EXTRA SERIES
26

THE PONTIFICAL ACADEMY OF SCIENCES

Statement on
Water and the Environment

issued by the working group
of the Pontifical Academy of Sciences

Dichiarazione su
Acqua e ambiente

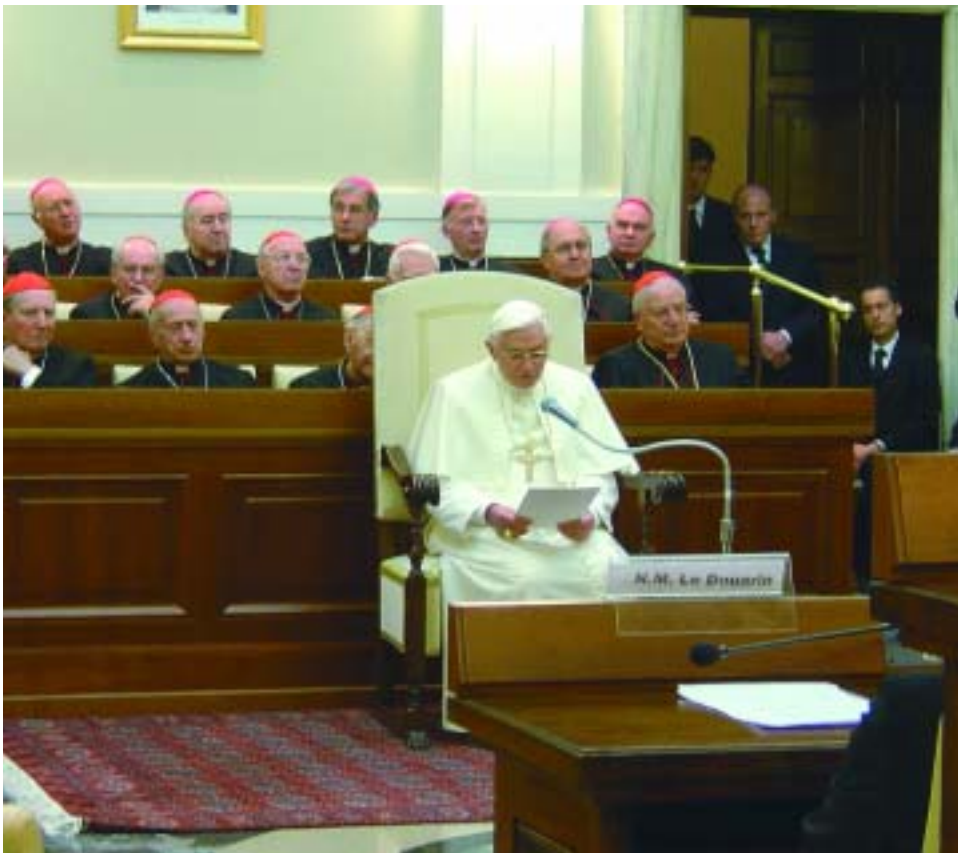
approvata dalla Pontificia Accademie delle Scienze
a conclusione del gruppo di lavoro

12-14 November 2005
Casina Pio IV

VATICAN CITY 2006

As you can imagine, we will not go into the technical question, or into the possibilities of its application, which would probably still be premature. But we know that it is a question of a kind of important metabolism, which it is in the interest of mankind to discern, since the shortage of reserves of fresh water threatens to hinder its development. Let us just emphasise, in the more general field of scientific research, two attitudes which, it seems to us, should characterise the scientist, and especially the scientist who is a Christian. On the one hand, he must honestly consider the question of the earthly future of mankind and, as a responsible person, help to prepare it, preserve it, and eliminate risks; we think that this solidarity with future generations is a form of charity to which a great many men are sensitive today, in the framework of ecology. But at the same time, the scientist must be animated by the confidence that nature has in store secret possibilities which it is up to intelligence to discover and make use of, in order to reach the development which is in the Creator's plan. This hope in the Author of nature and of the human spirit, rightly understood, is capable of giving new and serene energy to the researcher who is a believer.

Paul VI, *Address of 19 April 1975 to the participants of the study week on* 'Biological and Artificial Membranes and Desalination of Water', in *Papal Addresses*, The Pontifical Academy of Sciences, Scripta Varia 100, Vatican City 2003, p. 208 f.



Statement on

Water and the Environment

Dichiarazione su

Acqua e ambiente

Statement

Water and the Environment

This Statement on Water and the Environment was produced by the workshop on the same subject of 12-14 November 2005 which was held at Casina Pio IV. On the basis of a text by Prof. Rodríguez Iturbe with the collaboration of Prof. Hide, and in response to proposals made by President Prof. Cabibbo, Prof. Chahine, Prof. Crutzen, Prof. Gatto, Prof. Léna, Prof. Ramanathan, and the Bishop-Chancellor Sánchez, this document was formally approved by the Pontifical Academy of Sciences.

A scientific workshop on 'Water and the Environment' was held at the Pontifical Academy of Sciences on 12-14 November 2005. Underlying the programme of the workshop was the basic premise that the survival of humanity and all species on earth depend upon the fate of water. Where water is absent, life is absent. The common symbol of life for mankind and all species, valued and respected in all religions and cultures, today water is symbolic of social equity.

There are two facets to the question of 'Water and the Environment'. The first belongs strictly to the natural sciences and centres on the understanding of the hydrologic cycle and its interactions with the living and non-living components of the earth and its atmosphere. The second facet pertains more to the social sciences and focuses on the fair distribution of water, considering both quality and quantity aspects, as well as the impact of these issues in the economical and spiritual growth of people around the world. These two facets are inextricably linked, with scientific knowledge providing a basis for well-informed decisions expected from the policymakers involved, decisions that will affect all humanity over many generations to come.

The main emphasis of the workshop was on the first of the above-mentioned facets. It dealt in particular with up-to-date scientific research bearing on the impact of hydrologic dynamics on issues concerning sustainable development, in which water resources are of paramount importance. Contamination, ill-planned industrial development, mega cities, are just a few of many threats to these vital resources. Some hope of success in countering these threats is provided by concepts such as the so-called Integrated Resources Management — 'a (management) process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems' (Global Water Partnership, *TAC Background Paper*, No. 4).

Such coordinated development and concomitant decision-making needs firm scientific underpinning, in which the science of Hydrology – with its intimate links with Ecology and with its geophysical sister sciences, Geomorphology, Geology, Climatology and Meteorology – has a key role to play. In the words of Hedin et al. (*Report to the U.S. National Science Foundation*, 2002), 'this disciplinary convergence will over the next several decades transform our understanding of basic processes that control the stability and sustainability of natural environmental systems. The ensuing findings will have extraordinary implications for our abilities to predict and manage how humans impact the health of ecosystems across local, regional, and global scales. Such knowledge is a critical component of a safe, sustainable and prosperous future'.

The workshop was organized around recent advances in research in five main areas – Biodiversity, Global Hydrology, Climate Change, Land-Atmosphere Interactions, and River Basins – with hydrologic dynamics providing the unifying theme to the discussions. Particular emphasis was placed on the investigation of feedbacks and interactions between the five areas, with the goal of identifying some of the main scientific challenges that need to be faced in the immediate future.

The presentations and discussions of the different topics took place in the Casina Pio IV in an environment which could be described

by the eloquent words of Paul VI characterizing the attitude of a scientist: 'On the one hand, he must honestly consider the question of the earthly future of mankind and, as a responsible person, help to prepare it, preserve it, and eliminate risks; we think that this solidarity with future generations is a form of charity to which a great many men are sensitive today, in the framework of ecology. But at the same time, the scientist must be animated by the confidence that nature has in store secret possibilities which it is up to intelligence to discover and make use of, in order to reach the development which is in the Creator's plan. This hope in the Author of nature and the human spirit, rightly understood, is capable of giving new and serene energy to the researcher who is a believer' (Paul VI, *Papal Addresses*, The Pontifical Academy of Sciences, Scripta Varia 100, Vatican City 2003, p. 208 f.).

In order to keep the overall perspective and deal with the range of implications of the scientific topics, the workshop was opened and closed with two presentations providing a link between the science aspects and the social impacts of the themes under study. These presentations were entitled *The Fair Distribution of Water* and *Heading Towards Basin-level Hydrosolidarity: Goal for Land/Water/Ecosystem Coordination*. Thus the workshop opened with a strong message that access to sufficient and healthy water is a human right which has to be taken into consideration by governments without discriminations of any kind. It is essential to consider the fair distribution of water when applying concepts like 'sustainable development', 'globalization' and 'food security'. All these need to be discussed considering the challenges and obstacles of geographical, social, cultural and political character that impact any effort towards a world-wide fair distribution of water. The workshop then ended with the discussion of a road map towards hydrosolidarity framed on the scale of the multiple uses by different geographical regions of the water resources of a river basin. It involves a plea that it is an ethically demanding duty for the scientific community to prepare wisely for the water related challenges involved in the Millennium Development Goals over the next half century. Thus it will be crucial to develop a scientifically sound and ethic-based vision, that will stimulate new optimism and involve people in striving towards hydrosolidarity-based balances of interests and activities in river basins.

The five general themes of the workshop presented a challenging perspective of the scientific aspects of some of the most crucial areas related to water and the environment. Thus, in Biodiversity and Hydrologic Dynamics, the extremely important role of water was made clear in the preservation of biodiversity and in the temporal and spatial patterns that biodiversity exhibits. The main causes of accelerating extinction rates are habitat destruction and degradation, the introduction of exotic species, pollution, overexploitation and global climate change. In all key aspects of biodiversity, hydrologic dynamics play a crucial role and it was clearly shown that natural or human-caused fluctuations of the water cycle are fundamental drivers of the vegetation dynamics. The different characteristics of the interaction between vegetation and climate were discussed in-depth for both savannah and river basin ecosystems. In the case of savannas, the dynamic grass cover enhances the degree to which the savannah vegetation is optimal with respect to its use of the stochastic water input. In the case of river basins the deep coherence was made apparent between the geomorphological organization of the watershed and the vegetation patterns that exist around the river network.

In the session on Global Hydrology and Hydrologic Dynamics, special emphasis was made on the fact that impacts of climate change will be felt most strongly through changes in surface hydrology (e.g., changes in the frequencies of floods and droughts), which affect ecosystems and agriculture, as well as the water available for direct human use. The key drivers of contemporary changes in river flow (land use change, climate change, solar dimming and direct CO_2 effects) were assessed by comparing model simulations to continental-scale runoff records. These comparisons suggest that direct CO_2 effects can already be detected, with important consequences for water availability in the 21st century. Our ability to meet the water resources requirements of this century demands a coordinated scientific agenda at the international level and a review was provided of the progress towards address-

ing the above requirements for an integrated water resources management system.

The topic discussed above continued with the study of Climate Change and Hydrologic Dynamics where it was pointed out that anthropogenic climate change is expected to affect the hydrologic cycle in many ways and it is not unlikely that changes in precipitation will be more serious than those in temperature. Of particular concern are long-term changes in precipitation stretching over multiple years. Worldwide changes in evaporative demand are also of fundamental importance in this topic and received extensive discussion especially in what concerns the apparent paradox between global warming and decreased evaporative demand. Aerosols are another important factor impacting the hydrologic cycle since they change cloud characteristics in many ways. Human emissions of aerosols cause a reduction of solar radiation at the surface (e.g., solar dimming). This has important consequences for the surface energy budget and for the hydrologic cycle.

Land-Atmosphere Interactions are a key component of the intimate interdependence between water and the environment. A particularly important region for this mutual feedback is the Amazon River basin which contains the largest, contiguous extent of tropical forest on earth. Over the past 30 years almost 600,000 km^2 have been deforested in Brazil alone due to the rapid development of Amazonia. There are observational evidences of regional changes in the surface energy budget, cloudiness and lower troposphere radiative transfer due to biomass burning aerosol loadings. Observational evidence of changes in the hydrologic cycle includes reductions of streamflow and modelling studies of large scale deforestation indicate a likely drier and warmer post-deforestation climate. Precipitation suppression by anthropogenic air pollution is likely to lead to a major loss of water resources where we need them most. The study of the physical mechanisms responsible for suppressing the precipitation forming processes provides the scientific basis for corrective actions that were discussed. The need to quantify the linkage between plant hydraulics and leaf biochemistry was also shown for understanding how biosphere-atmosphere exchange of water and carbon occurs under current and projected climate conditions.

River Basins play a fundamental role in all aspects of water and the environment and they constitute complex adaptive systems where the action of water is central to the dynamic origin of their scaling characteristics. They also constitute fascinating laboratories for the study of how nature works across a wide range of scales. Of particular importance is the discussion of the dynamic origin of their scale-invariant forms which lies at the core of the organization and evolution of river networks and their associated ecosystems. How does biology affect landscape form and evolution? How do biotic processes influence weathering, erosion, and sediment transport mechanisms, and how such influences could be manifest in landscape-scale morphology? Is there a topographic signature of life? These questions are intimately linked to the basic premise of the workshop underlying all presentations: the survival of humanity and life depends on the fate of water. The preservation of earth as a planet that nurtures life crucially depends on the understanding of the hydrologic cycle and its interactions with the living and non-living components of the earth and its atmosphere.

All the above topics need measurements from space which have provided information on the water cycle with unprecedented accuracy. This new information provided by satellite shows that when comparing Mars, Venus and Earth, which are all of the same geological age, only Earth has liquid water whose dynamics is controlled by the hydrologic cycle. If we do not conserve the equilibrium of this cycle the singularity of Earth and the life it sustains are very much at risk and the Earth could become like other planets. Furthermore, given the global character of the processes involved any effective action will benefit immensely if it is planned under an international framework.

The workshop provided a truly unique opportunity for leading scientists of different disciplines to find a common ground in a problematic area that is of fundamental importance for mankind. The cross-fertilization and links that took place in a climate of free scientific discussion are bound to have a lasting impact.

Questa Dichiarazione su Acqua e ambiente è stata proposta a conclusione del gruppo di lavoro tenutosi presso la Casina Pio IV dal 12 al 14 novembre 2005. Tale Dichiarazione è stata ufficialmente approvata dalla Pontificia Accademia delle Scienze sulla base di un testo redatto dal Professor Rodríguez Iturbe in collaborazione con il Prof. Hide, e in risposta ai suggerimenti del Presidente Prof. Cabibbo, dei Professori Chahine, Crutzen, Gatto, Léna, Ramanathan e del Vescovo-Cancelliere Sánchez.

Dal 12 al 14 novembre 2005 presso la Pontificia Accademia delle Scienze si è tenuto un seminario scientifico dal titolo 'Acqua e ambiente'. Il programma del seminario ha preso le mosse dalla premessa fondamentale secondo cui la sopravvivenza dell'umanità e di tutte le specie sulla terra dipende dal destino dell'acqua. Dove non c'è acqua, non c'è vita. Simbolo di vita per l'umanità e per tutte le specie, apprezzata e onorata in tutte le religioni e le culture, oggi l'acqua è simbolo di equità sociale.

Sono due gli aspetti legati alla interrelazione tra 'Acqua e ambiente'. Il primo appartiene strettamente alle scienze naturali ed è incentrato sulla comprensione del ciclo idrologico e sulle sue interazioni con i componenti viventi e non-viventi della terra e dell'atmosfera. Il secondo aspetto pertiene più specificamente alle scienze sociali ed è focalizzato sulla equa distribuzione di acqua, sia nei suoi aspetti qualitativi che quantitativi, come anche sull'impatto che tali questioni hanno in tutto il mondo sulla crescita economica e spirituale delle persone. Questi due fattori sono inestricabilmente collegati, e in tale contesto le conoscenze scientifiche forniscono una base per decisioni ben informate che i responsabili della politica dovranno prendere, decisioni che influiranno su tutta l'umanità per molte generazioni a venire.

L'accento principale del seminario è stato posto sul primo degli aspetti summenzionati. In particolare il seminario si è occupato delle più recenti ricerche scientifiche che hanno relazione con l'impatto delle dinamiche idrologiche su questioni concernenti lo sviluppo sostenibile, in cui le risorse idriche sono di fondamentale importanza. La contaminazione, lo sviluppo industriale mal programmato, le megalopoli, sono solo alcune delle molte minacce che mettono in pericolo queste risorse vitali. Qualche speranza nel contrastarle viene da concetti quali la cosiddetta Gestione delle Risorse Integrate – 'un processo (gestionale) che promuove lo sviluppo coordinato e la gestione dell'acqua, della terra e delle risorse collegate, al fine di massimizzare il benessere economico e sociale che ne deriva in un modo equo e senza compromettere la sostenibilità degli ecosistemi vitali' (Global Water Partnership, *TAC Background Paper*, No. 4).

Tale sviluppo coordinato, e la concomitante capacità decisionale, necessita di un solido sostegno scientifico, in cui l'Idrologia – per i suoi stretti legami con l'Ecologia e con le sue scienze geofisiche consorelle, Geomorfologia, Geologia, Oceanografia, Climatologia e Meteorologia – riveste un ruolo chiave. Nelle parole di Hedin et al. (*Report to the U.S. National Science Foundation*, 2002), "questa convergenza di discipline nel corso dei prossimi decenni trasformerà la nostra comprensione dei processi di base che regolano la stabilità e la sostenibilità dei sistemi ambientali naturali. Le scoperte che seguiranno avranno straordinarie implicazioni sulle nostre capacità di predire e gestire le modalità in cui gli esseri umani influiscono sullo stato di salute degli ecosistemi su scala locale, regionale e globale. Tale sapere è un componente cruciale di un futuro sicuro, prospero e sostenibile".

Il seminario è stato organizzato intorno ai recenti progressi compiuti dalla ricerca in cinque aree principali – Biodiversità, Idrologia Globale, Cambiamento Climatico, Interazione Terra-Atmosfera, e Bacini Fluviali – con la dinamica idrologica come tema unificante dei dibattiti. Particolare enfasi è stata posta sull'analisi approfondita dei feedback e delle interazioni tra le cinque aree, al fine di identificare alcune delle principali sfide scientifiche che dovranno essere affrontate nell'immediato futuro.

Le relazioni e i dibattiti sui diversi temi hanno avuto luogo presso la Casina Pio IV in un clima che potrebbe essere descritto attraverso le eloquenti parole di Paolo VI utilizzate per definire l'atteggiamento di uno scienziato: "Da un lato, egli deve lealmente interrogarsi sull'avvenire terrestre dell'umanità e – da uomo responsabile – concorrere a prepararlo, a preservarlo, a eliminare i ri-

schi; noi riteniamo che questa solidarietà con le generazioni future sia una forma di carità alla quale molti, del resto, sono oggi sensibili nel quadro dell'ecologia. Ma, allo stesso tempo, lo scienziato deve essere animato dalla fiducia che la natura nasconde delle possibilità segrete, che spetta all'intelligenza scoprire e mettere in atto, per giungere allo sviluppo che è nel disegno del Creatore. Questa speranza nell'Autore della natura e dello spirito umano – rettamente intesa – è in grado di dare al ricercatore credente una energia nuova e serena" (Paolo VI, *Discorsi dei Papi*, Pontificia Accademia delle Scienze, Scripta Varia 100, Città del Vaticano 2003, p. 208 s.).

Al fine di mantenere la prospettiva generale ed affrontare la vasta gamma di implicazioni connesse agli argomenti scientifici, il seminario è stato aperto e chiuso da due relazioni che hanno fornito un collegamento tra gli aspetti scientifici e l'impatto sociale dei temi in studio. Tali relazioni erano intitolate *Un'equa distribuzione di acqua* e *Andare verso una idrosolidarietà di bacino: obiettivo del coordinamento terra/acqua/ecosistema*. In questo modo, il seminario si è aperto con il forte messaggio che l'accesso ad un'acqua sana e sufficiente è un diritto umano che i governi devono prendere in considerazione senza discriminazioni di alcun tipo. È essenziale tener conto dell'equa distribuzione dell'acqua quando si applicano concetti come 'sviluppo sostenibile', 'globalizzazione' e 'sicurezza alimentare'. Tutti questi temi devono essere discussi tenendo presenti le sfide e gli ostacoli di carattere geografico, sociale, culturale e politico che influiscono su qualunque sforzo che miri ad una equa distribuzione di acqua a livello mondiale. Il seminario si è quindi concluso con un dibattito circa una *road map* verso l'idrosolidarietà, elaborata tenendo conto dei molteplici usi delle risorse idriche di un bacino fluviale da parte di differenti regioni geografiche. Essa comporta un appello, che è un dovere etico per la comunità scientifica, a prepararsi coscienziosamente per le sfide collegate all'acqua ed inerenti agli Obiettivi di Sviluppo del Millennio nel corso del prossimo mezzo secolo. Dunque, sarà cruciale sviluppare una visione scientificamente solida e basata sull'etica, che possa stimolare un nuovo ottimismo e coinvolgere le persone nello sforzo teso al raggiungimento di un equilibrio, fondato sull'idrosolidarietà, tra interessi e attività nei bacini fluviali.

I cinque temi generali del seminario hanno offerto una prospettiva stimolante circa gli aspetti scientifici di alcune delle aree più cruciali collegate all'acqua e all'ambiente. Così, in Biodiversità e Dinamica Idrologica è stato chiarito il ruolo estremamente importante dell'acqua nella conservazione della biodiversità e nei modelli temporali e spaziali che la biodiversità mette in evidenza. Le principali cause di accelerazione nei tassi di estinzione sono la distruzione e il degrado dell'habitat naturale, l'introduzione di specie esotiche, l'inquinamento, l'eccessivo sfruttamento delle risorse naturali e il cambiamento del clima terrestre. In tutti gli aspetti chiave della biodiversità, la dinamica idrologica ha un ruolo cruciale ed è stato chiaramente dimostrato come le fluttuazioni, naturali o causate dall'uomo, del ciclo idrico sono elementi fondamentali nelle dinamiche della vegetazione. Le diverse caratteristiche dell'interazione tra vegetazione e clima sono state approfonditamente discusse sia per l'ecosistema della savana che per quello dei bacini fluviali. Nel caso delle savane, il manto d'erba dinamico aumenta il grado a cui la vegetazione della savana risulta ottimale rispetto al suo uso dell'immissione idrica stocastica. Nel caso dei bacini fluviali è apparsa evidente la profonda coerenza tra l'organizzazione geomorfologica del bacino idrico e le formazioni di vegetazione che si trovano intorno alla rete fluviale.

Nella sessione su Idrologia Globale e Dinamica Idrologica, una speciale enfasi è stata posta sul fatto che l'impatto del cambiamento climatico sarà più fortemente avvertito nei cambiamenti idrologici di superficie (per esempio, cambiamenti nella frequenza di alluvioni e siccità), che influiscono sugli ecosistemi e sull'agricoltura, così come sull'acqua disponibile per il diretto uso umano. I fattori chiave degli attuali cambiamenti nella portata dei fiumi (modifiche nell'utilizzo della terra, mutamenti climatici, diminuzione dell'irradiazione solare ed effetti del CO_2 diretto) sono stati valutati comparando i modelli di simulazione ai dati di deflusso su scala continentale. Questi confronti suggeriscono che gli effetti del CO_2 diretto possono essere già rilevati, con importanti conseguenze per la disponibilità di acqua nel corso del XXI secolo. La nostra capacità di soddisfare il fabbisogno di risorse idriche di questo secolo necessita di un'agenda scientifica coordinata a livello internazionale, e nel corso del seminario è stato fornito un resoconto dei progressi compiuti per rispondere alle summenzionate esigenze di una gestione integrata delle risorse idriche.

Questo stesso tema è stato discusso anche nell'ambito dello studio su Cambiamento Climatico e Dinamica Idrologica in cui è stato evidenziato

che un cambiamento climatico antropogenico si prevede incida in svariati modi sul ciclo idrologico, e non è improbabile che le alterazioni nelle precipitazioni saranno più serie delle variazioni di temperatura. Fonte di particolare preoccupazione è la modificazione a lungo termine delle precipitazioni, che avrà una durata di molteplici anni. Anche i cambiamenti mondiali nella richiesta evapotraspirativa sono di fondamentale importanza in questo contesto e sono stati oggetto di un'ampia discussione specialmente per quel che concerne l'apparente paradosso tra riscaldamento globale e decremento nella richiesta evapotraspirativa. Gli aerosol sono un altro fattore rilevante che influisce sul ciclo idrologico dal momento che modificano in svariati modi le caratteristiche delle nubi. Le emissioni umane di aerosol causano una riduzione nell'irradiazione solare alla superficie. Questo ha importanti conseguenze per il bilancio energetico di superficie e per il ciclo idrologico.

Le interazioni terra-atmosfera sono una componente chiave nella stretta interdipendenza tra acqua ed ambiente. Una regione di particolare importanza per questo doppio feedback è il bacino del Rio delle Amazzoni che contiene la più vasta e contigua estensione di foresta tropicale sulla terra. Negli ultimi 30 anni quasi 600.000 km^2 sono stati deforestati nel solo Brasile a seguito del rapido sviluppo dell'Amazzonia. In questa regione ci sono prove evidenziali di cambiamenti nel bilancio energetico di superficie, nella nuvolosità e nel più basso trasferimento radiativo nella troposfera dovuto a grandi quantità di pulviscolo atmosferico causato dalla combustione di biomassa. La prova dei mutamenti nel ciclo idrologico include le riduzioni del flusso fluviale, e studi modellistici di deforestazione su larga scala indicano un probabile clima post-deforestazione più caldo ed asciutto. La forte riduzione delle precipitazioni causata dall'inquinamento antropogenico dell'aria porterà verosimilmente a più consistenti perdite di risorse idriche proprio dove ce ne sarebbe maggior bisogno. Lo studio dei meccanismi fisici responsabili del forte decremento dei processi di formazione delle precipitazioni fornisce la base scientifica per le azioni correttive da intraprendere e che sono state discusse. È stato anche sottolineato il bisogno di quantificare il collegamento tra l'idraulica della pianta e la biochimica della foglia per capire come, nelle attuali condizioni climatiche e in quelle previste, si verifica lo scambio biosfera-atmosfera di acqua e carbonio.

I bacini fluviali hanno un ruolo fondamentale in tutti gli aspetti concernenti l'interdipendenza tra acqua ed ambiente, ed essi costituiscono complessi sistemi adattivi in cui l'azione dell'acqua risulta centrale per l'origine dinamica delle loro caratteristiche di scalatura. Essi costituiscono anche affascinanti laboratori per lo studio di come la natura opera attraverso una vasta gamma di scalature. Di particolare rilievo è la discussione sull'origine dinamica delle loro forme invarianti di scala che è al centro dell'organizzazione e dell'evoluzione delle reti fluviali e dei loro correlati ecosistemi. Come la biologia influisce sulla forma e sull'evoluzione del paesaggio? Come i processi biotici influenzano l'azione degli agenti atmosferici, l'erosione, e i meccanismi di trasporto dei sedimenti, e come tali influssi possono evidenziarsi nella morfologia del paesaggio? C'è una impronta topografica della vita? Queste domande sono strettamente collegate alla premessa fondamentale del seminario che è stata alla base di tutte le relazioni: la sopravvivenza dell'umanità e della vita dipende dal destino dell'acqua. La conservazione della terra come pianeta che nutre la vita dipende in modo cruciale dalla comprensione del ciclo idrologico e dalle sue interazioni con i componenti viventi e non viventi della terra e della sua atmosfera.

Tutti i temi summenzionati necessitano di misurazioni dallo spazio che hanno fornito informazioni sul ciclo idrico con una accuratezza che non ha precedenti nella storia. Queste nuove informazioni fornite dai satelliti mostrano che quando compariamo Marte, Venere e la Terra, che hanno la stessa età geologica, solo la Terra ha acqua allo stato liquido la cui dinamica è controllata dal ciclo idrologico. Se non conserviamo l'equilibrio di tale ciclo l'eccezionalità della Terra e della vita che essa sostiene è gravemente a rischio e la Terra potrebbe diventare simile ad altri pianeti. Inoltre, dato il carattere globale dei processi coinvolti, qualunque valida azione beneficerà immensamente da una pianificazione a carattere internazionale.

Il seminario ha fornito un'opportunità realmente unica per eminenti studiosi in discipline diverse di trovare un terreno comune in un settore problematico e di fondamentale importanza per l'umanità. L'ibridazione ed i collegamenti tematici che hanno avuto luogo in un clima di libero dibattito scientifico sono destinati ad avere un impatto duraturo.

SATURDAY, 12 NOVEMBER

9:00	General Introduction: **Prof. M. GOVIND KUMAR MENON** *The Pontifical Academy of Sciences, Welcome, and Goals*
9:15	Speaker: ◆ **Dr. REZA ARDAKANIAN** *The Fair Distribution of Water* Discussion
BIODIVERSITY AND HYDROLOGIC DYNAMICS	
10:15	Chairperson: **Prof. NICOLA CABIBBO** Speaker: ◆ **Prof. MARINO GATTO** *Threatened Biodiversity: Understanding, Forecasting, Taking Action* Discussion
11:15	Coffee Break
11:45	Speaker: ◆ **Prof. IGNACIO RODRÍGUEZ-ITURBE** *Hydrologic Fluctuations and Vegetation Dynamics* Discussion
13:00	Lunch at the Casina Pio IV
GLOBAL HYDROLOGY AND HYDROLOGIC DYNAMICS	
14.30	Chairperson: **Prof. IGNACIO RODRÍGUEZ-ITURBE** Speaker: ◆ **Dr. PETER M. COX** *Global Hydrology, Climate Change and Ecosystems* Discussion
15.30	Speaker: ◆ **Prof. SOROOSH SOROOSHIAN** *Water Distribution and Availability: An Overview of the Hydrologic Cycle, its Connection to Climate and Impact on Water Resources Management Strategies* Discussion
16.30	Coffee Break
CLIMATE CHANGE AND HYDROLOGIC DYNAMICS	
17:00	Speaker: ◆ **Prof. Dr. LENNART BENGTSSON** *Changes in Global Rainfall and the Hydrological Cycle: Present and Future Perspectives* Discussion

18:00	Speaker: ◆ **Prof. Graham Farquhar** *Worldwide Changes in Evaporative Demand* Discussion
19:00	Final Discussion
19:30	Dinner at Domus Sanctae Marthae

Sunday, 13 November

9:00	Beatification at St. Peter's Basilica of the Servants of God: Charles de Foucauld, Maria Pia Mastena, and Maria Crocifissa Curcio
12:30	Social Lunch at the Casina Pio IV
15:00	Guided Archaeological Visit to Vatican Necropolis

Monday, 14 November

9:00	Chairperson: **Prof. Raymond Hide** Speaker: ◆ **Prof. Ulrike Lohmann** *Impact of Aerosols on the Hydrologic Cycle* Discussion
	LAND-ATMOSPHERE INTERACTIONS
10:00	Speaker: ◆ **Prof. Gabriel Katul** *Bringing Photosynthesis to the Atmosphere:* *A Feedback on Terrestrial Water Cycling* Discussion
11:00	Coffee Break
11:30	Speaker: ◆ **Prof. Daniel Rosenfeld** *Precipitation Suppression by Anthropogenic Air Pollution:* *Major Loss of Water Resources Where We Need Them Most* Discussion
12:30	Speaker: ◆ **Dr. Carlos A. Nobre** *Biosphere-Atmosphere Interactions in Amazonia* Discussion
13:30	Lunch at the Casina Pio IV

RIVER BASINS	
15:00	Chairperson: **Prof. Veerabhadran Ramanathan** Speaker: ◆ **Prof. William Dietrich** *Is There a Topographic Signature of Life on Earth?* Discussion
16:00	Speaker: ◆ **Prof. Andrea Rinaldo** *River Basins: Water and Complex Adaptive Systems* Discussion
17:00	Speaker: ◆ **Dr. Moustafa Chahine** *NASA's Measurements of Water from Space* Discussion
18:00	Coffee Break
18:30	Speaker: ◆ **Prof. Malin Falkenmark** *Heading Towards Basin-level Hydrosolidarity – Goal for Land/Water/Ecosystem Coordination* Discussion
19:30	Final Discussion
20:00	Dinner at Domus Sanctae Marthae

LIST OF PARTICIPANTS

Outside Experts

NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE	PAPER
Dr. Reza Ardakanian	**IR** Teheran	Regional Center on Urban Water Management	*The Fair Distribution of Water*
Prof. Dr. Lennart Bengtsson	**D** Hamburg	Max Planck Institute for Metereology	*Changes in Global Rainfall and the Hydrological Cycle: Present and Future Perspectives*
Dr. Moustafa T. Chahine	**USA** Pasadena	Chief Scientist at NASA-JPL Jet Propulsion Laboratory	*NASA's Measurements of Water from Space*
Dr. Peter M. Cox	**UK** Dorchester	CEH – Dorset Winfrith Technology Centre	*Global Hydrology, Climate Change and Ecosystems*
Prof. William E. Dietrich	**USA** Berkeley	University of California, Berkeley Department of Earth and Planetary Science	*Is There a Topographic Signature of Life on Earth?*
Prof. Malin Falkenmark	**S** Stockholm	Stockholm Internatioanl Water Institute (SIWI)	*Heading towards Basin-Level Hydrosolidarity – Goal for Land/Water/Ecosystem Coordination*
Prof. Graham D. Farquhar	**AUS** Canberra	Australian National University Research School of Biological Sciences	*Worldwide Changes in Evaporative Demand*
Prof. Marino Gatto	**I** Milan	Polytechnic of Milan Department of Electronics and Information	*Threatened Biodiversity: Understanding, Forecasting, Taking Action*
Prof. Gabriel G. Katul	**USA** Durham	Duke University Nicholas School of the Environment and Earth Sciences	*Bringing Photosynthesis to the Atmosphere: A Feedback on Terrestrial Water Cycling*
Prof. Ulrike Lohmann	**CH** Zürich	Swiss Federal Institute for Technology (ETH) Institute for Atmospheric and Climate Science	*Impact of Aerosols on the Hydrologic Cycle*
Dr. Carlos A. Nobre	**BR** Cachoeria Paulista	Centre for Weather Forecasts and Climate Studies	*Biosphere-Atmosphere Interactions in Amazonia*
Prof. Andrea Rinaldo	**I** Padua	Padua University 'Dino Tonini' International Hydrology Centre	*River Basins: Water and Complex Adaptive Systems*
Prof. Ignacio J. Rodríguez-Iturbe	**USA** Princeton	Princeton University Department of Civil and Environmental Engineering	*Hydrologic Fluctuations and Vegetation Dynamics*
Prof. Daniel Rosenfeld	**IL** Jerusalem	The Hebrew University of Jerusalem Institute of Earth Sciences – Program of Atmospheric Sciences	*Precipitation Suppression by Anthropogenic Air Pollution: Major Loss of Water Resources*
Prof. Soroosh Sorooshian	**USA** Irvine	University of California, Irvine Department of Civil and Environmental Engineering	*Water Distribution and Availability: An Overview of the Hydrologic Cycle*

Observers

NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE
H.Em. Card. Geraldo Majella Agnelo	**BR** Brasilia	President of National Bishops' Conference of Brazil (C.N.B.B.)
Prof. James Dooge	**IRL** Dublin	Former Foreign Minister of Ireland
H.E. Msgr. Catalino Claudio Giménez Medina	**PY** Asunción	President of the Bishops' Conference of Paraguay (C.E.P.)

Observers

NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE
H.E. Msgr. Estanislao E. Karlic	**RA** Paraná	Former President of the Bishops' Conference of Argentina and Archbishop Emeritus of Paraná
H.E. Msgr. Eduardo Vicente Miras	**RA** Buenos Aires	President of the Bishops' Conference of Argentina (C.E.A.)
Prof. Viliam Novák	**SK** Bratislava	Slovak Academy of Sciences, Institute of Hydrology
Prof. Mary Power	**USA** Berkeley	University of California, Berkeley
Msgr. James Reinert	**V** Vatican City	Pontifical Council for Justice and Peace
Prof. Lucio Ubertini	**I** Rome	La Sapienza University of Rome
Prof. Howard S. Wheater	**UK** London	Imperial College, Faculty of Engineering

Academicians

NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE	PAPER
Prof. Nicola Cabibbo	**I** Rome	Professor of Physics La Sapienza University of Rome President of the Pontifical Academy of Sciences	*Welcome Address*
H.E. Msgr. Marcelo Sánchez Sorondo	**V** Vatican City	Professor of the History of Philosophy LUMSA University of Rome Chancellor of the Pontifical Academy of Sciences and the Pontifical Academy of Social Sciences	*Presentation of the Activity of the Pontifical Academies*
Prof. Paul J. Crutzen	**D** Mainz	Max Planck Institute for Chemistry Department of Atmospheric Chemistry Member of the Council of the PAS	
Prof. Raymond Hide	**UK** Surrey	Emeritus Professor of Physics, Oxford University Senior Research Investigator in Mathematics, Imperial College, London	
Prof. M. Govind Kumar Menon	**IND** New Delhi	Dr.Vikram Sarabhai Distinguished Professor, Indian Space Research Organisation, Govt. of India Member of the Council of the PAS	*The Pontifical Academy of Sciences, Welcome, and Goals*

Dr. Reza Ardakanian Born in 1958 in Yazd, Iran, holds an MSc and PhD from McMaster University of Canada and teaches/researches in the field of water resources management. He represents the I. R. Iran in the Intergovernmental Council of IHP in UNESCO. He sits on the Governing Board of UNESCO-IHE, an international water education institute based in Delft, the Netherlands. He is a board member of IHA (Intl. Hydropower Association) and President of IR-IHA. Dr. Ardakanian cooperates with the United Nations University as the member of the Advisory Committee for the Institute of Environmental & Human Security based in Bonn, Germany. He is the Founding Director of RCUWM, a regional center on urban water management based in Tehran, Iran and under the auspices of UNESCO. Until 8 October 2005, he was Deputy Minister for Water Affairs in the Ministry of Energy of Iran. In Dec. 2004 he was awarded life membership of 'The International Water Academy'.

ADDRESS: *RCUWM-Tehran*
(Regional Center on Urban Water Management)
120, Kharramshahr Street
15537-13511 Teheran (Iran)
Tel. +98 21 8905003 – Fax +98 21 8801555
Email: ardakanian@moe.org.ir

Prof. Dr. Lennart Bengtsson was born in Sweden in 1935 and obtained his PhD in Meteorology from the University of Stockholm. His fields of research are climate modelling, data assimilation and the hydrological cycle. He is currently an Emeritus Scientific Member of the Max Planck Institute for Metereology in Hamburg, Germany. He is also, among other awards and honours, a Fellow of the American Meteorological Society and a Member of the Academia Europea. He has published some 170 scientific papers in the fields of numerical analysis and data assimilation, numerical weather prediction and climate modelling.

ADDRESS: *Max-Planck-Institut für Meteorologie*
Bundesstrasse 55
D-20146 Hamburg (Germany)
Tel. +49 40 41173349 – Fax +49 40 41173366
Email: bengtsson@dkrz.de

Dr. Moustafa T. Chahine was born in Beirut, Lebanon, and received his PhD from the University of California at Berkeley. He is currently a 'JPL Senior Research Scientist' at NASA's Jet Propulsion Laboratory, a Division of the California Institute of Technology. He served as 'JPL Chief Scientist' from 1985-2000 and is currently the Principal Investigator on the Atmospheric Infrared Sounder (AIRS), which was launched onboard the NASA Aqua satellite in 2002 to study Earth's water cycle and energy fluxes. Dr. Chahine's primary interests are in remote sensing of planetary atmospheres, and in studies of climate processes. He has served as a member of NASA's Earth System Sciences Committee and as Chair of the World Meteorological Organization's Global Energy and Water Cycle Experiment (GEWEX) from 1989-2000. Among his publications is an essay on 'The hydrological cycle and its influence on climate' published in *Nature* 359, pp. 373-380, 1992. He is Fellow in the American Physical Society, the American Association for the Advancement of Science, the American Geophysical Union and the American and British Meteorological Societies.

ADDRESS: *Jet Propulsion Laboratory,*
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109 (USA)
Tel. +1 818 3546057 – Fax +1 818 3931554
Email: chahine@jpl.nasa.gov

Prof. Peter M. Cox was born in 1964 in London. He started as the Centre for Ecology & Hydrology (CEH) Science Director for Climate Change in December 2004, based in Dorset, having previously been at the Met Office Hadley Centre for Climate Prediction and Research (since 1990). His educational background is in Physics and Theoretical Physics (Physics BSc – Warwick, Part II Maths – Cambridge, Plasma Physics PhD – Imperial), but spent his years at the Hadley Centre thinking about the impacts of ecosystems on the physical climate system. His personal research has focused on modelling the interaction between the land surface and the climate, and he led the team which carried out the first climate projection to include vegetation and the carbon cycle as dynamic interactive elements. As a Science Director at CEH, he aims to improve the links between data and models, and to utilise long-term datasets to detect climate change impacts on ecohydrological systems.

ADDRESS: *CEH Dorset*
Winfrith Technology Centre
Winfrith Newburgh
Dorchester, Dorset DT2 8ZD (UK)
Tel. +44 1305 213501 – Fax +44 1305 213600
Email: pcox@ceh.ac.uk

Prof. William E. Dietrich A member of the U.S. National Academy of Sciences and many other academic societies, his research has focused on both theoretical problems in landscape evolution and practical problems in linking landuse activities to river ecosystems. He has conducted field studies and contributed to papers on runoff generation mechanisms, landslide processes, soil production and transport, channel initiation, sediment transport processes, river meander mechanics, floodplain sedimentation, and river incision into bedrock. He has been awarded numerous research distinctions throughout his career.

ADDRESS: *University of California, Berkeley*
Department of Earth and Planetary Science
313 McCone
Berkeley, CA 94720-4767 (USA)
Tel. +1 510 6422633 – Fax +1 510 6439980
Email: bill@eps.berkeley.edu

Prof. Malin Falkenmark was born in Stockholm, Sweden in 1925 and is a fil lic graduate from Uppsala University. She is Professor Emerita of Applied and International Hydrology, and since 1991 tied to the Stockholm International Water Insitute (SIWI) and for 12 years in charge of the scientific programme of the annual Stockholm Water Symposia. She has received two Honorary Doctorates (Philosophy from Linköping University in 1975, Technology from Lund University in 2005).

ADDRESS: *Stockholm International Water Institute (SIWI)*
Hantverkargatan 5
SE-112 21 Stockholm (Sweden)
Tel. +46 8 52213977 – Fax +46 8 52213961
Email: malin.falkenmark@siwi.org

Prof. Graham Farquhar was born in Australia in 1947 and is Distinguished Professor, FAA, FRS at the Environmental Biology Group Research School of Biological Sciences, Australian National University in Canberra. His research interests are integration of photosynthesis and growth with nitrogen and water use of plants; stomatal physiology; isotopic composition of plants; global change science. He has published extensively on these topics and is a member of several Australian and international learned societies and scientific academies.

ADDRESS: *Environmental Biology Group*
Research School of Biological Sciences
GPO Box 475
Canberra, ACT 2601 (Australia)
Tel. +61 2 61253743 – Fax +61 2 61254919
Email: graham.farquhar@anu.edu.au

Prof. Marino Gatto Born in 1949, Marino Gatto is Professor of Ecology, Faculty of Civil, Environmental and Land Engineering, Polytechnical School of Milan. He is the president of the Italian Society of Ecology. His cultural background is engineering and mathematical modelling and his research has entirely focused on ecology, sustainability and management of renewable resources since 1974.

ADDRESS: *Politecnico di Milano*
Dipartimento di Elettronica e Informazione – Room 210
Via Ponzio, 34/5
I-20133 Milano (Italy)
Tel. +39 02 23993536 – Fax +39 02 23993412
Email: gatto@elet.polimi.it

Dr. Gabriel G. Katul was born in 1966 in Beirut, Lebanon where he received his B.E. degree at the American University of Beirut in 1988. He received his M.S. degree in 1990 at Oregon State University and his Ph.D degree in 1993 at the University of California (in Davis). He is currently a professor of micrometeorology and surface hydrology at the Nicholas School of the Environment and Earth Sciences and the Department of Civil and Environmental Engineering at Duke University in Durham, North Carolina. He is currently serving as an associate editor for Boundary Layer Meteorology, Advances in Water Resources, and Water Resources Research. He was a visiting fellow of the Commonwealth Science and Industrial Research Organization in Australia, and has received several honorary awards, including an honorary certificate by La Sección de Agrofísica de la Sociedad Cubana de Física in Habana. He received the Macelwane award and became an elected fellow of the American Geophysical Union in 2002. He has authored more than 115 peer-reviewed manuscripts in mass, energy, and momentum exchange processes near the land-atmosphere interface.

ADDRESS: *Nicholas School of the Environment and Earth Sciences,*
Box 90328, Duke University
Durham, NC 27708-0328 (USA)
Tel. +1 919 6138033 – Fax +1 919 6848741
Email: gaby@duke.edu
Web: http://www.nicholas.duke.edu/people/faculty/katul/homepage.html

Prof. Ulrike Lohmann was born in 1966 in Berlin, Germany and obtained her MSc and PhD in climate modelling from the Max Planck Institute for Meteorology, Hamburg, Germany. She was Assistant and Associate Professor and Canada Research Chair at Dalhousie University, Halifax, Canada, before becoming Full Professor at the Institute for Atmospheric and Climate Science

at the Swiss Federal Institute for Technology, Zurich, Switzerland. Her research focuses on the role of aerosol particles and clouds in the climate system, with emphasis on the radiation balance and the hydrological cycle. She has published more than 60 peer-reviewed articles. She is a lead author for the Fourth Assessment Report of the Intergovernmental Panel for Climate Change (IPCC) and a member of the scientific steering committees of the International Global Atmospheric Chemistry Program, the International Commission of Clouds and Precipitation and the Global Energy and Water Cycle Experiment (GEWEX) Radiation Panel. She is an editor for Atmospheric Chemistry and Physics and member of the editorial board of Atmospheric Environment.

ADDRESS: *ETH, Institute for Atmospheric and Climate Science*
Schafmattstr. 30
CH-8093 Zurich (Switzerland)
Tel. +41 1 6330514 – Fax +41 1 6331058
Email: ulrike.lohmann@env.ethz.ch

Dr. Carlos A. Nobre received his Electrical Engineering Degree from the Instituto Tecnológico de Aeronáutica, Brazil, and his PhD in Meteorology from the Massachusetts Institute of Technology, USA. He is a Senior Scientist at the Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, and former Director of the Brazilian Center for Weather and Climate Forecasting (CPTEC) from 1991 through 2003. He is also a program scientist for the Large Scale Biosphere-Atmosphere Experiment in Amazonia. Chairman-elected (2006-2008) for IGBP. His research interests in Earth System modeling and biosphere-atmosphere interactions in Amazonia.

ADDRESS: *Centro de Previsäo de Tempo e Estudos Climáticos*
Rodovia Presidente Dutra, Km 39
12630-000 Cachoeria Paulista, SP (Brazil)
Fax +55 12 31012825
Email: nobre@cptec.inpe.br

Prof. Andrea Rinaldo was born in Venice in 1954. He graduated with honors in Hydraulic Engineering (110/110 summa cum laude) at the University of Padua and earned his PhD at Purdue University in 1983. Professor of Civil and Environmental Engineering (1986-) and Director, 'Dino Tonini' International Centre for Hydrology (1996-) at the University of Padua (Italy). Chair of Hydraulic Constructions (Costruzioni Idrauliche) since 1992. Research Affiliate, Visiting Professor and Research Associate at Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, 1993-2002, he is currently Visiting Professor at Princeton University (2004-). He received several awards and citations, including: the 2005 Dalton Medal of the European Geophysical Society; the AGU Hydrology (formerly Horton) Award (1999); the Fellowship of the American Geophysical Union (2000) together with the membership of several Italian Academies. Associate Editor of Advances in Water Resources (1994-) and Water Resources Research (2000-), he has been keynote lecturer at several international conferences. Author and coauthor of five books (among which: Fractal River Basins: Chance and Self-Organization, Cambridge Univ. Press, 1997 with I. Rodriguez-Iturbe) and more than 100 papers in refereed journals.

ADDRESS: *International Centre for Hydrology 'Dino Tonini'*
Università di Padova
via Loredan, 20
I-35131 Padova (Italy)
Tel. +39 049 8275431 – Fax +30 049 8275446
Email: rinaldo@idra.unipd.it

Prof. Ignacio J. Rodríguez-Iturbe is the Theodora Shelton Pitney Professor of Environmental Sciences and Professor of Civil and Environmental Engineering at Princeton University. Born and educated in Venezuela he taught for many years at the Simon Bolivar University in Caracas and at MIT in the USA. His research is in hydrology focusing in ecohydrology, geomorphohydrology and hydrometeorology. He is the author of over 200 papers in international research journals and 3 books in his field. He has been awarded numerous international prizes including the Stockholm Water Prize, the Horton and Macelwane Medals of the American Geophysical Union, the Mexico Prize of Science and Technology and the Venezuelan National Science Prize. He is a member of numerous academies throughout the world and the recipient of several honorary degrees.

ADDRESS: *Princeton University*
Department of Civil and Environmental Engineering
Princeton, NJ 08544 (USA)
Tel. +1 609 2582287
Email: irodrigu@princeton.edu

Prof. Daniel Rosenfeld was born in 1952. He received his PhD in meteorology from the Hebrew University of Jerusalem, Israel in 1986 and is currently a full professor at this university. Prof. Rosenfeld is a world-renown expert in clouds and precipitation, including deliberate attempts to augment precipitation through cloud seeding and documentation of the suppressive effects of particulate air pollution on precipitation. These findings, some of which have been documented using techniques

derived by Prof. Rosenfeld that makes use of multi-spectral satellite data, have major negative ramifications for water supplies in affected areas and for the world climate. These will have to be considered by groups and individuals deliberating on global fresh water supplies during the 21st Century. Prof. Rosenfeld has published more than 90 refereed papers and chapters in books. He is a 'Fellow' of the American Meteorological Society and received numerous awards. Some of his recent publications are: Rosenfeld D., 2000: Suppression of Rain and Snow by Urban and Industrial Air Pollution, *Science*, 287, 1793-1796; Rosenfeld D. and I. M. Lensky, 1998: Satellite-based insights into precipitation formation processes in continental and maritime convective clouds, *The Bulletin of American Meteorological Society*, 79, 2457-2476.

ADDRESS: *Institute of Earth Sciences*
The Hebrew University of Jerusalem
Jerusalem 91904 (Israel)
Tel. office +972 2 6585821 – Fax +972 2 6512372
Email: daniel.rosenfeld@huji.ac.il

Prof. Soroosh Sorooshian UCI-Distinguished Professor of Civil and Environmental Engineering, and Earth System Science, University of California-Irvine, was born in 1948 in Kerman, Iran. After completion of high school education, he moved to the USA and received his PhD in 1978, in Systems Engineering (Water Resources and Hydrologic Systems Analysis) from UCLA. Dr. Sorooshian is a member of the National Academy of Engineering (NAE); Corresponding Member, International Academy of Astronautics (IAA); Fellow, American Association for the Advancement of Science (AAAS); Fellow, American Geophysical Union (AGU); Fellow, American Meteorological Society (AMS); Fellow, International Water Resources Association (IWRA); Chair, Science Steering Group (SSG) of Global Energy and Water Cycle Experiment (GEWEX) of the World Climate Research Programme (WCRP). He has served on numerous advisory committees, including those of NRC, NASA, NOAA, NSF, EPA, and UNESCO. Sorooshian was named by NASA as the recipient of the 2005 Distinguished Public Service Medal. NASA cites Sorooshian for his 'distinguished record in providing scientific leadership for global water cycle research and assuring that NASA science is well integrated into international programs'.

ADDRESS: *University of California, Irvine*
Department of Civil and Environmental Engineering
E-4130 Engineering Gateway
Irvine, CA 92697-2175 (USA)
Tel. +1 949 8248825 – Fax +1 949 8248831
Email: soroosh@uci.edu

For the biographies of the Academicians cfr. Pontificia Academia Scientiarvm, *Year Book* (Vatican City 2004), p. 15 ff.


P.J. Cruzeiro

Noi non entreremo affatto, lo capite bene, nella complessità di questa questione tecnica né delle sue possibilità di applicazione, che senza dubbio sarebbero ancora premature. Ma sappiamo che si tratta qui di una sorta di importante metabolismo che l'umanità ha interesse a investigare a fondo, dato che la scarsità delle riserve di acqua dolce rischia di ostacolare il suo sviluppo. Sottolineiamo soltanto, nel più generale campo della ricerca scientifica, due atteggiamenti che ci sembra debbano caratterizzare lo scienziato e lo scienziato cristiano. Da un lato, egli deve lealmente interrogarsi sull'avvenire terrestre dell'umanità e – da uomo responsabile – concorrere a prepararlo, a preservarlo, a eliminare i rischi; noi riteniamo che questa solidarietà con le generazioni future sia una forma di carità alla quale molti, del resto, sono oggi sensibili nel quadro dell'ecologia. Ma, allo stesso tempo, lo scienziato deve essere animato dalla fiducia che la natura nasconde delle possibilità segrete, che spetta all'intelligenza scoprire e mettere in atto, per giungere allo sviluppo che è nel disegno del Creatore. Questa speranza nell'Autore della natura e dello spirito umano – rettamente intesa – è in grado di dare al ricercatore credente una energia nuova e serena.

Paul VI, *Address of 19 April 1975 to the participants of the study week on* 'Biological and Artificial Membranes and Desalination of Water', in *Papal Addresses*, The Pontifical Academy of Sciences, Scripta Varia 100, Vatican City 2003, p. 208 f.

CASINA PIO IV
V-00120 VATICAN CITY
Tel: 0039 0669883451 Fax: 0039 0669885218
Email: academy.sciences@acdscience.va

For further information please visit:
http://www.vatican.va/roman_curia/pontifical_academies/acdscien/index.htm