夏威夷熱帶土壤的多樣性分佈、多元化農業轉型所產生土壤沖蝕問題對環境的影響、珍珠港流域非點源污染對臨海的影響、高度風化土壤之沖蝕研究、非點源污染防治對水質提昇之成效、修正版通用土壤流失公式（Revised Universal Soil-Loss Equation; RUSLE）中作物與管理因子之研究、示範集水區水土保持計畫等。

- 90.1.5. – 上午指導並參與委員討論會分組討論之進行。本委員討論會經過 90.1.4.上午集體討論之決議，將中心議題「土壤沖蝕的量化」分成六個子題，於今天上午利用一個半小時的時間進行分組討論。六個子題包括：(1).國際土壤沖蝕研究網及研究資料庫的建立，(2).成立跨領域研究群對土壤沖蝕複雜機制中數個極具爭議的機制進行深入研究，(3).土壤沖蝕研究監測與量測技術的改進，(4).土壤沖蝕機制之時空變異特性量化，(5).過去國際間所累積土壤沖蝕研究資料之再評估，及(6).土壤沖蝕控制方法對社會經濟層面影響之量化等。

  上午 10:00 至 12:00，主持並整合本委員討論會分組討論之各方意見，以做為閉幕式中大會對土壤沖蝕研究於二十一世紀中應努力方向策劃行動方案之參考。

  下午 1:50 至 3:40，參與大會籌備委員會之會議，並提報委員會議之整合意見，共同研擬二十一世紀國際土壤沖蝕研究之重要行動方案。下午 4:00，參與大會閉幕式，並於閉幕式中提報委員會議之整合意見，本次國際會議於下午 5:30 順利閉幕。

- 90.1.6. – 會議結束，準備返程。
- 90.1.7. – 返回台灣。

三、心得：

本次研討會的發起，乃來自於個人於 1998 年國際農業工程年會之提議，認為有必要召開一次國際專題研討會，為土壤沖蝕研究邁入二十一世紀規劃出重要的十年方案，同時亦可履行 1995 年美國農業部自然資源保育署（USDA-NRCS）與我國行政院農業委員會（COA）

所簽署「中美雙邊水土保持技術交流備忘錄」中的協定。在美國農業工程學會（ASAE）、中華水土保持學會（CSWCS）、行政院農業委員會（COA）及其他共計 11 個國際學術與官方組織的共同支持下，本次國際研討會得以順利於 2001 年初於夏威夷召開。

本次出席「二十一世紀土壤沖蝕研究國際研討會」之目的，除發表研究論文兩篇外，更主持並擔任本次國際研討會中「土壤沖蝕量化」委員討論會及該委員會主席。就論文發表而言，個人以三年的研究成果，提出與現行土壤沖蝕機制觀念相違的實測證明，獲得與會專家的注意，更進一步點出目前土壤沖蝕研究方法上的錯誤。

就擔任並主持會議中的「土壤沖蝕量化」委員主席及委員討論會的成效而言，除於會前協助籌備本次國際研討會外，更於會中順利整合目前國際土壤沖蝕研究及量化上的重要疑點及缺失，為本次國際研討會勾畫出土壤沖蝕研究邁入新世紀的努力方向。本次國際研討會各委員討論會之決議，已於會後進行彙整，預計於 2001 年三月中旬完成意見整合，未來將提供做為全球暨本次國際研討會主、協辦單位，推動土壤沖蝕研究策略之參考依據。

就土壤沖蝕研究議題而言，本次會議的議題重點放在土壤沖蝕機制之研究，其中包含風蝕之機制、水蝕之機制、風蝕量之估算、水蝕量之估算及沖蝕控制技術等。土壤沖蝕的研究在國際學術研究的舞台上，已歷經相當長的時間，這些研究經驗與知識的累積，帶動了土壤流失量預測模式的發展。再藉由電腦演算能力的進步，使得土壤流失量預測模式，由先前的經驗公式或半經驗公式，進步到現在的模組化物理機制模式。雖然如此，模組化物理機制模式仍然需要現場實驗的配合，才能夠在電腦協助下，預測土壤的流失量。然而，現場實驗是需要時間的，實驗的成果往往沒有辦法趕上電腦數值模擬的步調，以至於部份電腦數值模擬模式，開始採用外插的方式，將數值模擬的適用範圍強迫推展到現場實驗的範圍之外。大膽外插的結果，往往造成預測的數值過大或過小，甚至完全模擬與現場相違的物理現象。如果姑且不談數值模擬的精確度，數值模擬無限度外插的最大後果，可能造成研究人員對物理現象的誤解，最後以訛傳訛，將研究的方向帶入錯誤的死胡同。

本次土壤沖蝕研究國際研討會各組討論的重點，不外乎對於現行模組式土壤流失量估算模式的精確度與實用性提出質疑；其中又以各模組中所謂的物理機制是否真實描述自然現象，及模組化電腦模式缺乏實用性為主要的討論及爭議焦點。目前學術研究單位在研究土壤沖

蝕現象上，其研究的主題大多有越來越細膩的現象。學術研究本應越研究越深入，但土壤沖蝕原屬自然現象，其中所涉及的變數甚多。過度精緻的研究課題，已造成研究參數的制定遠離現實；換句話說，目前土壤沖蝕研究已出現試驗室內營造出現實環境中無法實現的虛擬世界。如此的結果，使得目前土壤流失量估算模式變得過度複雜，所需的基本資料輸入量過細過多，使用者往往落於無基本資料可資使用，而土壤流失量估算的結果卻又不合理的超估。這種現象不僅充斥於土壤沖蝕研究的國際舞台，更是目前台灣在土壤沖蝕研究與土壤流失量估算上所遭遇的問題。

另一個值得國內土壤沖蝕研究群深思的議題，在於跨專業的合作。所謂的跨專業的合作，包含氣象、水文、地質、水利、土壤、農工、農藝、水土保持、輸砂、社會經濟等。本次國際土壤沖蝕研究研討會已注意到，若要提昇目前土壤沖蝕研究及土壤流失量估算的水準，不能再以單一的農業工程領域為主導，而必須結合水利與輸砂專長的專家，才能較正確地描述地表逕流水的水理及輸砂特性。再者，目前的土壤流失量估算模式大多未考慮不同水土保持處理所造成社會經濟的衝擊，以至於研究所得的水土保持處理往往面臨耗資或所需人力過高而無法推廣的窘境。國內也有類似的狀況，實在值得注意。

加速研究成果及資源的國際網路化（international networking），是此次與會的另一個心得與議題，其目的在減少人力與財力的浪費，更可強化國際間相同研究領域人員的集體合作。因此建議相關部會考慮以研究群的方式，打破國際、校際與研究機關的界線，讓台灣的研究成果早日整合並推向國際舞台。其次，土壤沖蝕的田間試驗（field experiments）及基礎研究資料庫的建立與共享，為本次國際土壤沖蝕研究研討會的重要共識。國內雖有較為優渥的研究資源，但資源的分配往往出現目標或任務導向，缺乏長時間觀測的遠見，使得原先辛苦建立的田間試驗區或長時間積極觀測的重要資料等，流於被迫停擺的命運。在台灣特殊地形、地質與水文條件下所觀測或研究的土壤沖蝕成果，應持續給予經費支援，好讓國內過去及未來的土壤沖蝕研究成果，得以共享甚至貢獻予全世界。

四、建議：

本次應邀參加「二十一世紀土壤沖蝕研究國際研討會」的會後建議條列如下，如有需要進一步瞭解之處，請參考本報告的「三、與會心得」部份。

1. 目前學術研究單位在研究土壤沖蝕現象上，其研究的主題大多有越來越細膩的現象。過度精緻的研究課題，已造成研究參數的制定遠離現實；換句話說，目前土壤沖蝕研究已出現試驗室內營造出現實環境中無法實現的虛擬世界。這種現象不僅充斥於土壤沖蝕研究的國際舞台，更是目前台灣在土壤沖蝕研究與土壤流失量估算上所遭遇的問題。建議　貴部繼續維持對國內專家學者出席國際會議的補助：尤其是參加自然科學相關的國際會議，除增加我國在國際學術舞台的曝光率與知名度外，更可讓國內專家學者增廣見聞，跟隨甚至領導國際學術研究的腳步。

2. 建議相關部會考慮以研究群的方式，打破國際、校際與研究機關的界線，讓台灣的研究成果早日整合並推向國際舞台。同時，建議貴部彙同相關部會整合國內各個學術研究群的研究成果，建立網際網路中英文網頁，以便利國內外資料及研究成果的交換，並藉此建立國內研究成果在國際舞台的知名度。

3. 土壤沖蝕的應用及基礎研究，往往較其他學門需要較長的時間方能得到高品質的成果。國內雖有較為優渥的研究資源，但資源的分配往往呈現目標或任務導向，缺乏長時間觀測的遠見，使得原先辛苦建立的田間試驗區或長時間觀測的重要資料，流於被迫停擺的命運。在台灣特殊地形、地質與水文條件下所觀測或研究的土壤沖蝕成果，建議　貴部與相關部會應持續給予經費支援，好讓國內過去及未來的土壤沖蝕研究成果，得以共享甚至貢獻予全世界。

4. 建議　貴部鼓勵受補助出席國際會議的學者專家，於與會期間主動參與、爭取或協助國際學術研討會的舉辦，並於適當時機給於行政或經費上的協助。

附　　錄

SYMPOSIUM STATEMENT

Draft 19 February, 2001 -- 8

Soil Erosion Research for the 21st Century

Honolulu, Hawaii; 3-5 January, 2001

At a symposium held in Honolulu, Hawaii on 3-5 January, 2001, sponsored by ASAE and the thirteen professional societies and agencies listed below[1], 210 researchers and field practitioners from 30 countries met to discuss the state of soil erosion research and to establish a vision to guide this research for the next 5-20 years.

It is the considered consensus of this group that:

1) Erosion and delivery of soil by wind, water, and physical disturbance are significant threats to the Earth's soil, air, and water resources. These phenomena reduce land productivity, complicate sustainable land use, and directly impact soil, air, and water quality. They also degrade environmental quality indirectly through the impact of deposited sediments, movement of other contaminants with the sediment, and influences on the global carbon cycle and climate change. Those impacts greatly affect human life and may even threaten survival in developing nations, as well as reducing the quality of life and economic well-being in all nations.

2) Research into erosion and delivery of soil must be a high priority in order to better define these impacts and their potential consequences, and to develop better control methods.

3) Soil erosion research must rapidly evolve and develop improved strategies to respond to the new and increasing demands for erosion assessment and for resource conservation, such as an increased need for information on offsite impacts.

4) There must be an effort to increase the awareness of policy makers and the general public of the impact of erosion and sediment transport on overall environmental quality, and of the importance of continued support for efforts to assess those impacts and to protect the environment.

5) Substantial progress has been made over the past 50 years in understanding erosion and sediment transport and their impact on the environment. This understanding has led to the development and adoption of a wide variety of erosion control practices, but problems caused by erosion and sediment continue and much remains to be done. Increased awareness of erosion impacts on air and water quality and on global climate change raises new challenges for erosion researchers.

The Symposium participants discussed the issues and challenges facing erosion researchers over the next 5-20 years in three general areas: Wind Erosion, Water Erosion, and Quantification of Erosion. A brief listing of the issues and suggested tasks in addressing

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[1] Co-sponsors were: American Society of Agronomy (ASA), Chinese Soil and Water Conservation Society (CSWCS) Taiwan, Council of Agriculture (COA) Taiwan, European Society for Soil Conservation (ESSC), International Erosion Control Association (IECA), International Union of Soil Sciences (IUSS), Soil Science Society of America (SSSA), Soil and Water Conservation Society (SWCS), USDA-Agricultural Research Service (ARS), USDA-Cooperative State Research, Education, and Extension Service (CSREES), USDA-Forest Service (FS), USDA-Natural Resource Conservation Service (NRCS), and World Association of Soil and Water Conservation (WASWC)

each are included below. The issues and responses most frequently raised were:

1) Long-term and large-scale coordinated erosion monitoring and broad data collection is critical, since it allows researchers to better ascertain the impacts of land management policies and practices on erosion, delivery, and the resulting degradation of soil, air, and water resources. These efforts must more fully reflect the impacts of spatial and temporal variability, of topographic complexity, and of spatial scale on erosion and delivery.

2) We need more interdisciplinary efforts in developing erosion prediction and control technology, and for ensuring better adoption of those technologies at the local level. Land managers and end users must be more involved in the entire process in order to increase the rate of adoption.

3) We need to do a better job of collecting erosion data in a more organized and useful manner, and must establish tools to allow for more effective sharing of that information.

4) We need to continue work on understanding the fundamental processes involved in both erosion and sediment transport by water and/or wind, and in how best to model those phenomena. Though our understanding has increased greatly over the past decades, there are still some substantial gaps, including such processes as streambank and gully erosion, transport and deposition processes, effects of sediment on biotic integrity, etc.

5) We must greatly increase our understanding of the transport of sediment by wind or water, and the off-site impacts of this sediment on air and water quality.

It is the considered consensus of the participants at this symposium that successfully addressing these issues will result in a far better understanding of erosion and sediment transport processes, in improved erosion control practices, and in better tools for land-use planners. These will ultimately result in better protection of the soil, air, and water resources in a more cost-effective and efficient manner.

Results of Symposium Discussions

It was the major goal of the International Symposium on Soil Erosion Research for the 21st Century to encourage discussion of the challenges and issues facing soil erosion research in order to achieve greater understanding and to move towards a common vision. Opportunities for discussion included panel sessions, small-group discussions, and informal rap sessions. To keep the size of these sessions reasonable, they were divided into the three general categories of Wind Erosion Research, Water Erosion Research, and Erosion Quantification. What follows is a summary of the main points raised during those discussions.

Issues of Greatest Importance Facing Wind Erosion Research

Issue: we need better physically-based equations to describe the entrainment, transport, and deposition of soil by wind at various scales

Implications:

- leads to an inadequate understanding of the processes involved and their relative importance
- can lead to inaccurate models, and poor conservation planning decisions

Tasks:

- establish multi-disciplinary research teams
- encourage increased fundamental research to better define the critical parameters and to verify the resulting equations
- develop, select, and properly use better data-collection equipment and techniques

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Issue: we do not have adequate tools to assess the environmental impact of land management decisions

Implications/Consequences:

- our current tools may not allow us to address whether current management practices are sustainable
- we may not be giving good comparisons of land management practices for cost/risk/benefit planning

Tasks:

- development of regional models by integrating existing wind erosion models and decision-support tools
- development of additional alternative management practices to minimize erosion
- improve understanding of the impacts of erosion on fertility
- better transfer of the technology to the end users

Issue: we have a poor understanding of off-site wind erosion impacts

Implications/Consequences:

- generally do a poor job of predicting air quality impacts and sedimentation problems caused by wind erosion
- this severely limits how well we can model these phenomena
- generally cannot adequately tie in economic costs, which are often primarily off-site

Tasks:

- develop indirect methods (e.g., remote sensing) to track off-site movement

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Issue: have inadequate technology transfer efforts
Implications/Consequences:
- hinders adoption of alternative management practices
- practices are sometimes used incorrectly
Tasks:
- form interdisciplinary links between all stakeholders
- involve all stakeholder groups throughout the effort
- provide informational / educational materials to schools, clubs, etc.

Issue: generally have inadequate methods of monitoring and assessing the spatial and temporal variation in wind erosion
Implications/Consequences:
- makes it very difficult and expensive to collect good data
- difficult to have a good sense of variability of erosion and the impact of that on decision-making
- are often forced to use information collected on another scale
- results in great uncertainty in making a planning recommendation
Tasks:
- resolve scale impacts on erosion and transport
- develop standardized methods for a series of measurement techniques
- develop reliable and standardized indirect measurement methods as surrogates for direct methods
- provide better ways of ground-truthing remotely-sensed information
- develop interdisciplinary teams to research and develop indirect methods

Issues of Greatest Importance Facing Water Erosion Research

Issue: we have an inadequate understanding of basic erosion processes, especially those related to irrigation, tile drainage, rangelands, water quality, gullies, deposition, and erosion caused by soil disturbance processes such as tillage.
Implications/Consequences:
- weakens credibility with model users when their cases are not represented in the models
- limits the usability of the models in these land-use cases or phenomena not intensively studied before
- results in poor model estimates and perhaps in poor conservation planning decisions
- limits flexibility in the use of these models
Tasks:
- develop fundamental research programs in some of these areas
- do a better job of integrating research by various scientists in different locations

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Issue: have at best a spotty record of conservation practices being adopted at the farm and local levels

Implications/Consequences:
- poor utilization of research resources
- poor protection of local, national, and global soil/water/air resources

Tasks:
- develop and document improved soil conservation practices
- develop a much better understanding of the factors controlling adoption / rejection of the practices at the farm and local levels

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Issue: have a very incomplete and limited data set describing erosion and sediment delivery

Implications/Consequences:
- data tend to be for specific situations (mineral soils, agricultural lands, moderate slopes, temperate climates)
- as expand erosion prediction and control to other regions and land uses, need a broader data set
- data sets often do not include parameters that are critical to understanding sediment delivery
- have very few long-term comprehensive data sets
- sometimes duplicate data collection efforts
- limits understanding of fundamental erosion/delivery processes

Tasks:
- develop long-term comprehensive monitoring programs, including all the factors associated with the entire erosion/delivery system
- set up systems specifically to collect information on the erosion and off-site impacts of extreme events
- develop international standards for data sets that will be useful across the broadest range of environments

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Issue: we have a poor general understanding of how best to approach modeling erosion, sediment yield, and related water quality impacts

Implications/Consequences:
- our models often are more complex than can be justified by the supporting data
- we must do a better job of modeling two-dimensional and long-term phenomena
- we need to improve our modeling of the consequences of erosion (e.g., soil quality and productivity changes, the sustainability of management systems, water quality impacts)
- we rarely integrate socio-economic factors in our models
- we often do a poor job of representing basic erosion processes, field conditions and associated variability, and topographic complexities
- our models are perhaps weakest in predicting sediment delivery and off-site impacts
- our models are generally based on what we know and can measure rather than on what is really important

Tasks:
- begin fundamental research in how most efficiently to use available information in building models
- develop fundamental new approaches to estimating sediment delivery in complex situations
- begin multi-disciplinary work on defining the appropriate degree of complexity for

these models
- develop better measures of spatial and temporal variability of critical parameters
- compile and strengthen information on the soil quality and water quality impacts of erosion and sediment delivery
- begin to compile socio-economic data related to soil erosion and sediment movement, and work on how to integrate those into combined assessment models

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Issue: we have generally not given enough attention to assessing the impacts and consequences of erosion and resulting sediment transport

Implications/Consequences:
- though we may have a good idea of how much soil is eroded, we know less about what is transported off-site, and even less idea of the implications of that transport
- makes it very difficult to use our results for good cost/risk/benefit analyses

Tasks:
- reassess the whole concept of soil loss tolerance
- examine how upland erosion impacts the TMDL of streams, reservoirs, wetlands, coastal zones, and off-coast impacts such as on the Great Barrier Reef and hypoxia in the Gulf of Mexico
- develop long-term field studies specifically looking at on- and off-site impacts, rather than just erosion rates
- develop better uses of erosion information and expertise in addressing critical water quality issues

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Issue: we have usually not done an adequate job of integrating our efforts and results

Implications/Consequences:
- we do not integrate well across spatial scales, which would require linking lab and plot studies with watersheds, which are often the scale of interest
- we often fail to integrate our work with the efforts of social scientists and economists, and even with physical scientists approaching the problem very differently (e.g., fluvial geomorphologists)
- we rarely integrate erosion and sediment transport by water with other land degradation processes (e.g., changes in soil structure, deforestation, salinization, tillage erosion)
- we too often do not integrate the end user into our efforts, resulting in poor adoption rates

Tasks:
- develop more interdisciplinary efforts
- begin an effort to better share data, and to standardize its collection and storage to make the sharing more efficient

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Issue: we do not always understand the large-scale implications of the phenomena we study on the small scale

Implications/Consequences:
- inadequate understanding of the impacts of erosion and sediment transport on global climate change, such as impacts on carbon sequestration

- poor understanding of erosion and sediment transport by scientists in other disciplines

Tasks:

- develop a sound conceptual understanding of the potential role of erosion and sediment transport on these phenomena
- begin to collect data to assess these impacts and to develop the understanding into concrete models

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Issue: poor rate of adoption of conservation strategies at the larger scales (watersheds, regions, etc.)

Implications/Consequences:

- the large area is usually the system of concern for water quality issues
- we get a poor return on scientific investment if we don't get adequate adoption

Tasks:

- involve end users in all stages of tool development and implementation
- develop technologies that are profitable, cheap, environmentally friendly, and easy to implement
- develop watershed planning documents using multiple strategies to resolve erosion problems
- integrate physical and social science models to develop acceptable techniques
- determine needs and priorities of users
- research to aid policy makers to encourage adoption of conservation systems

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Issue: in data-collection efforts, we too often don't fully understand what is being measured and its variability

Implications/Consequences:

- our measurement techniques often affect the parameter being measured, skewing the data
- we don't adequately measure the spatial and temporal variability of the parameter
- in sharing the data, we often don't provide information critical to assessing its usefulness
- a poor understanding of the data variability can lead to poor cost/risk/benefit analyses

Tasks:

- evaluate existing measurement techniques and resulting data
- develop new techniques to measure parameters with minimal or well-known impacts
- develop measurement technique standards, including Quality Control/Quality Assurance methods
- develop reporting standards that include spatial and temporal variability and the setting of the measurement

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Issue: we have no comprehensive database to allow us to efficiently use data collected by others

Implications/Consequences:

- makes it far more difficult to do any large-scale or global erosion assessment, or to track trends in air, water, or soil quality
- deprives modelers of data that would be invaluable for verification/validation

Tasks:

- establish an organization to build and maintain a meta-database (i.e., a catalog of what data are available, under what conditions they were collected, etc.)
- assess and catalog existing data
- periodically evaluate usefulness of the database

Issue: we have a poor understanding of how spatial and temporal variability in soil properties, surface conditions, and climate impact soil erosion

Implications/Consequences:

- since erosion often occurs only under certain combinations of conditions, not understanding the variability in those conditions leads to poor erosion predictions and resulting decisions

Tasks:

- continue long-term plot studies under a much wider range of conditions
- develop cheaper data-collection methods to allow for more replicates
- do a better job of incorporating variability into erosion prediction models
- develop a better conceptual understanding of the sources of the variability
- develop models assessing the long-term impacts of soil erosion on soil variability and soil quality

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Issue: our models are generally poor at making the long-term projections

Implications/Consequences:

- this information is required for good cost/risk/benefit analyses

Tasks:

- carry out a better compilation and analysis of historical data, and how best to use those records
- develop better projection tools for time-varying phenomena, including feedback mechanisms to show how current erosion will affect future erosion, etc.
- encourage collection of the representative data most useful in making these projections

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Issue: we generally do a much better job of estimating erosion on the hillslope than of modeling or quantifying sediment delivery from the source to some destination of concern

Implications/Consequences:

- results in poor water-quality models
- results in poor sediment-delivery measurements
- have a poor understanding of the pathways taken by the sediment and of its residence time within the area of interest

Tasks:

- educate policy makers and regulators on the importance of good sediment delivery quantification in meeting environmental standards, such as NPDES or TMDL limits
- establish an interdisciplinary team to develop a comprehensive research strategy
- identify pathways and mechanisms of sediment movement
- determine the impact of temporal and spatial scales on these pathways and mechanisms