

Secretariat of 21st-CENTURY EARTH AWARDS

Global Environmental Problem Proposal Competition

3-1-4-1004, Tsukiji, Chuo-ku, Tokyo 104 Japan TEL03-3545-6897 FAX03-3545-9769

21世紀地球賞事務局

地球環境論文コンペティション

〒104 東京都中央区築地3-1-4-1004 TEL03-3545-6897 FAX03-3545-9769

THE ITINERARY

- April 29 Thur. 17:10 ARR NARITA by SQ12(#1 TERMINAL)
To the hotel
*HOTEL: Hotel President Aoyama
(TEL 3497-0111)
- April 30 Fri. 8:45 Mr. Iida (GISPRI) will meet you at the
hotel for a breakfast meeting and take you
to the Keidanren Kaikan afterwards.
- 11:30 Meeting with an interpreter at the
Keidanren Kaikan (A copy of your keynote
address which you sent us has been passed
on to her/him.)
- 12:00 Lunch
- 13:00 Commemorative Symposium
(You have 50 minutes for your speech.)
- 17:00 Awarding Ceremony
- 18:00 Reception
- 20:00 Back to the hotel
- May 1 Sat. 9:30 Leave the hotel for NARITA airport.
(We'll make an arrangement for a car if
necessary.)
- 13:50 DEP NRT by MU 524

Agenda 21 for Japan's Contribution
toward Global Environmental

Problems

Dr. Shuji Fukukawa

- ① Population - Girl child
- ② Affluence; Better standard of life through less consumption - Awareness through action - Improved Sustainable lifestyles - Sustainable options

- ③ Technology - Training Mass media Cable TV Net works Trade

Prof. Takeuchi - Do nothing is not the correct approach.

Agenda 21

Dr. Fukukawa

Population - Girl child - Kerala

Ms. Yasuhara

Affluence: Improving quality of life - Sustainable options - facilitate their adoption.

Prof. Takeuchi

Technology - Information - Cable TV - Green Technology - Mass media - Network.

Mr. Ikeda

Training: Grass roots - NGO - ORCA Japanese youth - Awareness through Action

Trade:

Integrated Integ Conservation & Development programs Coastal crisis

The Second 21st Century Earth Awards
- Global Environmental Problem Proposal Competition -

COMMEMORATIVE SYMPOSIUM · PRESENTATION OF AWARDS · RECEPTION

○Date : April 30, 1993 1:00pm~8:00pm

○Venue: Keidanren Kaikan

1-9-4 Otemchi, Chiyoda-ku, Tokyo 100

Tel.03-3279-1411

○Program:

COMMEMORATIVE SYMPOSIUM

1:00pm to 4:30pm at the International Conference Hall(11F)

PRESENTATION OF AWARDS

5:00pm to 6:00pm at the Pearl Room(10F)

RECEPTION

6:00pm to 8:00pm at the Ruby Room(10F)

○Organizers:

Nihon Keizai Shimbun, Inc.

Global Industrial and Social Progress Research Institute
(GISPRI)

○Supporters:

Ministry of International Trade & Industry

Environment Agency

Ministry of Foreign Affairs

Ministry of Education

○Cooperators:

The United Nations University

Japan Junior Chamber Inc.

International Institute for Applied Systems Analysis

Resources for the Future

TATA Energy Research Institute

The Royal Institute of International Affairs

World Resources Institute

○Sponsor:

Toho Mutual Life Insurance Co.

PRESENTATION OF AWARDS

17:00 Opening Address

17:02 Organizer's speech

Takuhiko Tsuruta

President and Chief Executive Officer

Nihon Keizai Shimbun, Inc.

17:05 Review

Takashi Mukaibo

Chairman of the Screening Committee

Chairman, Global Industrial and Social Progress Policy Forum/

Professor Emeritus, The University of Tokyo

17:15 Presentation

21st Century Earth Award

-General Study Section-

21st Century Earth Award

-Life-style Proposal Section-

Nihon Keizai Shimbun Award

-General Study Section-

Nihon Keizai Shimbun Award

-Life-style Proposal Section-

GISPRI Award

-General Study Section-

GISPRI Award

-Life-style Proposal Section-

17:35 Comments from the recipients

21st Century Earth Award

-General Study Section-

by Mr. Daniel M. Kammen

21st Century Earth Award

-Life-style Proposal Section-

by Mr. Eiju Shinzawa

COMMEMORATIVE SYMPOSIUM

13:00 Opening Address

13:00 Keynote Speech 1

"Environment Protection In An Unequal World"

Dr. M. S. Swaminathan

Chairman of M.S. Swaminathan Research Foundation

14:00 Keynote Speech 2

"Environment Poverty and Development after UNCED -- Principles for Cooperation"

Dr. Jonathan J. Lash

President of World Resources Institute

14:50 Recess

15:00 Panel Discussion

"Japan's Contribution Toward International Environmental Problem"

16:30

Panelists

Prof Kei Takeuchi / Professor, The University of Tokyo

M Tadashi Yasuhara / Director General, Environmental Information Center

Mr Nobuhiro Okada / Chairman, Japan Junior Chamber Inc.

Mr Shinji Fukukawa / Senior Advisor, Global Industrial and Social Progress Research Institute (GISPRI)

Coordinator

Hiroyuki Torii / Nihon Keizai Shimbun, Inc.

Japan's agenda 2)

Technology
Training
Trade

Grassroots - Role of NGOs
Technological empowerment of the poor -
reaching the unreached.

(a) Do nothing
is not the correct
approach
(b) Promote
sustainable
life styles

2. Fukukawa

Population

Penal literacy - Girl child

eg. Kerala

Affluence

Sustainable life style -
biodegradable products
Non-polluting automobiles

Technology
Training
Trade: → Technology

Eco-technology - Good efforts to
compensate private industry
Intellectual contributions -
policy dialogue
Green energy

Mr. Okada

7 points

- (a) share common philosophy through
better communication - Global
citizens
- (b) Awareness through action

92-92 - Japanese Govt.

of Father of US Dollars
and Hirohito for ODA

M.S.SWAMINATHAN RESEARCH FOUNDATION

M.S. SWAMINATHAN

Chairman

MSS/SS/ETRE/
13 April, 1993

Hector Gurgulino de Souza
Rector
United Nations University
Tokyo, Japan.

Dear Dr. de Souza,

I am looking forward to my participation in the Commemorative Forum for the Second 21st Century Earth Awards. The title of my lecture will be Environment Protection in an Unequal World. I enclose a CV and list of publications.

My travel schedule is enclosed. Kindly ask your office to arrange suitable hotel accommodation for April 29 and 30th and give me a fax giving name and address of the hotel.

With warm personal regards,

Yours Sincerely,



M.S. Swaminathan

Encl: as above



FACSIMILE

UNU FAX: +81 3 3499 2828
TELEX: J25442 UNATUNIV

ALLOTMENT MBDE:
TYPED BY: MB/va

UNU SERIAL NO:	DATE: 8 April 1993	TIME: 16:06
----------------	--------------------	-------------

TO: Dr. M. S. Swaminathan Chairman, M.S. Swaminathan Research Foundation Madras, India	FAX NO: (91-44)47-8148
--	------------------------

FROM: Heitor Gurgulino de Souza Rector, United Nations University, Tokyo, Japan	Sender's Signature <i>Heitor Gurgulino de Souza</i>
--	--

Dear Dr. Swaminathan,

I am writing to you today, further to our telephone conversation last evening, to thank you for accepting to give a keynote speech at the Commemorative Forum for the Second 21st Century Earth Awards which will be held during the afternoon of 30 April 1993 in Tokyo, Japan. In cooperation with the United Nations University (UNU), an international essay contest is being organized by the Nihon Keizai Shimbun newspaper and the Global Industrial and Social Progress Research Institute (GISPRI). Details of the 21st Century Earth Awards were announced in the October 1, 1992 issue of Nature (Vol. 359, No. 6394). The forum is being held at the time of the commendation of the 21st Century Earth Awards.

Your keynote speech should be approximately one hour in duration. The specific title of your address would be very much your own choice, however, we are hopeful that it could be centered on the general theme of environmental protection and international cooperation. I would be most appreciative if you could let me know soonest the specific title of your address. Your address would be one of two to be given during the Forum; the other keynote speaker will be Dr. Jonathan Lash, President of the World Resources Institute. We would also appreciate it if you could be available to interact with the other forum participants and the audience as well as to attend the award ceremony and a reception the same afternoon.

A sum of US\$15,000 has been made available for the expenses (including travel, accommodation and honorarium) for your visit for the 30 April 1993 lecture. I would be most grateful if you could fax to me at your earliest convenience the name and address, and account number of the bank which this amount should be transferred. The transfer would be made to the account upon receipt of this information to enable you to begin to make your travel and other arrangements.

I would appreciate it if you could provide me with the requested details at fax number 81-3-3499-2810 in Tokyo. We would also be most appreciative if you could send to us by fastest means a photograph of yourself and summary C.V. that might be used in connection with the announcement of the keynote speech.

If you should require additional information, clarification or assistance, please do not hesitate to contact me.

With best regards,

Yours sincerely,

Heitor Gurgulino de Souza
Heitor Gurgulino de Souza
Rector



2-3



THE PRESIDENT HOTEL
 ホテル プレシデント 青山

〒107 東京都港区南青山2-2-3 TEL.03(3497)0111
 2-2-3 Minami-Aoyama, Minato-ku, Tokyo

3-3

The United Nations University

53-70, Jingumae 5-chome
Shibuya-ku, Tokyo 150
Japan

Telephone (03) 3499 2811
Fax (03) 3499 2828
Telex J25447



地下鉄表参道駅
Subway Omotesando Station

表参道

国際連合大学
United Nations University

青山学院大学
Aoyama Gakuin Univ.

首都高速3号

青山病院
Aoyama Hospital

こどもの城
National Children's
Castle

宮益坂

青山通り Aoyama St.

東横線
Toei Mita Line

JR渋谷駅
JR-Shibuya Station

M.S. SWAMINATHAN RESEARCH FOUNDATION
14, Second Main Road, Madras 600 085, INDIA

FAX MESSAGE

Reply Fax No. : 91-44-410031
Dial up No. : 91-44-416923

Total No. of Pages :
(incl. this page)

16 April, 1993

To: Mr. Max Bond
The United Nations University
Tokyo, Japan

FAX NO: (03) 3499 2828

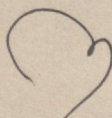
Telex: 125442

Dear Max Bond,

As desired I enclose two signed copies of the application form. I also enclose a copy of my travel itinerary.

With warm regards,

Yours Sincerely,



M.S. Swaminathan

Encl: 3 pages



The United Nations University

Headquarters

53-70 Jingumae 5-chome
Shibuya-ku, Tokyo 150
Japan

Telephone (03) 3499 2811
Fax (03) 3499 2828
Telex J25442
Cable UNATUNIV TOKYO
BITNET
UNUMBOX@JPNUNU00

国際連合大学 本部

〒150 東京都渋谷区神宮前5丁目53-70

FAX

UNU serial number _____ Page number 1 of 3

Date 14 April 1993 Time _____

To: Dr. M.S. Swaminathan

Fax Direct Telephone 91544-410031

Approving Officer _____

From: Max Bond, Planning & Dev. Officer

Signature

Dear Dr. Swaminathan,

I refer to Prof. de Souza's recent fax to you and your reply dated 9 April 1993 concerning your visit to Tokyo later this month to deliver a keynote address at the 21st Century Earth Awards. In order for the honorarium to be transferred to you, we need to receive back from you signed copies of the attached form, in duplicate. The form permits the organizers to transfer the honorarium to you without tax liability (both for you and the organizers). We have completed the forms as best we can with the information at hand. Kindly fax back to us the two signed copies soonest. It may be necessary for you to sign the originals when after you arrive in Tokyo, but this is not yet certain.

If you should have any questions or require additional clarification, please do not hesitate to contact me.

With best wishes,

租税条約に関する届出書

(税務署専用欄)
(For official use only)

APPLICATION FORM FOR INCOME TAX CONVENTION

(自由職業者・芸能人・運動家・短期滞在者の報酬・給与に対する所得税の免除)
Relief from Japanese Income Tax on Income Earned by Professionals, Entertainers, Athletes and Temporary Visitors

適用: 有 無

税務署長殿

この届出書の記載に当たっては、裏面の注意事項を参照してください。
See instructions on the reverse side.

To the Director of Taxation Office

1 適用を受ける租税条約に関する事項;
Applicable Income Tax Convention

日本国と インド との間の租税条約第 1 条第 1 項
The Income Tax Convention between Japan and India, Article 1, para. 1

2 報酬・給与の支払を受ける者に関する事項;
Details of Recipient of Salary or Remuneration

氏名 Full name	M. S. Swaminathan		
住所 Domicile	M. S. Swaminathan Research Foundation 14, II Main Road, Kottur Gardens, Kotturpuram, Madras 600 085, In		
国内における居所 Residence in Japan	c/o Hotel President, Tokyo (Tel. 03-3497-0111)		
(国籍 Nationality)	(入国年月日 Date of Entry)	(在留期間 Period of Stay)	(在留資格 Immigration Status)
Indian	29 April 1993	3 days	出入国管理及び難民認定法第4条第1項第...号該当 Immigration-Control and Refugee-Recognition Act, Article 4, para. 1, subpara. ...
下記「4」の報酬・給与につき居住者として課税される国及び納税地 Country where the recipient is taxable as resident on Salary or Remuneration mentioned in 4 below and the place where he is to pay tax			
自由職業者、芸能人又は運動家の場合(短期滞在者に該当する者を除く。): 日本国内の恒久的施設又は固定的施設の状態 In case of Professionals, Entertainers or Athletes (other than Temporary Visitors): Permanent establishment or fixed base in Japan <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	名称 Name	None	
	所在地 Address	None	
	事業の内容 Details of business	None	
短期滞在者の場合: 以前に日本国内に在留したことの有無及び在留したことのある場合にはその入出国年月日等 In case of Temporary Visitors: Particulars on previous stay <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	(以前の入国年月日) Date of Previous Entry	(以前の出国年月日) Date of Previous Departure	(以前の在留資格) Previous Immigration Status 出入国管理及び難民認定法第4条第1項第...号該当 Immigration-Control and Refugee-Recognition Act, Article 4, para. 1, subpara. ...

3 報酬・給与の支払者に関する事項;
Details of Payer of Salary or Remuneration

氏名又は名称 Full name	P. P. C. Corporation		
住所(居所)又は本店(主たる事務所)の所在地 Domicile (residence) or place of head office (main office)	3-1-4-801, Tsukiji, Chuo-ku, Tokyo Japan 104		
日本国内の恒久的施設又は固定的施設の状態 Permanent establishment or fixed base in Japan <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	名称 Name	Same as above (事業の内容 Details of Business) Management of Events	
	所在地 Address	Same as above	

4 上記「3」の支払者から支払を受ける報酬・給与で「1」の租税条約の規定の適用を受けるものに関する事項(注5);
Details of Salary or Remuneration received from the Payer to which the Convention mentioned in 1 above is applicable (Note 5)

提供したサービスの概要 Description of Services performed	提供期間 Period of Services performed	報酬・給与の支払期日 Due Date for Payment	報酬・給与の支払方法 Method of Payment of Salary, etc.	報酬・給与の金額及び月額・年額の区分 Amount of Salary, etc. (per month, year)
Lecture	Apr. 30, 1993		Bank Transfer	US\$15,000.-

5 上記「3」の支払者以外の者から日本国内における勤務又は人的役務の提供に関して支払を受ける報酬・給与に関する事項(注7);
Others Salaries or Remunerations paid by Persons other than 3 above for Personal Services performed in Japan (Note 7)

None

6 その他参考となるべき事項(注8);
Others (Note 8)

None

私は、この届出書の「4」に記載した報酬・給与が「1」に掲げる租税条約の規定の適用を受けるものであることを、「租税条約の実施に伴う所得税法、法人税法及び地方税法の特例等に関する法律」の施行に関する省令の規定により届け出るとともに、この届出書の記載事項が正確かつ完全であることを宣言します。

In accordance with the provisions of the Ministerial Ordinance for the Implementation of the Law concerning the Special Measures of the Income Tax Law, the Corporation Tax Law and the Local Tax Law for the Enforcement of Income Tax Conventions, I hereby submit this application form under the belief that the provisions of the Income Tax Convention mentioned in 1 above is applicable to Salary, etc., mentioned in 4 above and also hereby declare that the above statement is correct and complete to the best of my knowledge and belief.

Date April 14, 93

報酬・給与の支払を受ける者の署名
Signature of the Recipient of Salary or Remuneration

M. S. Swaminathan

租税条約に関する届出書

(税務署用紙)
For official use only

APPLICATION FORM FOR INCOME TAX CONVENTION

(自由職業者・芸能人・運動家・短期滞在者の報酬・給与に対する所得税の免除)
Relief from Japanese Income Tax on Income Earned by Professionals, Entertainers, Athletes and Temporary Visitors

適用：有、無



この届出書の記載に当たっては、裏面の注意事項を参照してください。
See instructions on the reverse side.

税務署長殿

To the Director of _____ Taxation Office

1 適用を受ける租税条約に関する事項;
Applicable Income Tax Convention

日本国と インド との間の租税条約第 条第 項
The Income Tax Convention between Japan and India, Article , para.

2 報酬・給与の支払を受ける者に関する事項;
Details of Recipient of Salary or Remuneration

氏名 Full name	M. S. Swaminathan		
住所 Domicile	M. S. Swaminathan Research Foundation 14, II Main Road, Kottur Gardens, Kotturpuram, Madras 600 085, India		
国内における居所 Residence in Japan	c/o Hotel President, Tokyo (Tel. 03-3497-0111)		
(国籍 Nationality)	(入国年月日 Date of Entry)	(在留期間 Period of Stay)	(在留資格 Immigration Status)
Indian	29 April 1993	3 days	出入国管理及び難民認定法第4条第1項第 <u> </u> 号該当 Immigration-Control and Refugee-Recognition Act, Article 4, para. 1, subpara. <u> </u>
下記「4」の報酬・給与につき居住者として課税される国及び納税地 Country where the recipient is taxable as resident on Salary or Remuneration mentioned in 4 below and the place where he is to pay tax			
自由職業者、芸能人又は運動家の場合(短期滞在者に該当する者を除く。); 日本国内の恒久的施設又は固定的施設の状態 In case of Professionals, Entertainers or Athletes (other than Temporary Visitors): Permanent establishment or fixed base in Japan <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	名称 Name	None	
	所在地 Address	None	
	事業の内容 Details of business	None	
短期滞在者の場合: 以前に日本国に在留したことのある者及び在留したことのある場合にはその入出国年月日等 In case of Temporary Visitors: Particulars on previous stay <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	(以前の入国年月日) Date of Previous Entry	(以前の出国年月日) Date of Previous Departure	(以前の在留資格) Previous Immigration Status 出入国管理及び難民認定法第4条第1項第 <u> </u> 号該当 Immigration-Control and Refugee-Recognition Act, Article 4, para. 1, subpara. <u> </u>

3 報酬・給与の支払者に関する事項;
Details of Payer of Salary or Remuneration

氏名又は名称 Full name	P. P. C. Corporation		
住所(居所)又は本店(主たる事務所)の所在地 Domicile (residence) or place of head office (main office)	3-1-4-801, Tsukiji, Chuo-ku Tokyo Japan 104		
日本国内の恒久的施設又は固定的施設の状態 Permanent establishment or fixed base in Japan <input type="checkbox"/> 有(Yes), <input type="checkbox"/> 無(No) If "Yes", explain:	名称 Name	Same as above Management of Events	
	所在地 Address	Same as above	
	事業の内容 Details of Business	Management of Events	

4 上記「3」の支払者から支払を受ける報酬・給与で「1」の租税条約の規定の適用を受けるものに関する事項(注5);
Details of Salary or Remuneration received from the Payer to which the Convention mentioned in 1 above is applicable (Note 5)

提供する役務の概要 Description of Services performed	役務提供期間 Period of Services performed	報酬・給与の支払期日 Due Date for Payment	報酬・給与の支払方法 Method of Payment of Salary, etc.	報酬・給与の金額及び月額・年額の区分 Amount of Salary, etc. (per month, year)
Lecture	Apr. 30, 1993		Bank Transfer	US\$15,000.-

5 上記「3」の支払者以外の者から日本国内における勤務又は人的役務の提供に関して支払を受ける報酬・給与に関する事項(注7);
Others Salaries or Remunerations paid by Persons other than 3 above for Personal Services performed in Japan (Note 7)

None

6 その他参考となるべき事項(注8);
Others (Note 8)

None

私は、この届出書の「4」に記載した報酬・給与が「1」に掲げる租税条約の規定の適用を受けるものであることを、「租税条約の実施に伴う所得税法、法人税法及び地方税法の特例等に関する法律」の施行に関する省令の規定により届け出るとともに、この届出書の記載事項が正確かつ完全であることを宣言します。

In accordance with the provisions of the Ministerial Ordinance for the Implementation of the Law concerning the Special Measures of the Income Tax Law, the Corporation Tax Law and the Local Tax Law for the Enforcement of Income Tax Conventions, I hereby submit this application form under the belief that the provisions of the Income Tax Convention mentioned in 1 above is applicable to Salary, etc., mentioned in 4 above and also hereby declare that the above statement is correct and complete to the best of my knowledge and belief.

Date April 04, 93

報酬・給与の支払を受ける者の署名
Signature of the Recipient of Salary or Remuneration

M. S. Swaminathan

MSS/KS

April 9, 1993

Dr. Heter Gurgulino de Souza
Rector, United Nations University
Tokyo, Japan

Fax No. 81 - 3 - 3499 - 2810

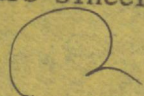
Dear Dr. Souza,

I thank you for your fax inviting me to deliver a key note address on the occasion of the 21st Century Earth Awards on 30th April 1993. I shall be happy to deliver the lecture on Environment Protection in an unequal world. I shall arrive in Tokyo on the afternoon of April 29th. I have to leave for Hangzho in China on May 1st. Hence kindly request your office to arrange accommodation for two nights (29th and 30th April).

I am sending the photograph and CV by speed post. My Bank A/c. No. SB 8660, State Bank of Mysore, Abhiramapuram Branch, C.P. Ramaswamy Iyer Road, Madras-600 018. Looking forward to welcoming you.

With warm regards,

Yours sincerely,



M.S. Swaminathan



(Transmitted to your office on 8 April at 16:06 hours)

UNITED NATIONS UNIVERSITY

FACSIMILE

UNU FAX: +81 3 3499 2828
TELEX: J25442 UNATUNIV

ALLOTMENT MBDE:
TYPED BY: MB/va

UNU SERIAL NO:	DATE: 8 April 1993	TIME: 16:06
----------------	--------------------	-------------

TO:	Dr. M. S. Swaminathan Chairman, M.S. Swaminathan Research Foundation Madras, India	FAX NO: (91-44)47-8148
-----	--	------------------------

FROM:	Heitor Gurgulino de Souza Rector, United Nations University, Tokyo, Japan	Sender's Signature <i>Heitor</i>
-------	--	-------------------------------------

Dear Dr. Swaminathan,

I am writing to you today, further to our telephone conversation last evening, to thank you for accepting to give a keynote speech at the Commemorative Forum for the Second 21st Century Earth Awards which will be held during the afternoon of 30 April 1993 in Tokyo, Japan. In cooperation with the United Nations University (UNU), an international essay contest is being organized by the Nihon Keizai Shimbun newspaper and the Global Industrial and Social Progress Research Institute (GISPRI). Details of the 21st Century Earth Awards were announced in the October 1, 1992 issue of Nature (Vol. 359, No. 6394). The forum is being held at the time of the commendation of the 21st Century Earth Awards.

Your keynote speech should be approximately one hour in duration. The specific title of your address would be very much your own choice, however, we are hopeful that it could be centered on the general theme of environmental protection and international cooperation. I would be most appreciative if you could let me know soonest the specific title of your address. Your address would be one of two to be given during the Forum; the other keynote speaker will be Dr. Jonathan Lash, President of the World Resources Institute. We would also appreciate it if you could be available to interact with the other forum participants and the audience as well as to attend the award ceremony and a reception the same afternoon.

A sum of US\$15,000 has been made available for the expenses (including travel, accommodation and honorarium) for your visit for the 30 April 1993 lecture. I would be most grateful if you could fax to me at your earliest convenience the name and address, and account number of the bank which this amount should be transferred. The transfer would be made to the account upon receipt of this information to enable you to begin to make your travel and other arrangements.

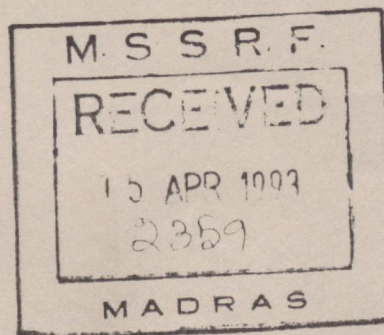
I would appreciate it if you could provide me with the requested details at fax number 81-3-3499-2810 in Tokyo. We would also be most appreciative if you could send to us by fastest means a photograph of yourself and summary C.V. that might be used in connection with the announcement of the keynote speech.

If you should require additional information, clarification or assistance, please do not hesitate to contact me.

With best regards,

Yours sincerely,

Heitor
Heitor Gurgulino de Souza
Rector





FACSIMILE

UNU FAX +81 3 3499 2828
TELEX: J25442 UNATUNIV

ALLOTMENT MBDE:
TYPED BY: MB/va

UNU SERIAL NO:	DATE: 8 April 1993	TIME:
----------------	--------------------	-------

TO:	Dr. M. S. Swaminathan Chairman, M.S. Swaminathan Research Foundation Madras, India	FAX NO: (91-44)47-8148
-----	--	------------------------

FROM:	Heitor Gurgulino de Souza Rector, United Nations University, Tokyo, Japan	Sender's Signature <i>Heitor Gurgulino de Souza</i>
-------	--	--

Dear Dr. Swaminathan,

I am writing to you today, further to our telephone conversation last evening, to thank you for accepting to give a keynote speech at the Commemorative Forum for the Second 21st Century Earth Awards which will be held during the afternoon of 30 April 1993 in Tokyo, Japan. In cooperation with the United Nations University (UNU), an international essay contest is being organized by the Nihon Keizai Shimbun newspaper and the Global Industrial and Social Progress Research Institute (GISPRI). Details of the 21st Century Earth Awards were announced in the October 1, 1992 issue of Nature (Vol. 359, No. 6394). The forum is being held at the time of the commendation of the 21st Century Earth Awards.

Your keynote speech should be approximately one hour in duration. The specific title of your address would be very much your own choice, however, we are hopeful that it could be centered on the general theme of environmental protection and international cooperation. I would be most appreciative if you could let me know soonest the specific title of your address. Your address would be one of two to be given during the Forum; the other keynote speaker will be Dr. Jonathan Lash, President of the World Resources Institute. We would also appreciate it if you could be available to interact with the other forum participants and the audience as well as to attend the award ceremony and a reception the same afternoon.

A sum of US\$15,000 has been made available for the expenses (including travel, accommodation and honorarium) for your visit for the 30 April 1993 lecture. I would be most grateful if you could fax to me at your earliest convenience the name and address, and account number of the bank which this amount should be transferred. The transfer would be made to the account upon receipt of this information to enable you to begin to make your travel and other arrangements.

I would appreciate it if you could provide me with the requested details at fax number 81-3-3499-2810 in Tokyo. We would also be most appreciative if you could send to us by fastest means a photograph of yourself and summary C.V. that might be used in connection with the announcement of the keynote speech.

If you should require additional information, clarification or assistance, please do not hesitate to contact me.

With best regards,

Yours sincerely,

Heitor Gurgulino de Souza
Heitor Gurgulino de Souza
Rector

Environment Protection
in an unequal
world

Departure: Madras
28th April night
Reach Tokyo 29th April
Stay in Tokyo 29+30 April

May 1. Leave for Hongkong + Hangzhou (via Shanghai)

**The United Nations
University**

Headquarters

FAX

UNU serial number

E-73-1506

Page number of

1 of 1

53-70, Jingumae 5-chome
Shibuya-ku, Tokyo 150
Japan

Telephone (03) 3499 2811

Fax (03) 3499 2828

Telex J25442

Cable UNATUNIV TOKYO

BITNET:

UNUMBOX@JPNUNU00

Date

7 April 1993

Time

国際連合大学 本部

To

Dr. M.S. Swaminathan, Chairman
M.S. Swaminathan Research Foundation, Madras, India

〒150 東京都渋谷区神宮前 5丁目 53-70

Fax ...

(91-44) 47-8148

Direct Telephone

Approving Officer

From

H. Gurgulino de Souza, Rector
The United Nations University, Tokyo, Japan

Signature

Re. UNU Agenda 21

In reference to my letter to you of 12 March 1993 on the above-mentioned subject, we have just finished our first meeting of the Advisory Team here in Tokyo to discuss the organization of the feasibility study on the above-mentioned initiative of the United Nations University. A report of the meeting is under preparation and will be sent to you within a week or two from now. We also discussed the venue and dates for the second meeting and find it convenient to hold it in Paris on 22 and 23 May 1993 (Saturday and Sunday), as originally scheduled, as far as those present at the first meeting are concerned.

I would ask you whether you will be able to attend the meeting in Paris on 22 and 23 May 1993. Alternatively, we are thinking of having a briefing meeting in Paris on 25 May (Tuesday) for those who will not be available on those dates. I would appreciate it very much if you could let me know of your availability by return, hopefully by Friday this week.

With best regards.

REVIEW

Takashi Mukaibo
Chairman of the Screening Committee
Chairman, Global Industrial and Social
Progress Policy Forum
Professor Emeritus,
The University of Tokyo

I'm very pleased and grateful that "The Second 21st Century Earth Awards - Global Environmental Problem Proposal Competition" was organized again following the last year.

While serious efforts have been made and various actions taken to solve ever growing global environmental problems and some of them have turned out to be fruitful, the environmental problems which face us all are far more enormous and critical, including global warming, deforestation and endangered species of wild life.

This competition creates an opportunity to collect excellent opinions and ideas from all over the world and to introduce them to the public. I hope that their studies and researches will be implemented or practiced as well as encourage more people to take actions, and therefore contribute to solve the problems and difficulties.

This year we received 381 proposals in total; 151 in the General Study Section and 230 in the Life-style Proposal Section. The 151 proposals in the General Study Section include 49 overseas entries from 15 different countries. This number is twice as many as that of last year and we owe this achievement to the overseas cooperating organizations.

From these many proposals, we have chosen 3 in the General Study Section and 4 including Commendation Award in the Life-style Proposal Section. The screening committee consists of 12 members including myself. They are all qualified and eminent people in their own professional fields.

Now I shall introduce each recipient and his or her work. First in the General Study Section and that will be followed by the Life-style Proposals. Main criteria applied in the judging process include their originality and feasibility.

The winner of the 21st Century Earth Award is Mr. Daniel M. Kammen from the United States who made this great success with "REDUCING GREENHOUSE GAS EMISSIONS AND IMPROVING ENVIRONMENTAL HEALTH IN

DEVELOPING NATIONS ; A PROGRAM FOR ENERGY MANAGEMENT, COOKING TECHNOLOGY AND EDUCATION” .

Food and Agricultural Organization (FAO) and the United Nations Environment Programme (UNEP) have reported that, as of the end of 1990, an yearly loss of tropical rain forest exceeds 16.8 million hectares. According to FAO, the leading factors of the problem include slash-and-burn farming, pasturing, development for settlement and farmland, and use of firewood.

As you all know, in developing nations people still depend on biomass energy such as wood and charcoal which closely relates to deforestation problem.

Mr. Kammen points out that this biomass burning contributes to greenhouse gas emissions and is firmly linked to acute respiratory infection (ARI). ARI is the leading health hazard to children in developing nations and results in an estimated 4.3 million deaths per year.

In his proposal, Mr. Kammen introduces modernized woodstoves and solar ovens for household cooking which can cut fossil-fuel use by 50% or more. With these technologies he presents a “win-win” situation: reducing both the threats of global warming and indoor air pollution.

In general, the renewable energy is considered not to be suitable for a large-scale, energy-consuming use. It also has a difficulty in its supplying stability. However, not impeded by these general arguments, Mr. Kammen has conducted devoted research and field study and successfully shown us a feasible solution to the global environmental problems.

As the winner of the Nihon Keizai Shimbun Inc. Award, we've chosen Mr. Hiroshi Shimizu who submitted a proposal titled “A PROPOSAL FOR SUSTAINABLE DEVELOPMENT : THE ASIACAR” . Mr. Shimizu foresees further environmental deterioration in Asian nations where automobiles are enormously increasing in number along with greenhouse gas emissions. To tackle these problems, Mr. Shimizu proposes an auto-system utilizing solar energy.

Various car-related problems including energy, accident, traffic congestion which all car-dependent communities suffer are also taken into consideration. Mr. Shimizu points out the problem in introducing the automobiles which have originally been developed in the United States where the population density is relatively low to the more densely populated Asian nations. To solve this problem, his unique

proposal suggests to utilize the most advanced technology as well as presents a feasible solution.

The winners of GISPRI Award are Mr. Toshie Nishizawa, Mr. Akio Tsuchiya, and Ms. Maria Magdarena Vieira Pinto who received this award with their joint effort on "CHARACTERISTICS AND UTILIZATION OF TREE SPECIES IN THE SEMI-ARID WOODLAND OF NORTHEAST BRAZIL". Today Mr. Nishizawa is present here with us.

The three researchers studied on the tree species called caatinga in Northeast Brazil, focusing on its response to water and estimating its plant succession. According to their study, while the caatinga forests are rapidly disappearing, these trees can regenerate within only 15 years. They are indispensable resources and are utilized for feed for livestock, firewood and bread-baking. Therefore, the group emphasized the appropriate and sensible management of this caatinga forest.

Many proposals have been made in different occasions for protection and preservation of tropical rain forests; however, this proposal deserves highest evaluation as experience-based, feasible proposition.

Now, I shall move on to the Life-style Proposal Section. In this section, proposals were expected to approach environmental problems on the everyday-life basis ; to suggest feasible action plans.

Applying these main criteria, we chose "THE FIRST STEP IN THE FEASIBLE PLAN WHICH CAN BE IMPLEMENTED STEADILY AND WIDELY" as the winner of the 21st Century Earth Award which is proposed by Mr. Eiju Shinzawa, Ms. Yukiyo Nakajima, Mr. Heiju Maeda, Mr. Kunihiro Takahashi and Mr. Shinji Suzuki. They're all working in the same company.

They prepared 2 sets of eco-friendly actions which were individually feasible ; one for the office, and the other at home. However, when they put each item into practice, there were much to learn ; for example, some turned out to be not so easy as it had seemed before. Their proposal tells us how they have achieved the first step toward environmental problems through trial and error. I hope that this kind of effort will be further extended to more offices and families.

The recipient of the Nihon Keizai Shimbun Award is Ms. Midori Kawabe who received this award with her proposal called "MEASURING

THE ENVIRONMENTAL VALUE"

In her proposal, she discusses the problem in a choice between environmental protection and development. To solve this problem, she proposes to develop one single standard to evaluate these two factors.

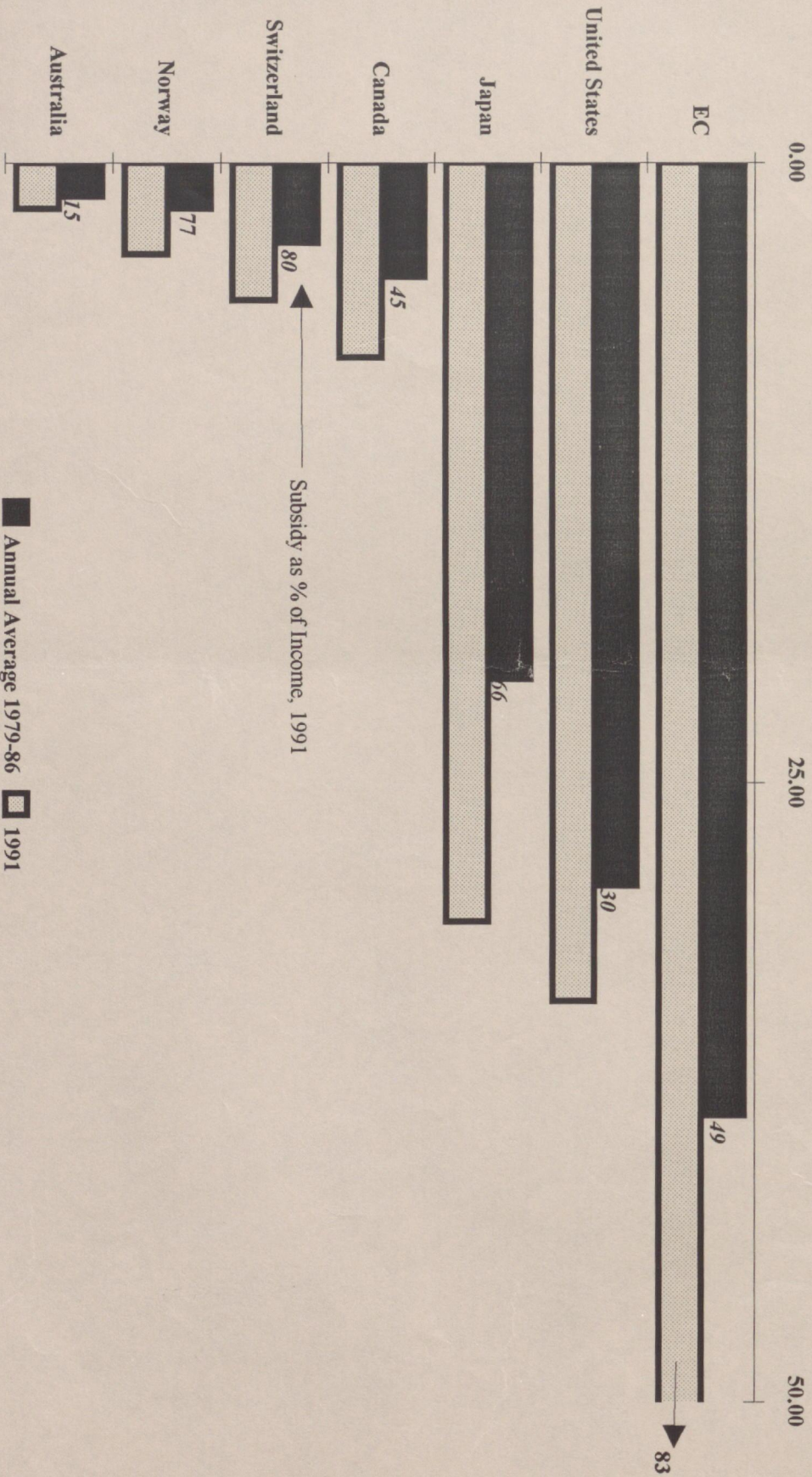
As one way to assess people's commitment, she suggests to ask them how much monetary cost they prepared to bear in order to protect and improve environment.

The recipient of the GISPRI Award is Ms. Manami Imakita. The title of her proposal is "RECYCLE WILL SAVE THE EARTH".

This is a documentary on environmental education taking place in a junior high school. Ms. Imakita, encouraging her students' involvement, launched a project called "Recycle Will Save the Earth" and presented the results at their cultural festival. In her proposal she tells us how they deepened their understanding to environmental problems through their studies and researches.

The recipient of Commendation Award is Mr. Hideo Sasaki who made this achievement with his proposal titled "HOW TO ENCOURGE ECO-FRIENDLY COMMUNITY IN NEIGHBORHOOD". This award is given only in the Life-style section.

Indulged Transfers to Producers



Source: OECD

■ Annual Average 1979-86 ▨ 1991



地球環境論文コンペティション

第2回 21世紀地球賞

地球環境問題解決のために —— 私の提言

●
記念シンポジウム

日時:1993年4月30日(金) 13:00~16:30

会場:経団連会館

●

主催:日本経済新聞社/財団法人 地球産業文化研究所

後援:通商産業省/環境庁/外務省/文部省

協力:国際連合大学/社団法人 日本青年会議所/国際応用システム解析研究所/未来資源研究所
タタエネルギー研究所/英国王立国際問題研究所/世界資源研究所

協賛:東邦生命保険相互会社

ご挨拶

21世紀を目前に控え、私たち人類が直面する環境問題に対し、今地球レベルでの真剣な取り組みが必要とされています。昨年1992年6月、史上最大の首脳会議となった国連環境開発会議(ブラジル地球サミット)も21世紀に向けて環境保全と開発の両立を誓い、閉幕しました。環境保全のための世界の“憲法”ともいべきリオ宣言をはじめ、行動計画であるアジェンダ21や各種条約が採択され、「地球を守ろう」という認識が世界共通のものになりつつあります。

本「第2回 21世紀地球賞—地球環境論文コンペティション」記念シンポジウムは、国際的規模で実施された論文募集事業の成果を踏まえ、さらに地球レベルでの環境問題をいかに解決していくのか、また我国の取り組み方はどうあるべきかを皆様方と共に考えるべく実施されるものです。本シンポジウムがご参加の皆様地球環境問題解決へ向けての新たな指針となれば幸いです。

講師紹介 (敬称略)

■ 基調講演 1 ■



M.S. スワミナサン
(Dr. M.S. Swaminathan)

1925年インド、タミールナドゥ州生まれ。トランヴァンコール、マドラス大学卒業。1952年英国ケンブリッジ大学で、農学博士号取得。フィリピン国際稲研究所元所長、国際自然・天然資源保全連合元評議会議長等を経て、現在、M.S. スワミナサン研究財団 (M.S. Swaminathan Research Foundation) 会長および国連大学「アジェンダ21」諮問委員会委員。また、マグサイサイ賞(1971年)、第1回世界食料賞(1987年)、タイラー賞(1991年)、本田賞(1991年)なども受賞されている。

■ 基調講演 2 ■



ジョナサン・ラッシュ
(Dr. Jonathan J. Lash)

貧困・開発・自然資源・環境の質の問題に関する政策研究やテクニカルな援助を行う民間の非営利で独立した世界資源研究所(WRI)の所長。就任前は、米国のロー・スクールの中の環境分野で第一位にランクされるバーモント・ロー・スクールの環境法センターの所長、バーモント州自然資源庁長官、バーモント州の環境局長を歴任。ハーバード大学卒業後、平和部隊員としてドミニカ共和国に4年滞在。カソリック大学の教育修士、法学博士。

記念シンポジウム 「国際会議場(11階)」 13:00~16:30

13:00~14:00

基調講演 1

M.S.スワミナサン M.S.スワミナサン研究財団(M.S. Swaminathan Research Foundation)会長
「不平等世界における環境保全」

14:00~14:50

基調講演 2

ジョナサン・ラッシュ 世界資源研究所(WRI)所長
「UNCED後の環境、貧困、そして開発—国際協力の原則—」

15:00~16:30

パネル・ディスカッション

「環境問題に於ける日本の国際貢献」

- パネリスト 竹内 啓 東京大学教授
安原 正 (財)環境情報普及センター理事長
岡田 伸浩 (社)日本青年会議所会頭
福川 伸次 (財)地球産業文化研究所顧問
- コーディネーター 鳥井 弘之 日本経済新聞社論説委員

■パネルディスカッション■



竹内 啓
(たけうち けんじ)

1933年生まれ。1956年東京大学経済学部卒業。1961年同大学大学院経済学部研究科博士課程終了。1963年東京大学経済学部助教授、1975年同大学経済学部教授、現在に至る。日本学術会議会員(13期~14期)、国民生活審議会委員を務める。専門は統計学、計量経済学、1986年~1993年3月東京大学先端科学技術研究センターに配属。最近は科学技術論、地球環境問題にも関心を持っている。



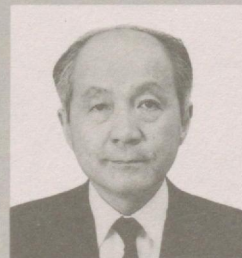
安原 正
(やすはら ただし)

1934年生まれ。1958年東京大学法学部卒業後、大蔵省入省。1986年理財局次長、1987年環境庁長官官房長、1988年企画調整局長などを経て、1990年環境事務次官に就任。1991年環境庁を退官後、農林漁業金融公庫副総裁に就任、また同年(財)環境情報普及センター理事長(兼務)就任、現在に至る。



岡田 伸浩
(おかだ のぶひろ)

1953年神奈川県生まれ。慶応義塾大学商学部卒業。(株)伊勢丹を経て、1978年(株)横浜岡田屋専務取締役役に就任、現在に至る。1984年(社)横浜青年会議所入会、1989年理事長、1991年(社)日本青年会議所常任理事開発室長、1992年副会頭を経て、現在会頭職を務める。1992年ブラジルでの地球サミットには公認NGOの(社)日本青年会議所の代表として参加した。



福川 伸次
(ふかわ しんじ)

1932年東京生まれ。1955年東京大学法学部卒業後、通商産業省に入省。内閣総理大臣秘書官、貿易局長、官房長、産業政策局長などを経て、1986年通商産業事務次官に就任。事務次官退官後、通商産業省顧問、(財)産業研究所顧問などを経て、1990年(株)神戸製鋼所代表取締役副社長に就任、現在に至る。現在、中央公害対策審議会委員(環境庁)、(財)地球産業文化研究所顧問など多数の委員を務める。著書に「21世紀・日本の選択」などがある。



鳥井 弘之
(とりい ひろゆき)

1942年東京生まれ。1967年東京大学工学部卒業。1969年同大学同学部修士修了後、日本経済新聞社に入社。編集局経済解説部、科学技術部、産業部などを経て、現在、日本経済新聞論説委員兼日経産業消費研究所産業研究部研究部長。学術審議会委員、原子力委員会専門委員なども務める。著書に「複合先端産業」「新産業革命」(すべて日本経済新聞社)などがある。



21世紀地球賞——地球環境論文コンペティション 概要

テーマ 地球環境問題解決のために私の提言

募集内容 ●総合研究部門

「気候変動」「森林減少」「生物学的種の多様性保全」等の地球環境問題の改善、解決に向けた提言的研究論文。

●生活提案部門

環境問題に関して、生活に密着した具体的提案や、生活者としての具体的な行動指針を示唆するような生活提案論文。

応募総数 381件

内訳 総合研究部門 151件

(国内102件、国外49件)

生活提案部門 230件

審査委員 [審査委員長]

向坊 隆 地球産業文化委員長
東京大学名誉教授

[審査委員]

石谷 久 東京大学教授
市岡揚一郎 日本経済新聞社取締役論説主幹
加藤 三郎 環境庁地球環境部長
茅 陽一 東京大学教授
近藤 次郎 日本学術会議会長
清木 克男 地球産業文化研究所専務理事
竹内 啓 東京大学教授
堤 富男 通商産業省立地公害局長
中村 桂子 早稲田大学教授
永田 勝也 早稲田大学教授
福川 伸次 地球産業文化研究所顧問
元通商産業事務次官

(五十音順・敬称略)

賞概要

	総合研究部門	生活提案部門
21世紀地球賞	賞状・盾	賞状・盾
各部門1件	賞金500万円(税込み)	賞金100万円(税込み)
日本経済新聞社賞	賞状・盾	賞状・盾
各部門1件	賞金200万円(税込み)	賞金30万円(税込み)
地球産業文化研究所賞	賞状・盾	賞状・盾
各部門1件	賞金200万円(税込み)	賞金30万円(税込み)
優秀賞 数件	—	賞状・盾

日本経済新聞社

〒100-66 東京都千代田区大手町1-9-5 ☎03(3270)0251(代)

財団法人 地球産業文化研究所

〒105 東京都港区虎ノ門3-8-21 第33森ビル7階 ☎03(3435)8800(代)

21世紀地球賞事務局:〒104 東京都中央区築地3-1-4-1004 ☎03(3545)6897

この用紙は、再生紙を利用しています。





地球環境論文コンペティション

第2回 21世紀地球賞

地球環境問題解決のために —— 私の提言

●
記念シンポジウム

日時:1993年4月30日(金) 13:00~16:30

会場:経団連会館

●
主催:日本経済新聞社/財団法人 地球産業文化研究所

後援:通商産業省/環境庁/外務省/文部省

協力:国際連合大学/社団法人 日本青年会議所/国際応用システム解析研究所/未来資源研究所
タタエネルギー研究所/英国王立国際問題研究所/世界資源研究所

協賛:東邦生命保険相互会社

ご挨拶

21世紀を目前に控え、私たち人類が直面する環境問題に対し、今地球レベルでの真剣な取り組みが必要とされています。昨年1992年6月、史上最大の首脳会議となった国連環境開発会議(ブラジル地球サミット)も21世紀に向けて環境保全と開発の両立を誓い、閉幕しました。環境保全のための世界の“憲法”ともいうべきリオ宣言をはじめ、行動計画であるアジェンダ21や各種条約が採択され、「地球を守ろう」という認識が世界共通のものになりつつあります。

本「第2回 21世紀地球賞—地球環境論文コンペティション」記念シンポジウムは、国際的規模で実施された論文募集事業の成果を踏まえ、さらに地球レベルでの環境問題をいかに解決していくのか、また我国の取り組み方はどうあるべきかを皆様方と共に考えるべく実施されるものです。本シンポジウムがご参加の皆様が地球環境問題解決へ向けての新たな指針となれば幸いです。

講師紹介 (敬称略)

■ 基調講演 1 ■



M.S. スワミナサン
(Dr. M.S. Swaminathan)

1925年インド、タミールナドゥ州生まれ。トランヴァンコール、マドラス大学卒業。1952年英国ケンブリッジ大学で、農学博士号取得。フィリピン国際稲研究所元所長、国際自然・天然資源保全連合元評議会議長等を経て、現在、M.S.スワミナサン研究財団(M.S. Swaminathan Research Foundation)会長および国連大学「アジェンダ21」諮問委員会委員。また、マグサイサイ賞(1971年)、第1回世界食料賞(1987年)、タイラー賞(1991年)、本田賞(1991年)なども受賞されている。

■ 基調講演 2 ■



ジョナサン・ラッシュ
(Dr. Jonathan J. Lash)

貧困・開発・自然資源・環境の質の問題に関する政策研究やテクニカルな援助を行う民間の非営利で独立した世界資源研究所(WRI)の所長。就任前は、米国のロー・スクールの中の環境分野で第一位にランクされるバーモント・ロー・スクールの環境法センターの所長、バーモント州自然資源庁長官、バーモント州の環境局長を歴任。ハーバード大学卒業後、平和部隊員としてドミニカ共和国に4年滞在。カソリック大学の教育修士、法学博士。

記念シンポジウム 「国際会議場(11階)」 13:00~16:30

13:00~14:00

基調講演 1

M.S.スワミナサン M.S.スワミナサン研究財団(M.S. Swaminathan Research Foundation)会長
「不平等世界における環境保全」

14:00~14:50

基調講演 2

ジョナサン・ラッシュ 世界資源研究所(WRI)所長
「UNCED後の環境、貧困、そして開発—国際協力の原則—」

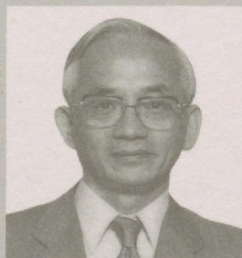
15:00~16:30

パネル・ディスカッション

「環境問題に於ける日本の国際貢献」

- パネリスト 竹内 啓 東京大学教授
安原 正 (財)環境情報普及センター理事長
岡田 伸浩 (社)日本青年会議所会頭
福川 伸次 (財)地球産業文化研究所顧問
- コーディネーター 鳥井 弘之 日本経済新聞社論説委員

■パネルディスカッション■



竹内 啓
(たけうち けい)

1933年生まれ。1956年東京大学経済学部卒業。1961年同大学大学院経済学部研究科博士課程終了。1963年東京大学経済学部助教授、1975年同大学経済学部教授、現在に至る。日本学術会議会員(13期~14期)、国民生活審議会委員を務める。専門は統計学、計量経済学。1986年~1993年3月東京大学先端科学技術研究センターに配属。最近は科学技術論、地球環境問題にも関心を持っている。



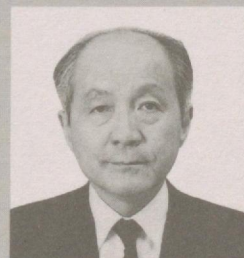
安原 正
(やすはら ただし)

1934年生まれ。1958年東京大学法学部卒業後、大蔵省入省。1986年理財局次長、1987年環境庁長官官房長、1988年企画調整局長などを経て、1990年環境事務次官に就任。1991年環境庁を退官後、農林漁業金融公庫副総裁に就任、また同年(財)環境情報普及センター理事長(兼務)就任、現在に至る。



岡田 伸浩
(おかだ のぶひろ)

1953年神奈川県生まれ。慶応義塾大学商学部卒業。(株)伊勢丹を経て、1978年(株)横浜岡田屋専務取締役就任、現在に至る。1984年(社)横浜青年会議所入会、1989年理事長、1991年(社)日本青年会議所常任理事開発室長、1992年副会頭を経て、現在会頭職を務める。1992年ブラジルの地球サミットには公認NGOの(社)日本青年会議所の代表として参加した。



福川 伸次
(ふくかわ しんじ)

1932年東京生まれ。1955年東京大学法学部卒業後、通商産業省に入省。内閣総理大臣秘書官、貿易局長、官房長、産業政策局長などを経て、1986年通商産業事務次官に就任。事務次官退官後、通商産業省顧問、(財)産業研究所顧問などを経て、1990年(株)神戸製鋼所代表取締役副社長に就任、現在に至る。現在、中央公害対策審議会委員(環境庁)、(財)地球産業文化研究所顧問など多数の委員を務める。著書に「21世紀・日本の選択」などがある。



鳥井 弘之
(とりい ひろゆき)

1942年東京生まれ。1967年東京大学工学部卒業。1969年同大学同学部修士修了後、日本経済新聞社に入社。編集局経済解説部、科学技術部、産業部などを経て、現在、日本経済新聞論説委員兼日経産業消費研究所産業研究部研究部長。学術審議会委員、原子力委員会専門委員なども務める。著書に「複合先端産業」「新産業革命」(すべて日本経済新聞社)などがある。



21世紀地球賞——地球環境論文コンペティション 概要

テーマ 地球環境問題解決のために—私の提言

募集内容 ●総合研究部門

「気候変動」「森林減少」「生物学的種の多様性保全」等の地球環境問題の改善、解決に向けた提言的研究論文。

●生活提案部門

環境問題に関して、生活に密着した具体的提案や、生活者としての具体的な行動指針を示唆するような生活提案論文。

応募総数 381件

内訳 総合研究部門 151件

(国内102件、国外49件)

生活提案部門 230件

審査委員 [審査委員長]

向坊 隆 地球産業文化委員長

東京大学名誉教授

[審査委員]

石谷 久 東京大学教授

市岡揚一郎 日本経済新聞社取締役論説主幹

加藤 三郎 環境庁地球環境部長

茅 陽一 東京大学教授

近藤 次郎 日本学術会議会長

清木 克男 地球産業文化研究所専務理事

竹内 啓 東京大学教授

堤 富男 通商産業省立地公害局長

中村 桂子 早稲田大学教授

永田 勝也 早稲田大学教授

福川 伸次 地球産業文化研究所顧問

元通商産業事務次官

(五十音順・敬称略)

賞概要

	総合研究部門	生活提案部門
21世紀地球賞	賞状・盾	賞状・盾
各部門1件	賞金500万円(税込み)	賞金100万円(税込み)
日本経済新聞社賞	賞状・盾	賞状・盾
各部門1件	賞金200万円(税込み)	賞金 30万円(税込み)
地球産業文化研究所賞	賞状・盾	賞状・盾
各部門1件	賞金200万円(税込み)	賞金 30万円(税込み)
優秀賞 数件	—	賞状・盾

日本経済新聞社

〒100-66 東京都千代田区大手町1-9-5 ☎03(3270)0251代

財団法人 地球産業文化研究所

〒105 東京都港区虎ノ門3-8-21 第33森ビル7階 ☎03(3435)8800代

21世紀地球賞事務局：〒104 東京都中央区築地3-1-4-1004 ☎03(3545)6897

この用紙は、再生紙を利用しています。



地球環境論文コンペティション

第2回 21世紀地球賞

主催●日本経済新聞社
財団法人 地球産業文化研究所

後援●通商産業省
環境庁
外務省
文部省

協力●国際連合大学
社団法人 日本青年会議所
国際応用システム解析研究所
未来資源研究所
タタエネルギー研究所
英国王立国際問題研究所
世界資源研究所

協賛●東邦生命保険相互会社

募集要項
Article Contents

Global Environmental Problem Proposal Competition

THE SECOND E21st - CENTURY EARTH AWARDS

Organizers●

Nihon Keizai Shimbun, Inc.
Global Industrial and
Social Progress Research
Institute (GISPRI)

Supporters●

Ministry of International
Trade and Industry
Environment Agency
Ministry of Foreign Affairs
Ministry of Education

Cooperators●

The United Nations University
Japan Junior Chamber Inc.
International Institute for Applied Systems Analysis
Resources for the Future
TATA Energy Research Institute
The Royal Institute of International Affairs
World Resources Institute

Sponsor●

Toho Mutual Life Insurance Co.



ごあいさつ

GREETINGS



平岩外四

財団法人 地球産業文化研究所理事長

Gaishi Hiraiwa

Chairman
Global Industrial and Social
Progress Research Institute
(GISPRI)

皆様も御高承の通り、本年6月、国連環境開発会議 (UNCED) がリオデジャネイロで開催され、約170ヶ国から約2万人の各界を代表する人々が参加し、衆知を集めた議論が展開されました。その結果、環境と開発に関するリオ宣言、行動計画アジェンダ21、森林原則声明、気候変動枠組み条約及び生物学的多様性保護条約等の多くの文書が採択されるなど、多大な成果が生まれました。この会議を契機として、地球環境を守っていくために人類が協力し合う第一歩が踏み出されたと言えるでしょう。今後とも、この成果の実効を上げるためのフォローアップが期待されるところです。

地球環境問題という新しい課題を解決するためには、何よりも南北問題や環境と開発といった問題に関する新しいアイデアやコンセプトが必要です。その意味で、今必要なことは、地球環境問題について、具体的な科学的知見や提言を広く世界中から募ることではないかと存じます。

さて、当地球産業文化研究所は昨年、「21世紀地球賞——地球環境論文コンペティション」(第1回)を実施いたしました。これには、日本はもとより、海外からも多数の御応募をいただき、たいへん大きな成果を上げることができました。こうした試みは、まさに時宣を得たものと考えられますので、今年度も第2回の21世紀地球賞を実施することにいたしました。

人類共通の大きな課題である地球環境問題の解決に向けた、皆様からの建設的な提案が、実りある財産を21世紀へもたらすことを祈念してやみません。

As you may already know, United Nations Conference on Environment and Development held in Rio de Janeiro this past June attracted about 20,000 representatives of various organizations from some 170 countries, drawing on their collective wisdom for dynamic discussions. These discussions produced a wealth of results, including the adoption of numerous statements, among them Rio Declaration on Environment and Development; Agenda 21; Statement on Forest Principles; Framework Convention on Climate Change; and Convention on Biological Diversity.

This conference may be viewed as the first step on the road universal cooperation aimed at protecting the global environment. We all hope that it will be followed by actions that put its results into practice.

First and foremost, finding solutions to the unprecedented global environmental problems facing us will require new ideas and concepts for the formulation of approaches to North-South disparities and environmental and developmental issues. In this sense our most pressing need at present is for a collection of detailed scientific knowledge and proposals regarding global environmental problems from a wide range of parties throughout the world.

Last year, our Institute held its first Global Environmental Proposal Competition, entitled the "21st-Century Earth Awards." This competition, which attracted entries not only from Japan but also from other countries, proved to be immensely successful. In our conviction that this kind of program is perfectly attuned to the needs of the times, we have decided to hold a second competition this year.

It is our fervent hope that constructive proposals submitted by the participants for the solution of global environmental problems as the most critical issue facing all humankind will leave a valuable legacy for the 21st century.

Thank you very much.



新井 明

日本経済新聞社代表取締役社長

Akira Arai

President and Chief
Executive Officer Nihon
Keizai Shimbun, Inc.

地球規模での環境問題は、現在世界の人類が直面する最も重大な課題となっています。本年6月、ブラジルのリオデジャネイロで「国連環境開発会議」（地球サミット）が開かれたのもこうした問題意識を反映したものにほかなりません。

日本経済新聞社は1876年（明治9年）創刊以来1世紀有余にわたり、「中正公平、わが国民生活の基礎たる経済の平和的、民主的発展を期す」という社是を不変のバックボーンとして言論・報道の任にあたってまいりました。今や世界最大の経済総合紙である「日本経済新聞」をはじめ、当社の新聞5紙は日米欧の世界3極での総合編集体制を基盤に発行しており、日本の動向を世界に発信するクオリティペーパーとして内外の読者から高い評価と信頼を得ております。

日本経済新聞社はこの「第2回21世紀地球賞——地球環境論文コンペティション」の実施にあたり、報道機関としての社会的使命を果たすとともに本賞が地球環境問題解決の一助となることを願っています。

Global-scale environmental problems are now the most critical issue facing mankind. The convening of the United Nations Conference on the Environment and Development (the Earth Summit) in Rio de Janeiro last June reflects awareness of this fact.

Throughout the more than 100 years since its founding in 1876, our company has gone about its business of reportage with an unswerving commitment to its founding principles: an insistence upon objectivity, fairness, and peaceful, democratic advancement of the economy as the underpinning for the national life. The Nihon Keizai Shimbun, the world's most widely read comprehensive economics journal, and our company's four other newspapers are published under a tripolar system with complete editing capabilities in Japan, North America, and Europe. They have won the respect and trust of their readership, both inside and outside Japan, as quality publications which accurately convey news of trends in Japan to the rest of the world.

It is our earnest hope that the Second 21st-Century Earth Awards——Global Environmental Problem Proposal Competition, besides helping to fulfill our responsibility to society as a news organization, will contribute to the solution of the environmental problems confronting our globe.

趣 旨

OBJECTIVES OF THE COMPETITION

21世紀を目前に控え、私たち人類が直面する環境問題に対し、今地球レベルでの真剣な取り組みが必要とされています。

去る6月、史上最大の首脳会議となった国連環境開発会議（地球サミット）も21世紀に向けて環境保全と開発の両立を誓い、閉幕しました。

環境保全のための世界の“憲法”ともいべきリオ宣言をはじめ、行動計画であるアジェンダ21や各種条約が採択され、「地球を守ろう」という認識が世界共通のものになりつつあります。

本「21世紀地球賞——地球環境論文コンペティション」は私たちが直面する地球規模の環境問題に関する意見や様々な提案を、日本国内はもとより広く海外の研究者からも公募するもので、今年で2回目をかぞえます。

昨年の第1回目は、全体で510件にもものぼる質的にも優れた作品の応募があり、当初の予想を上回る成果を収めることができました。

今年も本賞に寄せられる“研究提案”および“生活提案”が、地球環境問題解決への糸口となり、さらにはかけがえのない21世紀の持続可能な地球社会を築いていく上での一助となるよう希望します。

As the 21st century approaches, humankind is faced with environmental problems which urgently require addressing on a global scale.

In June of this year, the United Nations Conference on the Environment and Development (the Earth Summit), the largest summit conference in history, closed with a commitment to reconcile environmental protection with development into the 21st century. With the adoption of this “Rio Declaration” a world charter on environmental protection, as well as the Agenda 21 action plan and various treaties, the need to protect our earth has gained international recognition.

The 21st-Century Earth Awards - Global Environmental Problem Proposal Competition, of which this is the second, aims to collect opinions and proposals from researchers in Japan and abroad concerning the global environmental problems which face us all.

In the first competition last year, 510 extremely worthwhile articles were received, a number which was far greater than expected.

We hope that the entries in the Research Proposal and Lifestyle Proposal sections of this second competition will also offer ideas on ways of creating a secure, environmentally viable society for the 21st century.

募集要項

RULES OF THE COMPETITION

全体テーマ

地球環境問題解決のために——私の提言

募集内容

- 総合研究部門：「気候変動」「森林減少」「生物学的種の多様性保全」等の地球環境問題の改善、解決に向けた提言的研究論文。
- 生活提案部門：環境問題に関して、生活に密着した具体的な提案や、生活者としての具体的な行動指針を示唆するような生活提案論文。

応募資格

個人（連名も可）。
生活提案部門は、国内居住者に限ります。

応募規定

日本語または英文書式により書かれたものに限り、この応募要項の8ページおよび9ページの応募用紙に必要事項を記入するか、または作品の表紙に、応募部門・住所・氏名（または代表者名）・年齢・性別・職業・勤務先（または在学名）を明記して下さい。なお、応募作品は返却いたしません。

- 総合研究部門：400字詰原稿用紙で20～40枚、英文タイプド・ページで15～30枚に、600字以内（研究テーマ、目的、意義）の要約を添付して下さい。
未発表オリジナル作品に限り、但し、最近の専門の学術誌、学会誌、学術シンポジウム等に根拠となる内容を発表している場合はこの限りではありません。（発表誌、シンポジウム名を必ず明記）
- 生活提案部門：400字詰原稿用紙で15枚以内。独創性のある未発表作品に限り、両部門とも、資料・参考文献リストも含まれます。

Overall theme

Proposal-Toward a Lasting Earth

Entry contents

- General Study Section : Proposals for research papers concerning the amelioration or solution of such global environmental problems as climate change, deforestation or biodiversity preservation.
- Lifestyle Proposal Section : Environment-related proposals with immediate relevance to everyday life, indicating concrete suggestions for of behavior policies for the general consumer.

Entry qualifications

Individual(s). Entries for the Lifestyle Proposal Section can be accepted only from residents of Japan.

Method of entry

Articles must be written in Japanese or English. The following details should be provided on the application form on pages 8 and 9 of this application outline or on the cover of the submitted article : Section for which article is submitted (General Study Section or Lifestyle Proposal Section), Address, Name of author or group representative, Age, Sex, Profession, Affiliation or school. Entrants should keep copies of their work, as submitted entries will not be returned.

- General Study Section : Papers should be 20 to 40 pages (400 characters per page) in Japanese or 15 to 30 typed (double-spaced A4) pages in English. They should be accompanied by an abstract of up to 600 characters (250 words) explaining the theme of the entry and the purpose and broader implications of the proposal. Only unpublished original papers will be accepted. Entries based on the contents of materials recently presented in such forms as academic journals, journals of professional associations and academic symposia will, however, also be accepted. (In such cases, the source of the materials included should be specified.)
- Lifestyle Proposal Section : Works should be up to 15 pages (400 characters per page) in Japanese. Only unpublished original papers will be accepted. The specified length of articles in both sections includes the accompanying materials and bibliography.

審査基準

両部門とも共通する審査基準とします。

- ①独創性のあるもの
- ②論理的整合性があるもの
- ③実験による追試・検証が必要でないもの
- ④専門分野以外の読者にも理解かつ評価可能なもの
- ⑤提言内容についての実現の可能性のあるもの

募集締切

1992年12月25日必着

審査委員

(審査委員長)

向坊 隆／地球産業文化委員長／東京大学名誉教授

(審査委員)

石谷 久／東京大学教授

市岡揚一郎／日本経済新聞社取締役論説主幹

茅 陽一／東京大学教授

近藤 次郎／日本学術会議会長

清木 克男／地球産業文化研究所専務理事

竹内 啓／東京大学教授

中村 桂子／早稲田大学教授

永田 勝也／早稲田大学教授

福川 伸次／地球産業文化研究所顧問／元通商産業事務次官

※通商産業省、環境庁からも委員として参加の予定

(五十音順、敬称略)

Criteria for awards

The following criteria shall be applied in the judging of entries for both sections:

1. Originality of the proposal.
2. Logical consistency of the proposal.
3. Freedom from need for experimental confirmation or verification.
4. Comprehensibility of proposal for general readers and accessibility for intelligent evaluation by said readers.
5. Feasibility of the proposal.

Application period

Deadlines : December 25 1992.

Screening committee members

Takashi Mukaibo Chairman, Global Industrial and Social Progress Policy Forum/
Professor Emeritus, The University of Tokyo

Hisashi Ishitani Professor, The University of Tokyo
Yoichiro Ichioka Director Chief Editorial Writer, Nihon Keizai Shimbun. Inc.

Yoichi Kaya Professor, The University of Tokyo
Jiro Kondo President, Science Council of Japan
Katsuo Seiki Executive Director, Global Industrial and Social Progress Research Institute(GISPRI)

Kei Takeuchi Professor, The University of Tokyo
Keiko Nakamura Professor, Waseda University
Katsuya Nagata Professor, Waseda University
Shinji Fukukawa Advisor to Global Industrial and Social Progress Research Institute (GISPRI) /
Former Vice Minister, Ministry of International Trade and Industry

Evaluation committee(in random order with honorifics omitted):

●Committee members from MITI and the Environment Agency are also expected to participate.

入賞作品

	総合研究部門	生活提案部門
21世紀地球賞 各部門1件	賞状・盾 賞金 500万円 (税込み)	賞状・盾 賞金 100万円 (税込み)
日本経済新聞社賞 各部門1件	賞状・盾 賞金 200万円 (税込み)	賞状・盾 賞金 30万円 (税込み)
地球産業文化研究所賞 各部門1件	賞状・盾 賞金 200万円 (税込み)	賞状・盾 賞金 30万円 (税込み)
優秀賞 数件	—————	賞状・盾

入賞作品の著作権・著作権

21世紀地球賞、日本経済新聞社賞、地球産業文化研究所賞の入選作品の著作権・著作権は主催者に帰属し、出版・商品化に関しては別途協議いたします。

入賞発表・表彰

1993年3月予定。日本経済新聞にて発表し、入賞決定後、御本人に御通知いたします。入賞作品は、要約を（優秀賞を除く）日本経済新聞、全文を日経サイエンスに掲載いたします。また、受賞記念フォーラムにて入賞者（優秀賞を除く）の表彰を行います。

Awards

	General Study Section	Lifestyle Proposal Section
21st-Century Earth Award (One per section)	Certificate of merit, plaque and 5 million yen in prize money (before taxes)	Certificate of merit, plaque and 1 million yen in prize money (before taxes)
Nihon Keizai Shimbun Award (One per section)	Certificate of merit, plaque and 2 million yen in prize money (before taxes)	Certificate of merit, plaque and 300,000 yen in prize money (before taxes)
GISPRI Award (One per section)	Certificates of merit, plaque and 2 million yen in prize money (before taxes)	Certificate of merit, plaque and 300,000 yen in prize money (before taxes)
Commendation awards (As appropriate)	—————	Certificate of merit, plaque

Copyrights for award-winning entries

The copyrights for winners of the 21st-Century Earth Award, the Nihon Keizai Shimbun Award and the GISPRI Award shall belong to the organizers. Publishing and merchandising of award-winning articles shall be discussed separately.

Announcement of winners and presentation of awards

Announcement of the winners shall be made in March 1993 in the Nihon Keizai Shimbun. Winners shall be notified when award recipients have been determined. With the exception of the commendation awards, abstracts of award-winning entries will be published in the Nihon Keizai Shimbun, and the articles will be published in full in the Nikkei Science magazine. A ceremony will be held for presentation of awards (except commendation awards) to the winning entrants.

第1回 21世紀地球賞入賞者

THE WINNERS OF THE FIRST 21st-CENTURY EARTH AWARD

【21世紀地球賞】

■総合研究部門——「ブラジル・ノルデステの総合農業開発とアマゾン熱帯雨林破壊に対する抜本的な対策」／吉田昭彦氏（産能短期大学教授）

■生活提案部門——「新たな資源リサイクルの方向——リサイクル度評価表示制度の提案」／中野加都子氏（関西大学研究室アシスタント）

【日本経済新聞社賞】

■総合研究部門——「バイオマスとハイドロカーブによる大気からのCO₂除去技術」／マイヤー・スタインバーグ氏（米国・ブルックヘブン国立研究所）

■生活提案部門——「実践してみた環境教育」／山田馨子氏・清水佳子氏

【地球産業文化研究所賞】

■総合研究部門——「洋上風力エネルギーの利用システム」／青木繁光氏（ヤマハ発動機株）

■生活提案部門——「環境家庭会議のすすめ」／坂本雅司氏（松下電器産業株）

【優秀賞】

■総合研究部門——「サービスカンパニーの提案—省エネルギーと環境保護の推進におけるマーケットアプローチ」／ナジェンドラ・スバクリシュナ氏（米国）

「砂漠化防止と砂漠緑化による地球環境の保全」／遠山権雄氏（鳥取大学乾燥地研究センター助教授）

■生活提案部門——「家庭および地域社会レベルで可能な地球環境問題解決のための私の提言」／斎藤直子氏（東京都三鷹市立第四中学校教諭）

「美しい地球を残していくために」／阿部廣美氏（静岡県立静岡工業高等学校教諭）

「森林資源を守るための紙に関する二つの提案」／高島秀行氏（日本電信電話株）

「今後の地球環境保護に向けた活動—エコロジー・ネットワークづくりの提案」／中野嗣己氏（関西リクルート人材センター）

【21st-Century Earth Award】

■General Study Section——「COMPREHENSIVE AGRICULTURAL DEVELOPMENT OF NORDESTE IN BRAZIL AND MEASURES NECESSARY TO AVOID DESTRUCTION OF THE AMAZON TROPICAL RAIN FOREST」/Dr. Akihiko Yoshida (Professor of Sanno Junior College)

■Lifestyle Proposal Section——「PROPOSED GUIDE TO PRODUCT RECYCLABILITY—A NEW DIRECTION IN THE RECYCLING OF RESOURCES」/Ms. Kazuko Nakano (Laboratory Assistant of Kansai University)

【Nihon Keizai Shimbun Award】

■General Study Section——「BIOMASS AND HYDROCARBON TECHNOLOGY FOR REMOVAL OF ATMOSPHERIC CO₂」/Dr. Meyer Steinberg (U.S.A. Department of Applied Science Brookhaven National Laboratory)

■Lifestyle Proposal Section——「ENVIRONMENTAL EDUCATION PUT INTO PRACTICE」/Ms. Keiko Yamada Ms. Keiko Shimizu

【GISPRI Award】

■General Study Section——「UTILIZATION OF OCEAN WIND ENERGY」/Mr. Shigemitsu Aoki (YAMAHA MOTOR CO.,LTD.)

■Lifestyle Proposal Section——「PROPOSAL FOR FAMILY CONFERENCES ON THE ENVIRONMENT」/Mr. Masashi Sakamoto (Matsushita Electric Industrial Co.,Ltd.)

【Commendation awards】

■General Study Section——「SERVICE COMPANIES (SCOs)—A MARKET APPROACH FOR PROMOTING ENERGY EFFICIENCY & ENVIRONMENTAL CONSERVATION」/Mr. Nagendra Subbakrishna (U.S.A)

「PRESERVATION OF THE EARTH'S ENVIRONMENT BY CURTAILING DESERT EXPANSION AND AFFORESTATION OF THE DESERT」/Dr. Masao Toyama (Assistant Professor of Tottori University Arid Land Research Center)

■Lifestyle Proposal Section——「PROPOSALS TO RESOLVE GLOBAL ENVIRONMENTAL PROBLEMS WHICH CAN BE PRACTICED IN THE HOME AND LOCAL COMMUNITY」/Ms. Naoko Saito (Teacher of Municipal Mitaka Daiyon Junior High School)

「PRESERVATION OF OUR BEAUTIFUL EARTH」/Mr. Hiromi Abe (Teacher of Prefectural of Shizuoka Technical High School)

「PROTECTION OF FOREST RESOURCES BY TWO PROPOSALS CONCERNING PAPER」/Mr. Hideyuki Takashima (Nippon Telegraph and Telephone Corporation)

「ACTIVITIES TOWARD FUTURE GLOBAL ENVIRONMENTAL PROTECTION—FORMATION OF AN ECOLOGY NETWORK」/Mr. Tsuguo Nakano (Kansai Recruit Jinzai Center Co.,Ltd.)

応募用紙

ENTRY FORM

General Study Section/総合研究部門

■Title/題名

■Research theme/研究テーマ

Choose three or fewer key words from the list below that most accurately describe the contents of your paper./以下の例を参考にこの研究論文の内容を表すのに最も適当なレベルのキーワード（3つ以内）で記入して下さい。

[Key words]

Afforestation, tropical forest use, biomass utilization, control of energy demand, solar energy systems, improvement of efficiency, effects of a carbon tax, analytical study, etc.

[キーワード]

植林、熱帯雨林利用、バイオマス利用、エネルギー需要抑制、太陽エネルギー利用システム、高効率化、炭素税の影響、分析等

■Research format/研究形態

Joint research/共同研究 Individual research/個人研究

■Contents of research by category/内容の種別

Check all categories which adequately describe the nature and contents of your research.

Explication or analysis of phenomena Technology for system components
 Comprehensive measures, technology, systems, policy, response Experimental report
 Collection and analysis of data Modeling of phenomena System proposal and/or evaluation
 Report on practical system results Other (Please give appropriate explanation.)

該当するもの全てに×印をつけて下さい。

現象の解明あるいは解析 個別システム、要素システム 総合的対策、技術、システム、政策、対応政策
 実験報告 データ収集と分析 現象のモデル化 システムの提案あるいは評価 システムの成果報告
 その他（任意記入）

Total Pages/総枚数

Name/氏名

Sex/性別

Male 男性 Female 女性

Date of birth/生年月日

Nationality/国籍

Residence/現住所

Phone No.

Facsimile No.

Affiliation/勤務先

■How did you hear about 21st CENTURY EARTH AWARD ?/21世紀地球賞を何で知りましたか。ご記入下さい。

I agree to all conditions set, and apply for THE SECOND 21st-CENTURY EARTH AWARDS – Global Environmental Problem Proposal Competition.

私は、第2回21世紀地球賞—地球環境論文コンペティションの応募規定全ての条件に同意し、応募します。

■Signature/サイン

応募用紙

ENTRY FORM

Lifestyle Proposal Section/生活提案部門

■ Title/題名

■ Category/分野

■ Total Pages/総枚数

■ Name/氏名

■ Sex/性別

Male 男性 Female 女性

■ Date of birth/生年月日

■ Residence/現住所

■ Phone No.

■ Facsimile No.

■ Affiliation/勤務先

■ How did you hear about 21st-CENTURY EARTH AWARD?/21世紀地球賞を何で知りましたか。ご記入下さい。

I agree to all conditions set, and apply for THE SECOND 21st-CENTURY EARTH AWARDS—Global Environmental Problem Proposal Competition.

私は、第2回21世紀地球賞—地球環境論文コンペティションの応募規定全ての条件に同意し、応募します。

■ Signature/サイン

応募・問い合わせ先

Applications/Inquiries

21世紀地球賞事務局

〒104 東京都中央区築地3-1-4-1004

TEL 03-3545-6897/FAX 03-3545-9769

(電話受付時間)

月曜日～金曜日/10:00～18:00 (土日祭日を除く)

To the Secretariat. 21st-Century Earth Award :

3-1-4-1004, Tsukiji, Chuo-ku, Tokyo 104, Japan

Phone 03-3545-6897/FAX 03-3545-9769

Telephone calls accepted Monday through Friday,

between 10:00 and 18:00 (in local time) except
holidays and Sundays.

Global Environmental Problem Proposal Competition

THE SECOND

E21st - CENTURY EARTH AWARDS

Proposal-Toward a Lasting Earth

Award Winning Proposals



Organizers

Nihon Keizai Shimbun, Inc.
Global Industrial and
Social Progress Research
Institute (GISPRI)

Supporters

Ministry of International
Trade and Industry
Environment Agency
Ministry of Foreign Affairs
Ministry of Education

Cooperators

The United Nations University
Japan Junior Chamber Inc.
International Institute for Applied Systems Analysis
Resources for the Future
TATA Energy Research Institute
The Royal Institute of International Affairs
World Resources Institute

Sponsor

Toho Mutual Life Insurance Co.



Global Environmental Problem Proposal Competition

THE SECOND 21st-CENTURY EARTH AWARDS

Proposal-Toward a Lasting Earth

CONTENTS

General Study Section

21st-Century Earth Award

REDUCING GREENHOUSE GAS EMISSIONS AND IMPROVING ENVIRONMENTAL HEALTH IN DEVELOPING NATIONS:
A PROGRAM FOR ENERGY MANAGEMENT, COOKING TECHNOLOGY AND EDUCATION

Daniel M.Kammen, Ph. D.

Center for Global Environmental Change Jefferson Physical Laboratory Harvard University

Age:30 Male U.S.A.

5p

Nihon Keizai Shimbun Award

A Proposal for Sustainable Development: The Asiatic

Hiroshi Shimizu

Team Head, The National Institute for Environmental Studies

Age:45 Male Japan

21p

GISPRI Award

Characteristics and Utilization of Tree Species in the Semi-arid Woodland of Northeast Brazil

Toshie Nishizawa

Professor, Tokyo Seitoku University

Age:64 Male Japan

Akio Tsuchiya

Visiting Scholar at the Laboratory of Tree-Ring Research, University of Arizona

Age:31 Male Japan

Maria Magdalena Vieira Pinto

Director (retired) of Instituto Brasileiro de Geografia e Estatística

Age:63 Female Brazil

31p

THE SECOND 21st-CENTURY EARTH AWARDS

INTRODUCTION

As the 21st century approaches, humankind is faced with environmental problems for which a global effort is required and a serious action must be taken.

The United Nations Conference on the Environment and Development (the Earth Summit), the largest summit conference in history was held last June and closed with a commitment to reconcile environmental protection with development into the 21st century. With the adoption of this "Rio Declaration" a world charter on environmental protection as well as the Agenda 21 action plan and various other treaties, the need to protect our earth has gained international recognition.

The 21st Century Earth Awards-Global Environmental Problem Proposal Competition, of which this is the second, aims to collect opinions and proposals from researchers in Japan and abroad concerning the global environmental issues which face us all. This competition was organized by Nihon Keizai Shimbun Inc. and Global Industrial and Social Progress Research Institute, and sponsored by Toho Mutual Life Insurance Co.. It also received much assistance from a variety of organizations such as the United Nations University, Japan Junior Chamber Inc., International Institute for Applied Systems Analysis, Resources for the Future, TATA Energy Research Institute, the Royal Institute of International Affairs and World Resources Institute while firmly endorsed and supported by Ministry of International Trade and Industry, Environment Agency, Ministry of Foreign Affairs, and Ministry of Education.

In this second competition 381 highly qualified proposals were received, showing that it made far greater achievement than expected. As the number includes 49 items from overseas, it should be also noted that the project won international recognition. We're delighted to introduce the winning proposals here in this publication. They have passed fare and through screening with reliable judgement. We hope that these precious work will offer ideas to solve the global environmental problems as well as contribute to create a secure, environmentally responsible society for the 21st century.

THE SECOND 21st-CENTURY EARTH AWARDS

RULES OF THE COMPETITION

Overall theme

Proposal-Toward a Lasting Earth

Entry contents

■ **General Study Section**: Proposals for research papers concerning the amelioration or solution of such global environmental problems as climate change, deforestation or biodiversity preservation,

Entry qualifications

Individual(s).

Method of entry

Articles must be written in Japanese or English.

The following details should be provided on the attached application form: Title of the proposal, Address, Name of author or group representative, Age, Sex, Profession, Affiliation or school. Entrants should keep copies of their work, as submitted entries will not be returned.

■ **General Study Section**: Papers should be 20 to 40 pages (400 characters per page) in Japanese or 15 to 30 typed (double-spaced A4) pages in English. They should be accompanied by an abstract of up to 600 characters (250 words) explaining the theme of the entry and the purpose and broader implications of the proposal.

Only unpublished original papers will be accepted.

Entries based on the contents of materials recently presented in such forms as academic journals, journals of professional associations and academic symposia will, however, also be accepted. (In such cases, the source of the materials included should be specified)

Criteria for awards

1. Originality of the proposal.
2. Logical consistency of the proposal.
3. Freedom from need for experimental confirmation or verification.
4. Comprehensibility of proposal for general readers and accessibility for intelligent evaluation by said readers.
5. Feasibility of the proposal.

Application period

September 18 thru December 25.

Screening committee members

Takashi Mukaibo Chairman, Global Industrial and Social Progress Policy Forum/Professor Emeritus, The University of Tokyo

Hisashi Ishitani Professor, The University of Tokyo

Yoichiro Ichioka Director Chief Editorial Writer, Nihon Keizai Shimbun, Inc.

Saburo Kato Director/General, Global Environment Department, Environment Agency

Yoichi Kaya Professor, The University of Tokyo

Jiro Kondo President, Science Council of Japan

Katsuo Seiki Executive Director, Global Industrial and Social Progress Research Institute (GISPRI)

Kei Takeuchi Professor, The University of Tokyo

Tomio Tsutsumi Director/General, Industrial Location and Environmental Protection Bureau, Ministry of International Trade and Industry

Keiko Nakamura Professor, Waseda University

Katsuya Nagata Professor, Waseda University

Shinji Fukukawa Advisor to Global Industrial and Social Progress Research Institute (GISPRI)/ Former Vice Minister, Ministry of International Trade and Industry

Evaluation committee (in random order with honorifics omitted):

Awards

■ **General Study Section**

21st-Century Earth Award Certificate of merit, Plaque and 5 million yen in prize money (One per section) (before taxes)

Nihon Keizai Shimbun Award Certificate of merit, Plaque and 2 million yen in prize money (One per section) (before taxes)

GISPRI Award Certificate of merit, Plaque and 2 million yen in prize money (One per section) (before taxes)

Copyrights for award-winning entries

The copyrights for winners of the 21st-Century Earth Award, the Nihon Keizai Shimbun Award and the GISPRI Award shall belong to the organizers. Publishing and merchandising of award-winning articles shall be discussed separately.

THE SECOND 21st-CENTURY EARTH AWARDS

THE WINNERS OF THE SECOND 21st-CENTURY EARTH AWARDS

General Study Section

21st-Century Earth Award

- "Reducing Greenhouse Gas Emission and Improving Environmental Health in Developing Nations : A Program for Energy Management, Cooking Technology and Education"

by Daniel M. Kammen, Ph. D.

Center for Grobal Environmental Change Jefferson Physical Laboratory
Harvard University

◆COMMENT

The proposal convinces us of possible utilization of renewable energy in developing nations, In general the renewable energy does not produce enough energy for a large-scale use. It also has a problem in its stability. However, this proposal clears those impediments and successfully presents the solution not only to energy problem but also to health hazard in developing nations.

Nihon Keizai Shimbun Award

- "A Proposal for Sustainable Development : The Asiacar"

by Hiroshi Shimizu

Team Head, The National Institute for Environmental Studies

◆COMMENT

To tackle inevitable environmental deterioration in Asian nations where the number of automobiles is largely increasing, this proposal suggests a unique auto-system which would reduce greenhouse gas emission from automobiles. Applying this system, this proposal says, at least in theory about 10,000km per annum should be covered only by solar energy in countries such as Thailand taking advantage of their long daylight hours and high altitude of the sun.

GISPRI Award

- "Characteristics and Utilization of Tree Species in the Semi-arid Woodland of Northeast Brazil"

by Toshie Nishizawa Professor, Tokyo Seitoku University /Akio Tsuchiya
Visiting Scholar at the Laboratory of Tree-Ring Research, University of
Arizona /Maria Magdalena Vieira Pinto Director of Instituto Brasileiro de
Geografia e Estatistica

◆COMMENT

This proposal introduces the sixteen caatinga tree species classifying them into three groups according to response and tolerance to the water stress. It also estimates more dominant species among them in the plant succession Processes, and eventually suggests that it should be effectively utilized.

21st Century Earth Award

REDUCING GREENHOUSE GAS EMISSIONS AND IMPROVING ENVIRONMENTAL HEALTH IN DEVELOPING NATIONS: A PROGRAM FOR ENERGY MANAGEMENT, COOKING TECHNOLOGY AND EDUCATION

Daniel M. Kammen, Ph.D.

Center for Global Environmental Change
Jefferson Physical Laboratory
Harvard University

Age 30, Male, U.S.A.

ABSTRACT

Energy is a basic resource necessary for development and economic growth, yet its use can degrade regional ecosystems, the global environment, and human health. Over two billion people worldwide depend on the "traditional" fuels of wood, charcoal, dung and crop residues to meet their daily needs. Half the worldwide wood harvest of three billion tons of wood is used as fuel with domestic cooking accounting for over 60% of total. Furthermore, biomass burning in developing nations contributes up to 40% of greenhouse gas emissions worldwide, and is firmly linked to acute respiratory infection (ARI). ARI, the leading health hazard to children in developing nations, results in an estimated 4.3 million deaths per year. Modernized woodstoves and solar ovens for household cooking can cut traditional or fossil-fuel use by 50% or more. These technologies represent a "win-win" situation: reducing both the threats of global warming and indoor air pollution. In pilot projects we and others are testing technological options and social strategies to integrate these systems into the resource base of developing na-

tions. We propose that the dissemination of improved biomass stoves, solar ovens, and other small-scale renewables be included as a basic component of assistance programs in developing nations. Existing non-governmental, national, and international aid organizations are ideally suited to promote this campaign, and only require increased exposure to these ideas and pilot programs.

Introduction: The Energy and Environmental Crisis

Two billion people worldwide depend primarily on wood for their energy needs, while biomass burning leads to deforestation and contributes up to 40% of global emissions of carbon dioxide and other greenhouse gases. In addition, biomass combustion presents a serious health hazard in developing nations.

Over the past 40 years the world's agricultural, health, and energy problems have been addressed primarily from a technological standpoint. The disappointment of the "Green Revolution" and the construction of huge hydroelectric dams

in remote, and often environmentally sensitive, regions in developed and developing nations are striking examples of this ideology. In the face of population pressure and a global demand for energy expected to more than double in 20 years, preservation of regional ecosystems and the global environment necessitates a change of strategy.

Alternative and renewable energy systems hold significant potential to contribute to environmental preservation on both local and global scales. Traditional cookstoves are estimated to be the primary means of food preparation for one billion people worldwide, with roughly half the world population relying on such stoves with some regularity. Indoor air pollution from domestic combustion is linked to respiratory and pulmonary disorders including lung cancer, complications associated with pregnancy, and often serious burns (Smith, 1987, 1993). CO₂ emissions from enclosed burning systems in developing countries are estimated to be in excess of 1 GT (10¹⁵ grams) of carbon per year (see Table 1) (Meyers

and Leach, 1989). Furthermore, recent quantitative studies in the Philippines and Kenya suggest that trace gas emissions from stoves may be even higher than previously estimated (Smith et al., 1992; Kammen and Fayemi Kammen, 1992).

The recent concern with greenhouse warming opens an interesting, and often understated, aspect of solar oven projects: the potentially significant role of renewable energy technology to reduce local CO₂ and CH₄ emissions. Energy policy analysis (Hall et al., 1991) and multinational assistance organizations (Lovins and Lovins, 1991) have focused significant attention on proposals to reduce the generation greenhouse gases, devising elaborate schemes to "tax" carbon emissions. While per capita carbon emission is small developing nations, in total it contributes more than one quarter of the total global source and is the fastest growing emissions category. A common theme among policy analysts and environmentalists is that greenhouse warming is a global issue, and thus reduced carbon emissions -- regardless of the geographic source -- should be encouraged. The construction of modern and more efficient energy facilities in developing nations are frequently less than in developed nations because of low labor and materials costs. Based on economics alone it may be advantageous for developed nations to offset some of their emissions in other countries through technology transfer of small-scale energy systems.

A Tale of Two Technologies: Improved Stoves and Solar Ovens

A number of efforts to introduce improved stoves, such as the Kenya Ceramic Jiko, shown in Figure 1, that burn less wood and thus produce less pollution, have been undertaken over the last decade (Krugmann, 1987). In East Africa over 30 million people have been acquainted with these stoves, and over 700,000 such stoves are in general use (Table 2). Kirk Smith and colleagues have chronicled a massive and largely unrecognized effort in China that successfully introduced over 100 million improved cookstoves (Shuhua et al., 1991). A history of improved cookstoves can be found in Krugmann, (1987) while here we out-

line the history of the lesser known case, solar ovens.

While solar ovens (Figure 2) date from the 1950's (Curtis, 1991; Bremm-Gerhards, 1991; Kammen, 1991, 1992a), only in the last few years has significant progress in publicizing and disseminating this prototypical "renewable energy technology" been evidenced. The historical lack of widespread dissemination is surprising given that solar ovens are technically simple to construct (Kammen and Lankford, 1990a, b, 1991) and that, in Africa for example, wood for domestic cooking accounts for well over 60% of the total energy use (Figure 3). Traditional fuels, in the form of wood, charcoal, and crop residues account for over 70% of total energy consumption in Benin, Burkina Faso, Ghana, Guinea, Kenya, Malawi, Niger, Rwanda, Sierra Leone, Somalia, Tanzania, Uganda, and Zaire and account for less than 50% of the total in only six sub-Saharan nations (Armitage and Schramm, 1989).

Recent efforts to introduce solar ovens in Asia, Africa, and Latin America have all been sufficiently positive to convince a broad spectrum of non-governmental organizations, local district and village councils, that solar ovens are a cost effective means to combat the chronic fuel shortage and associated environmental damage that traditional cooking methods entail (Kammen, 1991; Kammen, 1992a, b). In Kenya, for example, the materials for a durable wooden solar oven (Figure 2) cost less than US\$ 30; a serious sum where annual per capita income hovers around US\$ 400, but not when weighted against the 30 - 40% of family income that is frequently spent on fuel.

On the other hand, the reasons for failure of many previous solar oven projects are not difficult to identify and must be addressed. Throughout the 1960's, 1970's and the early 1980's the focus of international assistance projects was on massive, centralized, energy initiatives, exemplified by large (over 1000 MW) hydro projects and the development of fossil-fuel burning plants even in nations without significant coal or oil resources (Hardin, 1968). Efforts to introduce solar ovens, wind generation equipment, micro-hydro systems, biogas digesters, and even photo-

voltaic equipment were regarded as "homespun"; the antithesis of meaningful national development (Kammen, 1991). Solar oven programs involved an even greater hurdle to much of the international aid community: direct interaction with the end-users of the technology, invariably women (NPL, 1957)

One issue frequently cited as an impediment to the widespread use of solar ovens is the change in cooking style required, and the possible disruption of important cultural practices (NPL, 1957). In field tests in both Central America (Kammen and Lankford, 1990b) and East Africa (Kammen, 1992a, b), however, we found that while education and follow-up to illustrate solar cooking methods are required, no cultural obstacle impeded the steady increase in oven use. In a number of communities in Africa, solar ovens are now widely used and replace over half of domestic wood use (Kammen, 1992a, b).

The failure of initiatives such as the "Green Revolution" that exemplify a "technical fix" approach to development (Hardin, 1968; England and Kammen, 1991) necessitated alternative projects that foster education and local control of resources. Recent solar oven initiatives, and programs such as the Grameen Bank, where lending on the scale of US\$ 20 - 400 directly to women wishing to begin small-scale business is encouraged, are examples of successful projects that follow this new ideology (Kammen, 1991). Central to this "small is beautiful" approach is an emphasis on resource diversification that large monolithic projects fail to capture. Even the most fervent proponents of intermediate technology programs do not claim that a particular windmill, hydro-system, or biogas plant is a panacea for all energy needs. A survey of the more than 100 solar oven projects worldwide reveals that on average solar ovens replace the use of roughly 50% of traditional cooking fuels, and are most effective when used synergistically with improved wood stoves, systems that generate natural gas from animal dung, and other renewable energy technologies (Bremm-Gerhards, 1991). To illustrate the point, the dramatic rise in solar oven projects in Kenya is chronicled in Table 3.

Health Issues: The Food-Fuel Link

While the health impact of biomass smoke has been studied worldwide, particularly in China (Shuhua et al., 1991) and India, we shall consider the case of Africa as a case study. Over two billion people worldwide depend primarily on biomass, or the "traditional" fuels of wood, charcoal, dung and crop residues, to prepare food. Domestic cooking accounts for over 60% of total energy use in sub-Saharan Africa. By contrast, highly industrialized countries expend less than 5% of total energy consumed on food preparation (see Figure 3 for a comparison). Thus, reliance on traditional fuel and energy resources consumes significant amounts of time and scarce capital, contributes to deforestation and the emission of greenhouse gases.

The process of food preparation is arguably one of the most pressing health and development issue facing poorer nations. Biomass cooking on traditional stoves -- "three stone fires", simple metal stoves and in some cases "improved" or modernized stoves -- is a major source of smoke and concentrated local and indoor air pollution. The smoke from biomass fires contains high levels of respirable particulate matter, carbon monoxide, nitrogen oxides, benzene, formaldehyde, benzo(a)pyrene and aromatics (Smith, 1993). In African countries, as in most developing nations, cooking smoke is often produced in confined indoor settings where women and children in particular, are exposed to dangerously high concentrations of a variety of noxious agents. Thus, the pollution levels in homes and cooking huts can exceed those measured in industrial cities, and represent the equivalent of smoking several packs of cigarettes per day (Smith, 1987).

The Cooking Environment and Smoke Exposure

The living conditions that expose people to high levels of indoor air pollution have been well documented in Africa. The majority of sub-Saharan Africans live in rural areas; Kenya, for example, is only about 20% urban. Family homes generally consist of small multi-purpose buildings, where the same room or few rooms are used for cooking, sleeping and working. In many cases the total

indoor volume is less than 30 m³; while in an extreme case of Masaai homes in Kenya we determined indoor air volumes to be consistently under 15 m³. A feature common to rural homes worldwide is minimal ventilation for the large output of smoke from cooking fires. Furthermore, we and others (Bradley, 1991) observe that when cooking, people may close the door, or, when they exist plug the windows with cloth.

The small size of many cooking enclosures in developing nations concentrates smoke. This problem is exacerbated by poor ventilation. In a series of studies Kirk Smith (1987) has measured the exchange rate, T, or the number of times per hour (h⁻¹) that air in a room or house is exchanged with that outside. While T may exceed 50 h⁻¹ for village huts with doors and ventilation holes kept open, such as during the dry season, values of T < 10 h⁻¹ may predominate during the rainy season, cold spells or at higher elevations. High pollution levels are by no means confined to rural areas. The close quarters of urban slums, the minimal spaces sometimes allocated for domestic servants, and the heavy use of charcoal pose significant health risks in cities. Overcrowding can even increase outdoor pollution concentrations over entire neighborhoods to levels approaching those of indoor cooking areas.

Pollution emitted from traditional cooking systems can easily build to unhealthy levels and remain that way over the course of a day. Compounding the problem is the type of cooking practiced in much of Africa. In many countries the staple foods are grains which require long cooking times, leading to extended periods of fuel combustion and increased indoor pollution levels. In Kenya, for example, the preparation of the staple maize and bean dishes (ugali, a hardened corn meal, and irio, a mixture of several beans) both require several hours of softening and simmering that can consume wood at the relatively high rates of 1.5 - 3.0 kg/hr (Smith, 1987; Bradley, 1991; Kammen, 1992b, c).

The Health Effects of Biomass Burning

Elevated levels of indoor air pollution have serious health implications.

Acute respiratory infection (ARI), in particular pneumonia, afflicts all demographic groups but is the leading health hazard to children in developing nations, resulting in an estimated 4.3 million deaths per year (Kammen and Fayemi Kammen, 1992; Smith, 1993). Among all endemic diseases, including diarrhea, ARI is the most pervasive cause of chronic illness in poorer nations. The segment of the African population most continuously exposed to indoor air pollution, however, are women -- who generally perform over 90% of domestic chores including cooking -- and their children (Kammen and Lankford, 1990b). This crisis has severe health and sanitation implications in developing nations and is the focus of the 1992 World Bank Development Report and call for action (World Bank, 1992).

A variety of studies in Africa have now been completed that demonstrate a consistent positive correlation between exposure to smoke from indoor biomass burning and ARI (Table 4). In a summary of the African studies Smith (1993) demonstrates that long-term exposure to smoke from biomass combustion elevates the risk of a child developing ARI of between 100 and 400%. Studies from China have also definitively linked indoor combustion of charcoal to ARI and lung cancer in children (Smith and Liu, 1992). Less well documented studies have also linked woodsmoke to an increased incidence of eye infections, low birth weight and cancer (US OTA, 1991; World Bank, 1992). Health clinics and mobile physician programs in developing nations routinely treat children and adults for serious burns resulting from direct contact with cooking fires (Kammen and Lankford, 1990b).

The Impact of Appropriate Technology

With the health, deforestation, and global warming risks associated with biomass cooking becoming increasingly clear, steps to improve the situation logically focus on combustion technology and education. There is a well recognized "energy ladder" of roughly increasing stove efficiency, cost, and desirability among the population. The ladder, shown in Figure 4, ranges from dung or crop residues combusted in three-stone fires, to wood or charcoal use in metal or improved stoves, to kerosene wick or

pressure systems, and finally to propane, liquid petroleum and electric appliances (US OTA, 1991). In comparable cooking applications wood stoves typically release 50 times more pollutants than a gas stove (Smith, 1993). While a significant body of "appropriate technology" literature exists on some of these stoves, quantitative analysis of the associated pollution emissions under actual field conditions is a rather new area of research (Smith, et al., 1992; Kammen and Fayemi Kammen, 1992).

In a series of measurements, we are beginning to quantify the indoor concentration of pollutants from cookstoves in rural Kenya. Initial measurements of carbon monoxide, CO, are very suggestive. The concentrations of CO, [CO], observed from both wood and charcoal burning in traditional and "improved" stoves are significantly above the WHO 1-hour recommended limit of 45.8 parts per million, ppm, (or 40 mg/m³). As can be seen in Figure 5, the [CO] near three stone wood (5(A)) and dung (5(C)) fires as well as charcoal fires (5(D - E)) can all exceed 2000 ppm.

Only the Kerosene stove (Figure 5(B)), the most advanced, expensive, and least common cooking technology that we encountered with any frequency, resulted in significantly reduced CO emissions. Interesting are the pollution levels found in so-called "improved stoves" (Figure 5). Because carbon monoxide is odorless and colorless, the high [CO] may lead to poisoning without the warning of coughing and tearing that is associated with hydrocarbons and particulates in woodsmoke (Figure 5). The health problems of pollution from improved stoves can be minimized if directly addressed in the educational component of stove dissemination programs (Kammen, 1992b).

Proposal: Dissemination of Appropriate Technology Cooking Systems

We propose that improved stoves, solar ovens, and related educational programs be integrated in: the basic workings of disaster relief and reconstruction programs worldwide (England and Kammen, 1991); energy; agricultural; health; and economic development assistance programs. To illustrate

the practical workings of this proposal we detail the case of Kenya, where the author directs a solar oven pilot project. We begin with a history of energy related development projects in Kenya, present the solar oven story, and then conclude with a general outline of the proposal, including both improved stoves, solar ovens, and community education components.

Pilot Project Background: Energy in Kenya

Kenya, a relatively prosperous "developing nation", illustrates the paradox of international technical assistance: despite high levels of donor aid there has been little progress away from a subsistence economy for much of the populace. Gross national product per person decreased from US\$ 410 to 370 during the 1980's. Figure 6 illustrates the near stagnation in the energy sector, where wood and other traditional fuels continue to occupy the same share of the total energy mix as they did ten years ago. Total energy consumption rose only from 13 to 19 GJ/year. Furthermore, international assistance has averaged about 10% of the Kenyan GNP for the period 1979 to 1989, with energy projects given a high priority. It is thus apparent that the traditional assistance and development approach should be revised.

Kenya currently devotes over 40% of GNP to the purchase of imported fossil fuels. In the face of this situation Kenya, like most developing nations, is in need of projects that encourage energy diversity and reliance on renewable, and locally controlled, sources of energy. This situation is dramatically illustrated by current power shortages, that has forced the government to limit residential energy to 8 - 12 hours per day.

While fossil fuels contribute only 24% of the Kenyan national energy supply and charcoal comprises roughly 9% of the total, the impact of these fuels is significant. The situation in semi-arid Kitui District illustrates the role of charcoal in the local economy. Wood harvesting, charcoal production and sale constitutes one of the largest source of capital for the rural inhabitants (Figure 7). In fact charcoal production is the dominant cause of local deforestation, as large trees are felled primarily to supply wood for the most

expensive (old growth/hardwood) variety of charcoal. Few rural inhabitants can afford to use charcoal themselves: in a survey of 35 families in the town of Zombe (total: 900 families), only three used charcoal on a regular basis (Kammen, 1992c). Of the three families, one family of 9 supplied all their cooking needs with the purchase of one 50 kg bag every four days, while the other two families supplemented their supply of fuelwood with one bag of charcoal per week. Over half of the families derived more than 30% of total cash income from the sale of charcoal. The reliance on charcoal as a fuel contributes to deforestation, habitat reduction and hence loss of biodiversity, and a stagnant economy.

The Kenya Solar Oven Project: 1990 - 1992, and Beyond

Building on successful programs in Central America (Kammen and Lankford, 1990a, b, 1991), we have begun a "North-South" cooperative project where Earthwatch Volunteers from the U. S., Japan and Europe (Figure 8), and students from the University of Nairobi are teaching women's groups how to construct and manage solar ovens. Working in rural communities in Eastern and Southern Kenya, the goal is to fully "transfer" the technology so that local groups and craft persons can modify and exploit various renewable energy systems; integrating them into the local resource base.

The process of "technology transfer" and "North-South" cooperation are frequently echoed buzzwords in the international development and environment community. In this project, these concepts are put directly to work. EarthCorps volunteers spend a first week at the University of Nairobi learning (by doing) how to construct solar ovens (and, beginning in 1993 windmills as well: see page 9) and then travel to field sites where they share their experience in workshops that result in ready-to-use solar ovens. Additional tasks involve measurement of fuel use and carbon monoxide/dioxide and methane emissions from traditional cooking fires. This process could easily be formalized and presented to international assistance organizations such as U. S., Japanese, and European aid organizations, UNDP, WHO and the FAO. Even relatively mod-

est -- but long term -- improved stove and solar oven programs by these groups would generate widespread technology conversion due to the tendency of international assistance funds to "seed" similar program spending and attention by other groups.

Working in two pilot communities, Earthwatch Volunteers contributed to the construction of over 30 solar ovens during the first season, and waiting lists now exist for participation in further sessions that will be organized and directed by local Kenyan "Renewable Energy Committees." The solar ovens have demonstrated the practical benefits of renewable energy, and boosted interest in windmills and further renewable energy projects (Figure 8).

Teaching the basic physical principles of solar oven performance is vital to the process of "technology transfer". In each community, we cook a variety of foods before and during the construction workshop, and demonstrate the capability of the solar ovens. Figure 9 shows temperature vs. time plot of a solar oven during the boiling of two liters of water for soup. Notice that in only 50 minutes the oven has passed the boiling point of water.

The process of fully integrating a new technology, particularly in a realm of lifestyle as fundamental as cooking, can take several years. However, only six months after the first visit to Zombe, Kenya (one of the solar oven pilot communities) Mrs. Mwota, the Secretary of the Renewable Energy Committee wrote:

Dear Daniel Kammen: As we have arranged, a one day solar cooking seminar was [held] on September 26, 1992. It was a sunny day. We used two solar jikos [ovens] to cook tea, cake, rice mixed with meat, potatoes and tomatoes. Tea took 1 hour 45 minutes, cake took 4 hours and 11 minutes, rice took 3 hours and 41 minutes. All the food was well cooked; it was very successful and all the members enjoyed the food. The group suggested that if the jikos could have [even] more heat some hard foods like chapati [Indian flat bread] will be easily cooked. People with the solar ovens said that they have cooked many foods and they are enjoying cooking with them.

In these community projects solar ovens do not necessarily replace biomass stoves or improved jikos (although they have in some areas). Solar ovens provide an additional energy resource that is typically used more and more as people become increasingly comfortable with the technology. This pattern is fully consistent with human nature everywhere and the prevailing cultural tendency in developing nations, to maintain a diversity of energy technologies. It is rare that even the most wealthy families in Nairobi, for example, will discard technologies as they move up the energy ladder (Figure 4). A single family may regularly use six or more different fuels and types of stoves. While slowing the transition away from the most polluting fuels, this behavior helps to ease the introduction of new technologies and keeps people from rejecting them if, for example, a long rainy season were to keep a solar oven from use for several months.

Impact on Biomass Burning: Reducing Greenhouse Gases Economically

In Kenya, the materials for a solar oven cost about US\$ 30 while in parts of Latin America the price may be US\$ 100 (Kammen and Lankford, 1990b). As shown in Figure 3, the average Kenya burns almost a ton of wood per year. Given that solar ovens have been demonstrated to reduce the demand for fuelwood by over 50% (Bremm-Gerhards, 1991; Kammen, 1991) solar ovens replace biomass combustion and hence sequester CO₂ and other greenhouse gases at the equivalent of \$20 - 30 ton⁻¹ of carbon. Similarly, improved stoves in Kenya save 20 - 50% on the firewood needed by most families (Krugmann, 1987), cost \$3 - 8 depending on the size, and thus over a ten year lifetime cost \$10 - 20 for each ton of carbon dioxide not emitted to the atmosphere from cooking fires. These prices compare favorably with the costs associated with a variety of systems including reforestation schemes (to sequester CO₂ in new tree growth), implementing new "clean" coal technologies, and state of the art photovoltaic systems (Hall, et al., 1992; Rosillo-Calle and Hall, 1992). A series of example programs are listed in Table 5. With energy demand in developing countries expected to double in under 20 years, international support for small-scale renewable energy systems repre-

sents a logical avenue to promote energy self-sufficiency and to economically combat global climate change.

Commercial Energy Needs: the Example of Windmills

Solar ovens and improved stoves serve a second vital role in addition to reducing biomass burning. As simple technologies that are used in the everyday activity of cooking, they introduce people to the unfamiliar area of alternative and renewable energy. This vital step was often missing from previous international aid projects: "paving the way" and providing people with concrete assurance that these novel systems do indeed work and are worth considering. This is a common problem for all new technologies, from CD players and cellular telephones to cook-stoves and windmills.

Overwhelmingly, residents of developing nations feel a need for additional income (England and Kammen, 1991) that generally necessitate more complex technology than solar ovens or improved stoves. In Kenya, we are using solar ovens ease the introduction of windmills that can pump water for drinking and growing additional crops. In our Earthwatch pilot project in Kenya Savonius and Cretan Sail windmills are slated for demonstration and dissemination during the 1993 field season (see Figure 8).

In many respects the history of modern vertical axis windmills is similar to that of solar ovens. Both the Savonius rotor, invented over 60 years ago, and the Cretan Sail (a small "Don Quixote" type windmill) are only recently beginning to attract widespread attention outside of the "appropriate technology" community (Hankins, 1987). The Savonius rotor (Savonius, 1931) is an omni-directional vertical axis windmill that is constructed from a 55 gallon (220 liter) drum that is cut vertically in half and offset (overlapping) around a central shaft. A "stacked" version utilizing two drums is shown in Figure 10.

In the past critics of the Savonius rotor have cited its high mass and low maximum power, P, output as drawbacks. The power coefficient, C_p, is defined as

$$C_p = \frac{P}{(1/2) \rho v^3 A}$$

where p is the density of air, v the wind velocity, and A the swept area of the rotor. For a one-bucket Savonius rotor the maximum measured $C_p = 0.24$, while for the two-bucket design shown in Figure 10, $C_p = 0.24 - 0.28$ is about the effective experimental maximum (Ushiyama and Nagai, 1988). More complex "propeller" windmills can achieve $C_p > 0.35$ (the theoretical limit, $C_{Betz} = 0.59$) but at the cost of increased expense and design complexity. Experimental results for several windmill designs are summarized in Figure 11. With the cost of Savonius windmills under \$200, we have concentrated on that design.

Recent engineering research focused on optimizing the overlap and aspect ratios has significantly increased the efficiency of "modernized" rotors, prompting a second look at Savonius systems for application in developing nations (Ushiyama and Nagai, 1988; Kammen, 1992c). The principal advantage of the Savonius system, however, is the ease of construction and durability. Modernized Savonius designs are capable of providing 5 - 50 Watts and can pump 100 - 300 liters hr^{-1} from a depth of 10 meters given a 6 m sec^{-1} wind. This output of water is significantly better for the price.

The success of the solar oven, windmill and other renewable energy projects is not only be measured in the number of solar ovens and windmills constructed, but also in the degree to which the process of building and adapting the technologies provides a springboard for the community. As in our first pilot case of Zombe, Kenya, the communities slowly gain a significant measure of direct control over the supply of domestic and commercial energy resources.

Proposal: Technologies and Policies to Improve Environmental Health

Successful environmental and development projects generally require a combination of community involvement and initiative, and technical or financial assistance. Thus while this proposal is a call for the integration of solar oven, improved cookstove, and other renewable energy technologies into the standard packages provided by assistance organizations throughout the world, a number of

immediate changes can be made that will reduce greenhouse gas emission and improve indoor air quality and health. As a starting point, these organizations could include solar ovens in all community projects in the tropics (15 degrees North to 15 degrees South). The items listed below combine behavioral and hence educational, technological, and policy programs for community, national, multinational and non-governmental organizations:

1. Good ventilation is essential: educational programs should stress that even invisible gases can be harmful; while cooking, a door or window should be kept open even during the rainy season.

2. Reduce exposures for children: children under five years of age may be particularly sensitive to the hazards of indoor air pollution; limit their extended exposure. This is not always possible particularly due to the diverse demands on women, but extended African families and family compounds provide the means to monitor young children away from cooking fires.

3. Economic improvement brings health improvement: numerous studies indicate that when given the option or economic resources, people opt for more modern stoves and move up the "energy ladder" [9] towards cleaner fuels. Grameen (communal lending) Banks and other programs indicate that poor communities efficiently utilize even small amounts of capital.

4. Further research on cooking technology is needed: a "win-win" situation exists for public health improvements, and energy and environmental conservation, when development funds are spent on modernizing cooking systems that currently consume the bulk of energy in developing nations.

5. Solar cooking can be a "win-win-win" proposition: successful pilot programs indicate that in a diverse set of developing nations solar ovens provide a way to cook many foods without any smoke and to cut fuel use. Solar oven workshops could be inexpensively included in a wide variety of education and development programs.

In summary, a benefit to both developing

and developed nations exists in improving cooking technology. As much as 40% of worldwide CO_2 emission originates in developing nations, that in turn devote an inordinate share of total energy resources to food preparation. The ever pressing need for fuel contributes to deforestation and threatens biodiversity. Because CO_2 emitted anywhere increases the atmospheric loading of greenhouse gases, abatement programs in developing nations simultaneously serves regional and global environmental goals.

We further propose that aid organizations in industrialized nations (that generally produce large amounts of CO_2 per capita) to fund development projects that reduce CO_2 emission elsewhere in the world, while receiving a credit towards their greenhouse gas quotas in the process. One frequently discussed scheme, that of tradeable emissions permits (see, for example, Nordhaus, 1992), readily provides a framework for this proposal and is not difficult to arrange. This was demonstrated by the success of the Montreal Protocol for the elimination of CFC's. Furthermore, no new verification or experimental testing would be necessary to implement this plan. International aid organizations already monitor the outcome of their programs (and perform environmental impact assessments). The reduction in biomass burning will be apparent in surveys of local fuel prices (and in satellite remote sensing surveys of forest areas), national fossil fuel imports, funds spent on health care (such as the treatment of ARI), and in the general interest and awareness of appropriate technology systems. If implemented, this proposal would direct international assistance towards projects -- such as improved stoves and solar ovens -- that maximize energy efficiency and contribute significantly to local environmental health and global environmental sustainability: a "win-win" proposition.

Acknowledgements

This ongoing research has been supported by The Kenya National Academy of Sciences, Ambassadors Development Agency, The University of Nairobi, and grants from the Harvard Medical School, and Earthwatch and its Research Corps. I thank A. Burnfield, W. Chin, R. O. Genga, A. O. Lucas, R. M.

Munavu, T. R. Odhiambo, K. R. Smith and give special thanks to the Solar Oven

Committees of Zombe and Loitoiktok, Kenya.

REFERENCES

- Armitage, J. and Schramm, G. (1989) In: Environmental Management and Economic Development, Schramm, G. and Warford, J. J. (eds.), Johns Hopkins University Press: Balt., MD, 139 – 191.
- Bradley, P. N. (1991) Woodfuel, Women and Woodlots: The Foundations of a Woodfuel Development Strategy for East Africa, (Macmillan: London).
- Bremm-Gerhards, U. (1991) Chancen solarer Kochkisten als angepasste Technologie in Entwicklungslandern, Social Science Studies on International Problems, 165, (Verlag: Saarbrücken).
- Curtis, D. O. (1991) An appreciation of Solar Cooking (Sy Dimensions: Healdsburg, CA).
- England, S. B. and Kammen, D. M. (1991) "Renewable energy and disaster relief/development: a critique of the dominant paradigm" *Nature*, 352, 752.
- Graham, N. M. H. (1990) "The epidemiology of acute respiratory infections in children and adults: Global perspectives" *Epidem. rev.*, 12, 149 – 178.
- Hall, D. O., Mynick, H. E. and Williams, R. H. (1991) "Alternative roles for biomass in coping with greenhouse warming" *Science & Global Security*, 2, 1 – 39.
- Hankins, M. (1987) Renewable Energy in Kenya, (Motif Ltd.: Nairobi).
- Hardin, G. (1968) "The tragedy of the commons" *Science*, 162, 1243 – 1248.
- Kammen, D. M. (1991) "Technology for development: sustaining, not obliterating, the environment" *Research & Exploration*, 7, 3 – 5.
- Kammen, D. M. (1992a) "The Kenya solar box: appropriate technology dissemination in Africa" *African Technology Forum*, 5 (1), 12 – 13.
- Kammen, D. M. (1992b) "Participatory rural appraisal: environmental resource accounting and management" *African Technology Forum*, 5 (2), 22 – 24.
- Kammen, D. M. (1992c) "Renewable energy alternatives: appropriate technology and sociology in developing nations" presented at the Grand Solar Challenge, Kanazawa, JAPAN, September 5 – 6.
- Kammen, D. M. and Lankford, W. F. (1990a) "Comparative study of box-type solar cookers in Nicaragua" *Solar & Wind technol.*, 7, 463 – 471.
- Kammen, D. M. and Lankford, W. F. (1990b) "Cooking in the sunshine" *Nature*, 348, 385 – 386.
- Kammen, D. M. and Lankford, W. F. (1991) "Designing better solar cookers" *Nature*, 351, 21.
- Kammen, D. M. and Fayemi Kammen, B. (1992) "Energy, food preparation and health in Africa: the roles of technology, education, and resource management" *African Technology Forum*, 5 (4).
- Krugmann, H. (1987) Review of issues and research relating to improved cookstoves (International Development Research Centre: Ottawa, Canada), IDRC-MR152e.
- Lovins, A. B. and Lovins, L. H. (1991) "Least-cost climatic stabilization" *Ann. Review Energy & Env.*, 16, 433 – 531.
- Meyers, S. and Leach, G. (1989) Biomass Fuels in Developing Countries: An Overview, LBL-27222 (Lawrence Berkeley Laboratory: Berkeley CA, 1989).
- NPL (1957) Twelve Month Status Report on the Viability of Solar Cooking in New Dehli, (National Physical Laboratory: India).
- Nkonoki, S. R. and Sorensen, B. (1984) "A rural energy study in Tanzania: the case of Bundilya village" *Nat. Res. Forum*, 8, 51 – 62.
- Nordhaus, W. D. (1992) "Optimal transition path for controlling greenhouse gases" *Science*, 258, 1315 – 1319.
- Rosillo-Calle, F. and Hall, D. O. (1992) "Biomass energy, forests and global warming" *Energy Policy*, 20, 124 – 136.
- Savonius, S. J. (1931) "A novel vertical-axis windmill" *Mechanical Eng.*, 53, 333 – 338.
- Shuhua, G., Kum, H., Daixong, Q. and Smith, K. R. (1991) "100 million improved cookstoves in China: how was it done?" Country Study No. 1, Risk and Development Program, East-West Center.
- Smith, K. R. (1993) "The health impact of cookstove smoke in Africa", in African development perspectives yearbook, 3, Oesterdiekhoff, P. (ed.).
- Smith, K. R. (1987) Biofuels, air pollution and health (Plenum: New York).
- Smith, K. R., Khalil, M. A. K., Rasmussen, R. A., Thornehoe, Manegdeg, F. and Apte, M. (1992) "Greenhouse gases from biomass and fossil fuel stoves in developing countries: a Manila pilot study" *Chemosphere*, 26.
- Smith, R. R. and Liu, Y. (1992, forthcoming) Indoor air pollution in developing countries, in J. Samet, ed., *Epidemiology of Lung Cancer* (Marcel Dekker: NYC)
- U. S. Congress, Office of Technology Assessment (1991) Energy in developing countries, OTA-E-486 (Washington, DC: US Government Printing Office).

Ushiyama, I. and Nagai, H. "Optimal design configurations and performance of Savonius rotors" (1988) *Wind Engineering*, 12, 59 - 75.

World Development Report 1992: Development and the environment (World Bank and Oxford university Press: London).

Wickramagamage, P. (1991) "Improved cookstove programs in East and Central Africa" Country Study No. 5. Risk and Development Program, East-West Center.

TABLES

TABLE 1: Total Carbon Released from Biomass Combustion.

SOURCE	Tg/yr
OPEN BURNING	
Swidden Agriculture	500 - 1000
Permanent Deforestation	200 - 700
Savanna Fires	300 - 450
Total: Open Burning	1150 - 3750
ENCLOSED BURNING (Developing Nations)	
Crop Residues	350 - 500
Firewood	500 - 800
Wood for Charcoal	100 - 300
Total: Enclosed Burning	950 - 1600
TOTAL BIOMASS	2100 - 5350
TOTAL FOSSIL FUELS	5300 - 5800

TABLE 1 LEGEND: Note, in particular the emissions from enclosed (domestic/household) biomass burning. 1 Tg = 10¹² grams; 1 Pg = 1 GT = 10¹⁵ grams. Data taken from Smith et al. 1992, Kammen, 1992b).

TABLE 2: Estimated Number of Improved Stoves in East Africa, 1991.

COUNTRY	TOTAL		PROGRAM STATUS
	Urban	Rural	
Botswana	1,500	-	Active
Ethiopia	900	-	?
Kenya	550,300	52,000	Reduced, 1989
Malawi	3,700	-	Active
Rwanda	20,000	-	Inactive, Civil War
Sudan	16,580	1,380	Ended, 1987
Zimbabwe	10,880	-	Ended, 1989

TABLE 2 LEGEND: The number of stoves is taken from official (international agency, governmental, or non-governmental organization) project figures for the number of stoves "disseminated", or introduced. The number of stoves in use, however, may be greatly less for unsuccessful projects or may be an underestimate, such as in Kenya, where local stove manufacture has continued after the end of the formal project. Adapted from Wickramagamage (1991).

TABLE 3: Solar Oven Projects in Kenya, 1977 - 1992:

1977 The German company GTZ initiated and then abandoned a project in the Nairobi area. The failure was attributed to design flaws and availability concerns for equipment, primarily imported from Europe.

1985 The Catholic Mission in North Horr sponsored the construction of 80 ovens for promotion and sale. The project was not followed-up, and only scattered reports of current oven use persist.

1986 A project was announced by a Catholic Mission in Mwingi. No further information has been made available.

1990 The Baringo Fuel and Fodder Project included the construction of solar ovens as part of its agricultural and household education program (St. Lawrence University, USA).

1991 Kenyan craftsmen in Nairobi began production of solar ovens for export to Tanzania and Uganda, indicating interest in solar ovens from an economic standpoint.

1991 Solar Box Cookers Northwest (Seattle, Washington USA), and SBCI have filled requests for literature and plans for simple cardboard demonstration models from over 80 government and private groups in Kenya.

1991 The Institute of Cultural Affairs, a non-profit corporation based in Nairobi, distributed 250 solar ovens (termed the Ulog Solar Jiko) through a series of demonstration sessions. ICA encourages carpenters to construct the ovens that are estimated to cost \$US 50 - 70.

1992 The Earthwatch Foundation awarded DM Kammen a multi-year grant to test and promote solar oven and other appropriate technologies in Kenya. The project, in collaboration with the University of Nairobi, the International Centre for Insect

Physiology and Ecology, and Ambassadors Development Agency (all based in Nairobi), began in June 1992, and will incorporate volunteer assistants from the United States as well as community leaders from two regions of Kenya.

1992 The African Medical and Research Foundation (based in Nairobi, and serving much of East Africa) has formed a partnership with Solar Box Cookers International (Sacramento, California, USA) to include solar ovens as part of their ongoing mobile health project.

TABLE 3 LEGEND: A chronology of solar oven projects in Kenya, demonstrating the recent growth of interest in community-oriented renewable energy initiatives. The post-1990 projects illustrate the range of economic approaches (both grant-in-aid and indigenous free-market) and the mix of domestic and international collaboration that is typical of recent successful solar oven projects worldwide. This flowering of activity illustrates the success of these programs and demonstrates end-user interest. The time appears right for these programs to be expanded through international and national level funding.

TABLE 4: Studies of Domestic Biomass Combustion and Acute Respiratory Infections (ARI) in African Children.

STUDY (year)	SUBJECTS (case/control)	HEALTH MONITORING (ARI determination)	ARI RISK (Relative Risk)
1. Natal (1980) South Africa	132/18	Clinical X-Ray	4.8 1.7 - 13.6
2. Basse (1989) The Gambia	587	Reported shortness of breath	2.8 1.3 - 6.1
3. Maragua, Kenya (1990)	36	WHO Guidelines	N/S
4. Marondera (1990) Zimbabwe	244/500	Hospitalization for ARI	2.2 1.4 - 3.3
5. Basse (1991) The Gambia	587	Reported Shortness of breath	Girls: 6.0 1.1 - 34.0 Boys: N/S

TABLE 4 LEGEND: The exposure conditions were to cookstove smoke for children, 0 - 59 months of age, with the children frequently carried on their mother's back. The relative risk (incidence ratio to that in the control group) is shown with the uncertainty range at the 95% confidence level. N/S: not statistically significant. Adapted from Graham (1990) and Smith (1993).

Table 5: Comparison of Prices to Sequester CO₂ Under Various Potential Schemes.

Proposal	Sequestering Cost (US \$ per ton)
Kenya Ceramic Jiko	15 - 30
Solar Ovens	20 - 30
Reforestation	25 - 40
Savonius Windmills: Pumping H ₂ O	45 - 135
"Clean" Coal Technology	50 - 120
Photovoltaic: Pumping H ₂ O	100 - 240

TABLE 5 LEGEND: Estimated cost (per ton of carbon sequestered) of various schemes proposed in the literature. The solar oven project is based on ovens with a ten year lifetime, costing US\$ 100, and offsetting 50% of the wood use of a family with a per capita income of US\$ 400. The reforestation proposal is for the United States, and involves use of 139 million hectares of economically marginal land (Hall et al., 1991). The windmill and photovoltaic costs are based on application only for irrigation, estimated for Tanzania at 90 Watts cap⁻¹ yr⁻¹, with firewood the equivalent of 570 Watts ton⁻¹ and for technologies with a five year lifetime (Nkonoki and Sorensen, 1984).

FIGURE LEGENDS

FIGURE 1

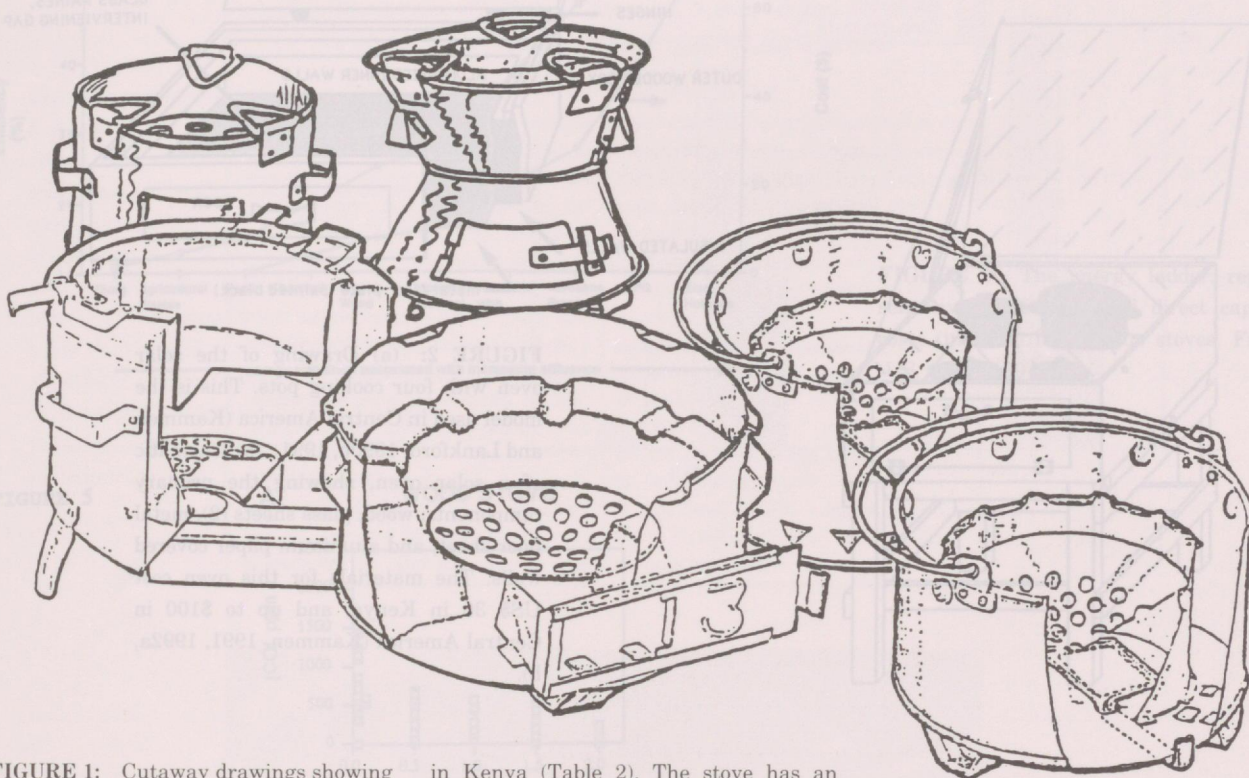


FIGURE 1: Cutaway drawings showing the interior linings of several improved cookstove designs. The two at top are versions of the Kenya Ceramic Jiko, an improved stove that has been widely disseminated and introduced into the local economy in East Africa, and particularly

in Kenya (Table 2). The stove has an enclosed cooking chamber and ceramic walls to improve heat retention and efficiency. Local craft shops make and sell the jikos for \$US 5 – 15. Periodic replacement of the ceramic lining is necessary.



Figure 1a: Photo/D.M. Kammen
Smoky indoor cooking fire



Figure 1b: Photo/D.M. Kammen
Kenya Ceramic Jiko (right)
Cooking pot (left)

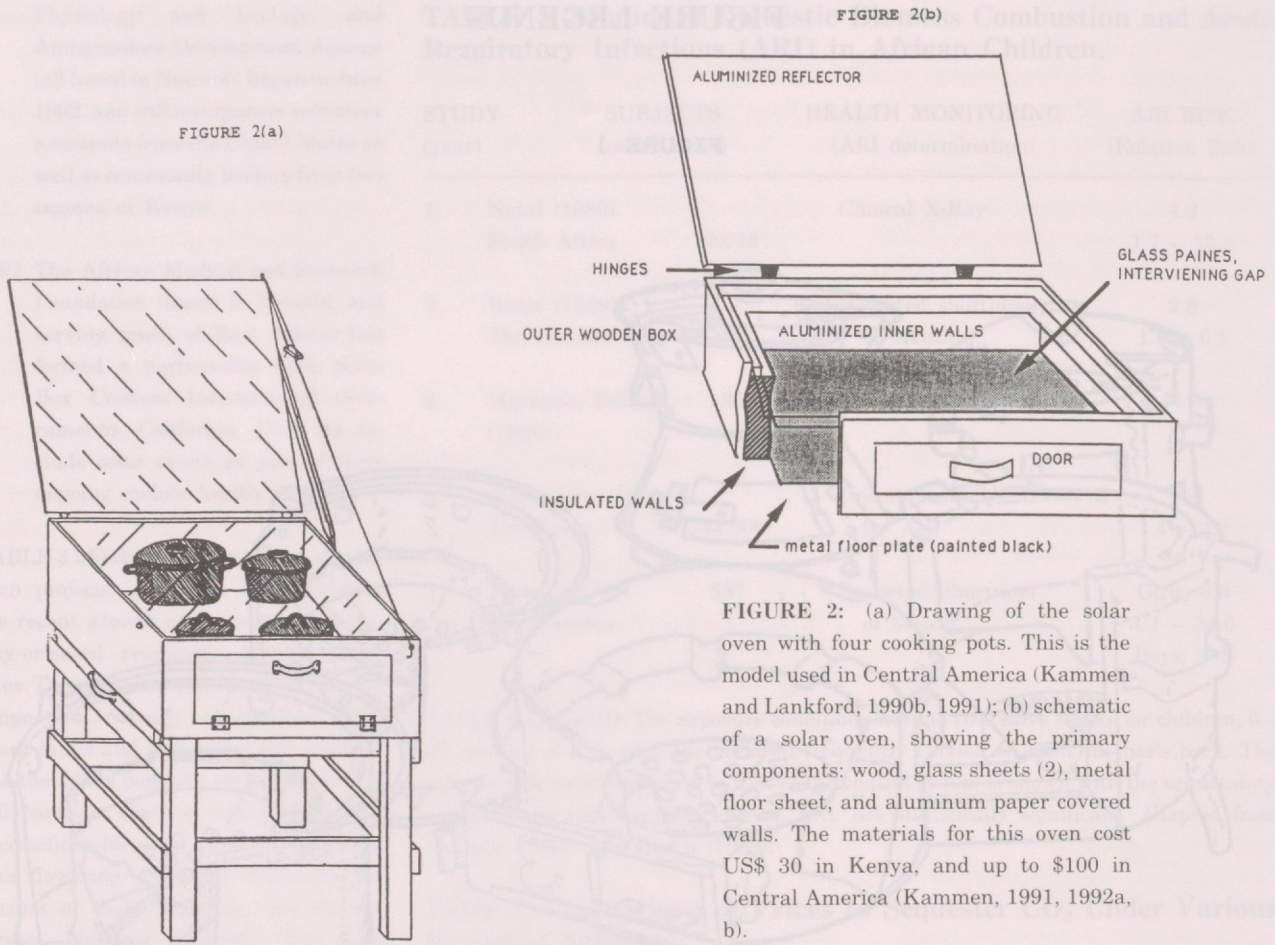


FIGURE 2: (a) Drawing of the solar oven with four cooking pots. This is the model used in Central America (Kammen and Lankford, 1990b, 1991); (b) schematic of a solar oven, showing the primary components: wood, glass sheets (2), metal floor sheet, and aluminum paper covered walls. The materials for this oven cost US\$ 30 in Kenya, and up to \$100 in Central America (Kammen, 1991, 1992a, b).

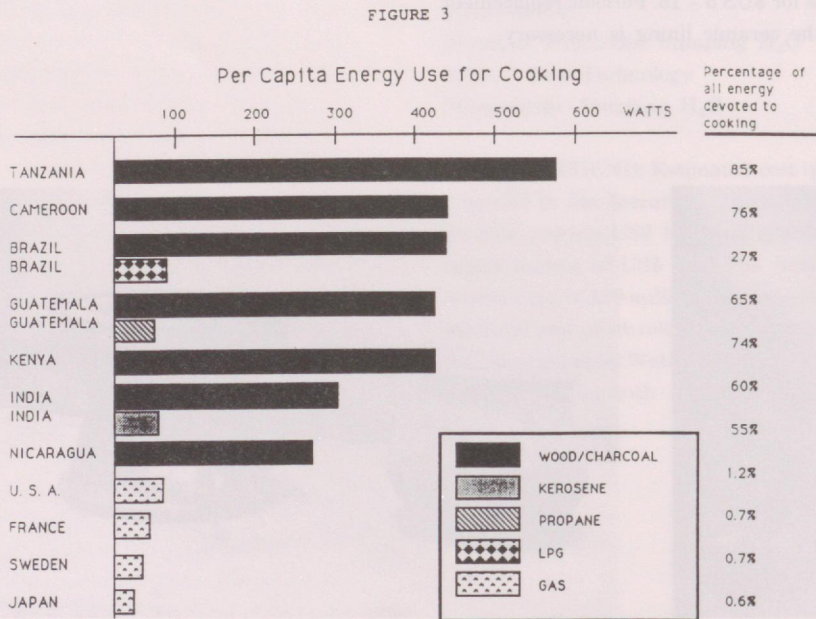


FIGURE 3: Per capita energy use for cooking in developing nations. To reflect the diversity of cooking fuels used in each nation, the primary fuels are listed for several examples.

FIGURE 4

Comparison of Stove Efficiency and Cost

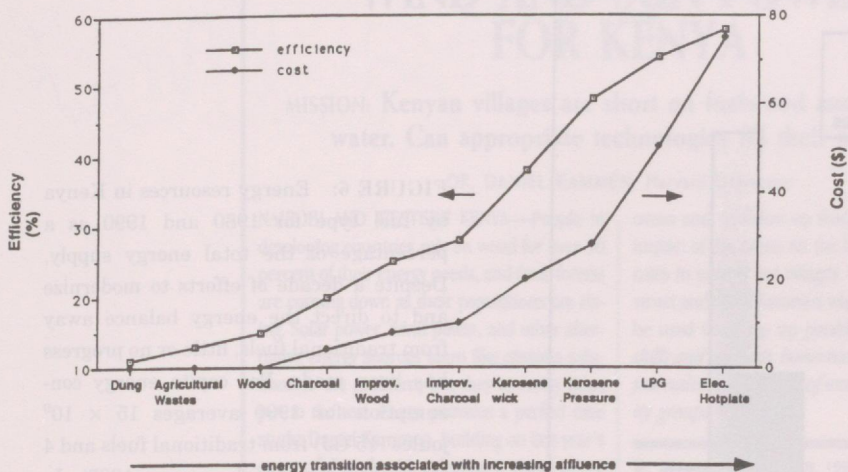
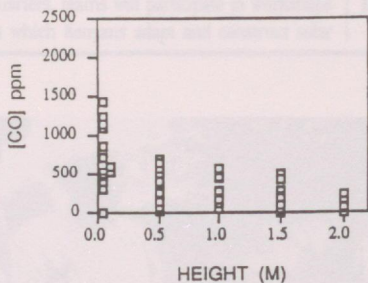


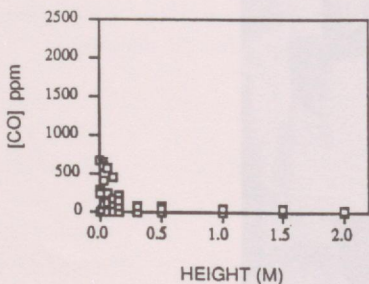
FIGURE 4: The energy ladder: representative efficiencies and direct capital costs (in US\$) for various stoves. From (US OTA, 1991).

FIGURE 5

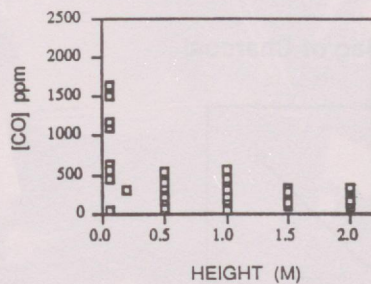
A. WOOD STOVE



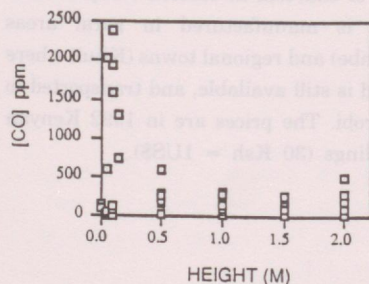
B. KEROSENE



C. DUNG



D. IMPROVED JIKO: CHARCOAL



E. TRADITIONAL JIKO: CHARCOAL

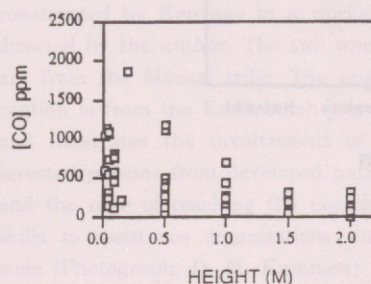


FIGURE 5: The concentration of carbon monoxide, [CO], versus height (in meters) above the fire in small cooking huts or homes for several types of cookstoves. The data in each panel is aggregated from a number of stoves, and was measured while boiling water. The data is preliminary, but indicates that CO emission is significantly reduced only for the "high tech", and least common, Kerosene stove (B). Note that burning of wood (A) or dung (C) are not appreciably worse than charcoal in either an "improved" jiko (D; Figure 4) or a simple metal stove (E). The WHO recommended one hour exposure limit is 45.8 ppm while some measurements exceed 2000 ppm. Note, the panels are not histograms, but scatter plots; thus, the highest value at each height is the maximum concentration observed with lower values also occurring.

FIGURE 6

Energy Mix in Kenya, 1980 - 1990

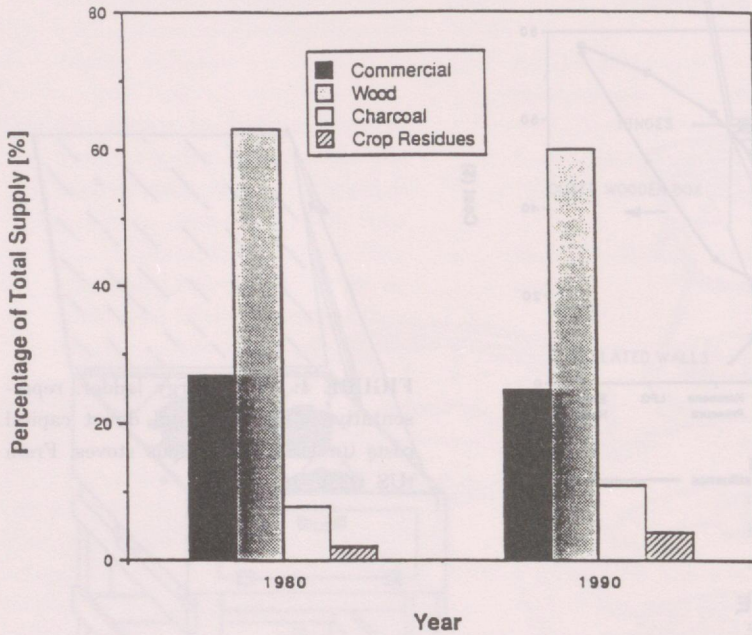


FIGURE 6: Energy resources in Kenya by fuel type for 1980 and 1990 as a percentage of the total energy supply. Despite a decade of efforts to modernize and to direct the energy balance away from traditional fuels, little or no progress has been made. Per capita energy consumption for 1990 averages 15×10^9 joules (15 GJ) from traditional fuels and 4 GJ from commercial sources (1987). In 1980 total consumption was 30% less than in 1990 when traditional fuels supplied 11 GJ/capita; while fossil fuels accounted for 2 GJ/capita.

FIGURE 7

Market Price of 50 kg Bag of Charcoal

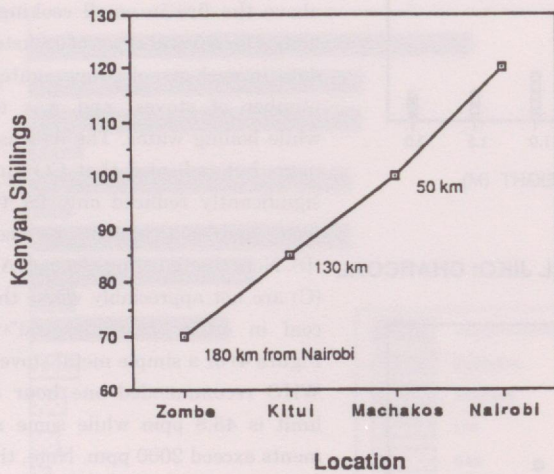


FIGURE 7: The market price of a 50 kg bag of charcoal in eastern Kenya. Charcoal is manufactured in rural areas (Zombe) and regional towns (Kitui) where wood is still available, and transported to Nairobi. The prices are in 1992 Kenyan Shillings (30 Ksh = 1US\$).

FIGURE 8

WIND AND SUN POWER FOR KENYA

MISSION: Kenyan villages are short on fuelwood and drinking water. Can appropriate technologies fill their needs?

DR. DANIEL KAMMEN, Harvard University

NAIROBI AND WESTERN KENYA—People in developing countries rely on wood for over 50 percent of their energy needs, and their forests are coming down as their populations are rising. Solar power, wind power, and other alternative energy sources seem like obvious solutions to the problem, but they've rarely been put to the test. Kenya provides a perfect case study. Daniel Kammen, building on last year's successful work with volunteers, wants to see whether solar ovens and windmills can both fulfill the Kenyans' energy needs and fit in with their society.

Field Conditions: Based in a residence hall at the University of Nairobi and in field quarters, teams will participate in workshops in which Kenyans adapt and construct solar

ovens and, in follow-up studies, will chart the impact of the ovens on the household economies in several test villages. Team II will construct and test a Savonius windmill, which will be used to pump up potable water. *Related skills and interests: home economics, Swahili, journalism, the status of women and minority groups.*

- TEAM I: Jun 28-Jul 10, 1993
- TEAM II: Jul 19-31
- TEAM III: Aug 4-16
- STAGING AREA: Nairobi, Kenya
- PROJECT COST: \$50,850
- YOUR SHARE: \$1,695 ■ £995 ■ A\$2,325
- CO-SPONSORS: University of Nairobi, Kenya Academy of Sciences

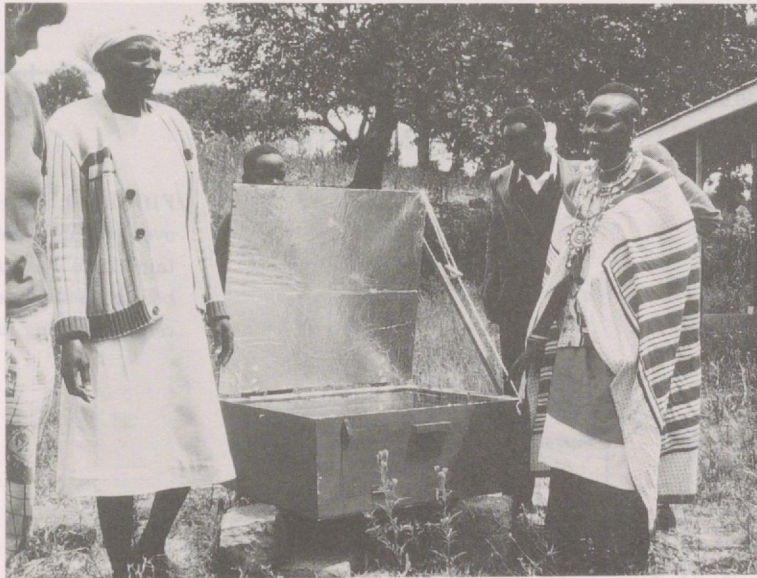


FIGURE 8: Photograph of a solar oven constructed by Kenyans in a workshop directed by the author. The two women are from the Masaai tribe. The project caption is from the Earthwatch journal, and illustrates the involvement of interested persons from developed nations and the ease of teaching the necessary skills to assistance organizations worldwide [Photograph: D. M. Kammen].

FIGURE 9

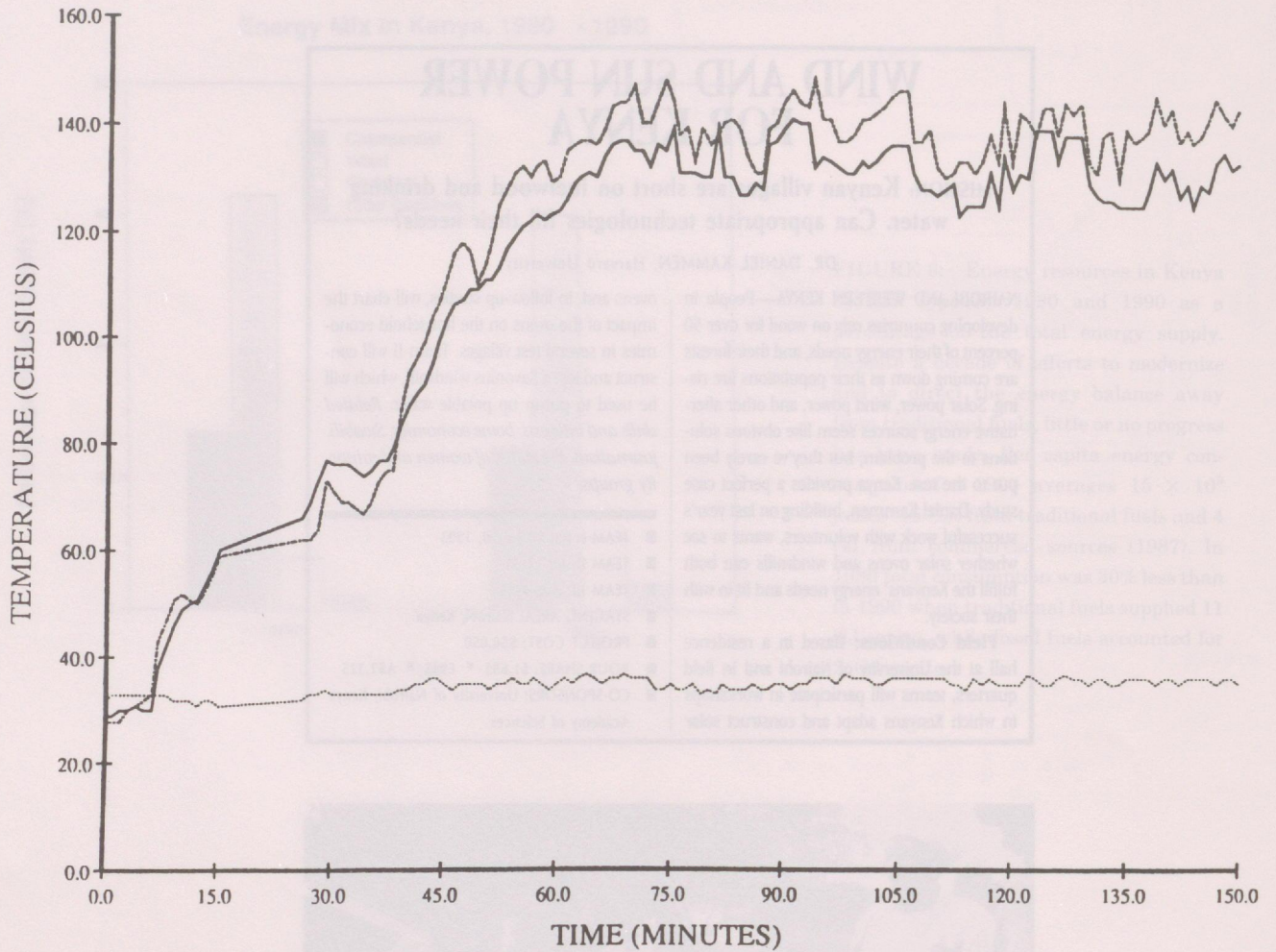


FIGURE 9: The temperature in a solar oven versus time. The solar oven contained two liters of water that were begin boil to make soup. The temperature reaches boiling after 50 minutes.

FIGURE 10

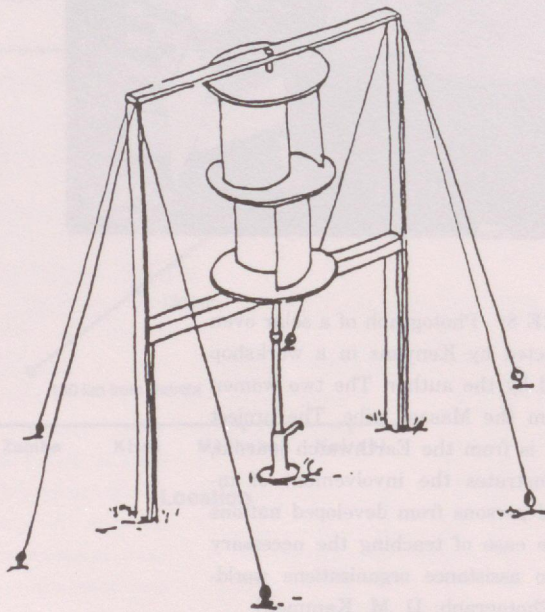


FIGURE 10: Sketch of Installed Savonius Rotor for Pumping Water. This model consists of two "buckets" mounted on the vertical drive pole.

FIGURE 11

EXPERIMENTAL POWER COEFFICIENT: WINDMILL COMPARISON

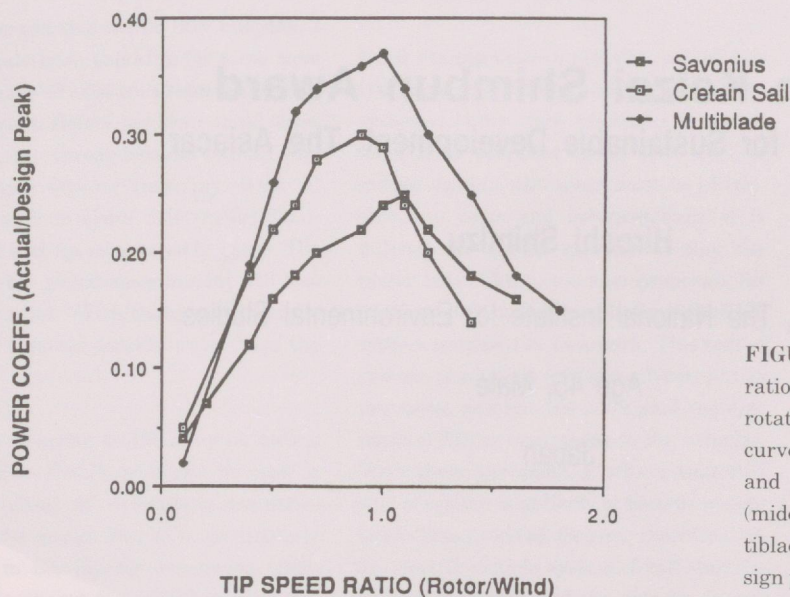


FIGURE 11: Power delivered versus tip rotation (wind speed divided by the speed of rotation) for the Savonius rotor (lower curve; filled boxes), and two more complex and expensive designs: the Cretan Sail (middle curve; open boxes); and the Multiblade (top curve; filled circles). The design parameters are discussed in the text.

Nihon Keizai Shimbun Award

A Proposal for Sustainable Development: The Asiacar

Hiroshi Shimizu

Team Head, The National Institute for Environmental Studies

Age 45, Male

Japan

Summary

This proposal suggests an electric vehicle transportation system designed to combat the deterioration of the environment which will accompany the expected availability of electric vehicles to the masses in the countries of Asia as well as to suppress the generation of greenhouse gases by electric vehicle traffic. It also examines solutions to the problems of energy use, accidents and congestion that blight our electric vehicle-centered society.

The author, who has participated in the development of high-performance electric vehicles, combines that expertise here with knowledge of the use of solar cells to achieve energy savings and a major reduction in environmental load. The proposal also shows how the number of accidents can be greatly reduced by implementing an automatic driving system which includes functions to prevent collisions, cause cars to stop properly at red lights, and keep cars within their traffic lanes. Significant increases in road and parking lot capacities can be achieved by introducing a new standard which re-

duces car widths to no more than 120 cm. Limiting the overall weight to a maximum of two tons would permit a change in road structures -- ordinary roads could be multilayered and three-dimensional, unlike today's roads, the overwhelming majority of which employ flat, single-deck surfaces. This would make it substantially easier to construct roads in our cities.

This proposal brings together all these different elements.

The cars proposed here are two-seaters, with one seat in front and one behind. This configuration can be altered, however, according to requirements. The basic model can accomplish 250 km of city driving on a single battery charge and achieve a maximum speed of 130 km/h. Charging solely by solar cells allows an annual range of 18,000 km. The purchase price can be lower than that of a standard Japanese minicar.

Implementing this program step by step in stages can eventually yield solutions to all the problems caused by electric vehi-

cles. The program is also ideally suited to the trend toward mass availability of cars in Asia.

1. Introduction

Come with me for a moment to Sukhumvit Road in Bangkok, the capital of Thailand. This is one of the roads with the heaviest traffic flow in Thailand, a country with remarkable economic growth. There are three traffic lanes in each direction and wide sidewalks on either side. Some of Bangkok's top hotels and department stores line the road.

We stand on the sidewalk, watching cars passing by. Above us the spreads bright blue tropic sky, however, at the ground level it is too hazy to look beyond even two blocks away. When the light turns green, the road is filled by moving vehicles. First come all the two-wheelers which were lined up between the cars at the light. Next come the mass of ordinary cars, all dashing forward. They are followed by the three-wheeled samlor taxis. And buses filled with passengers and fully-laden

trucks bring up the rear. Every one of these vehicles is running at full-throttle, making an unbearable noise and pouring out black smoke.

As I observed this traffic flow one day, I had already been thinking for some time about Thailand's future urban traffic and environment. Before my ideas could form, however, my throat became painful and tears began flowing from my eyes. "If nothing is done about this traffic, Thailand will end up in a terrible state. The effect on the global environment will also be substantial." With thoughts like these in mind, I moved quickly away from the scene.

This sort of urban traffic is by no means restricted to Bangkok; it can be seen in the big cities of developing countries around the world. But it is particularly striking in the rapidly developing countries of Southeast Asia. As their economic strength grows, we can expect the number of cars on the city streets to grow, too. It is only too clear that the pollution caused by traffic, including environmental pollution and noise pollution, will become worse. Furthermore, the carbon dioxide generated by these cars will add to the greenhouse effect, and the denatured NO_x in their exhaust will produce acid rain.

Approximately 20% of the carbon dioxide production in Western countries is due to cars. If developing countries are included, this proportion rises to 25%. There are currently 500 million cars on the world's roads, one for every 10 people. If you consider how this figure will multiply if car ownership in the developing countries reaches the levels of the West, you can see just how decisive an effect the electric vehicle will have on the global environment.

One easy way to solve this problem would be to restrict the number of cars. In light of the number of cars already on the road in the West, however, this solution becomes virtually impossible. Some method must be found to begin reducing global carbon dioxide discharges. Here, I would like to propose a transportation system for the future that can stop further deterioration of the environment in both the Asian region and the world as a whole.

The aim of this proposal is to propose a practical transportation system with the above perspective for the developing countries, mainly in Asia, where high economic growth is assumed.

Land transportation systems are of two types: guided systems and electric vehicle systems. Many "new transport systems" have been proposed using some sort of guided system. However, because of construction costs and inconvenience, it is difficult for guided systems to play the major role. There are also proposals for "dual mode" systems, including the RUF system proposed in Denmark. This sort of system also needs a major infrastructure provision, and has the additional requirement of fitting equipment to the vehicles. With these problems, I believe that this sort of system is unlikely to become widely used. This proposal focuses, therefore, on an electric vehicle system. I call this the "Asiacar" system and the vehicles it employs "Asiacars".

2. The Electric Vehicle as the Basis for the Asiacar

The general attitude towards electric vehicles is that, although they are clean and quiet, they remain a long way from practical use, with applications restricted to golf carts and toy cars in theme parks. It is also generally believed that a major increase in battery performance is essential if electric cars are to become a practical proposition.

Virtually all the electric vehicles produced to date are converted cars, which have been produced by removing the engine from an ordinary car and replacing it with motors and batteries. The performance of the batteries in this sort of car still leaves a great deal to be desired.

For this reason, I have designed an electric car from scratch. Adding a few new techniques in a new design is the way to make dramatic strides in performance. This has been the basis for my thoughts for the last 15 years. Over this period, I have been assisted and supported by many people, and have been given the chance to develop an electric car based on this approach.

The result was an electric vehicle called

the IZA, which was completed in the fall of 1991. The IZA was a 4-passenger electric car capable of running up to 548 km on one recharging at a constant cruising speed of 40 km/h. Its top speed was 176 km/h, and its acceleration came extremely close to that of today's conventional cars. In addition, it achieved a high degree of energy efficiency; if this car had used crude oil as its primary energy source, its energy consumption would have been approximately one-third that of a gasoline-powered car of the same size.

As you can see, we have reached an age when electric cars can be put on the road which are scarcely inferior to conventional cars. Not only that, but ongoing improvements in individual components and general technical progress reveal plenty of scope for development of even higher performance and greater energy savings.

Another point we should note is the ability to recharge the batteries using solar cells. Most cars in practical use spend much more time standing still than actually running. If solar cells are used to charge the batteries, particularly when a car is at a standstill, the car can travel a very substantial distance each year on solar power alone. If 80% of the IZA's surface were covered with 15% efficiency solar cells, for example, and the car were normally parked outdoors, solar power would provide enough energy for it to travel 4,000 km per year in Japan. Since the average car in Japan today covers approximately 7,000 km per year, solar power could provide more than half its energy requirements.

The efficiency of solar cells is developing quickly, and there are now cells on the market that achieve 20% efficiency. The average amount of sunshine in Japan is around 1,800 hours per year, but for most Asian countries, the figure exceeds 3,000 hours. If a car in this region used high-efficiency solar cells, it would consequently not be impossible for it to operate on solar power alone.

It is also important in considering the energy consumed by a car to consider the energy used in its manufacture in addition to that employed to run it. According to our analysis, the manufacture of a gasoline-powered car requires an amount

of energy equivalent to 1.2 times the car's weight in crude oil. This ratio is essentially the same for electric cars.

By contrast, the amount of energy used by a gasoline-powered car by the time it reaches the end of its working life is equivalent to eight times its weight in crude oil. Thus, the amount of energy used to operate it is approximately six times that employed in its manufacture. For this reason, reducing the amount of energy used for its operation is the most important factor in reducing a car's overall energy consumption. Making the car lighter also has an important bearing on consumption, because it cuts the energy requirements for both manufacture and operation.

When contemplating the mass use of electric cars, provision of resources for the batteries must be taken into consideration, but this poses no particular problem.

3. The Basic Concept of the Asiacar System

The electric vehicle-based society faces four major problems -- environmental deterioration, pressure for energy resources, accidents, and congestion. The main focus of this proposal is on contributing to the global environment, but any proposal for a transportation system must examine all of these topics.

As described above, the performance of electric cars is improving steadily, their low energy consumption and environmental impact are something to be proud of. The mass utilization of electric cars can therefore go some way toward solving the environmental and energy problems caused by the electric vehicle. But the other problems affecting the electric vehicle-based society -- accidents and congestion -- have yet to be solved. The countries of Asia have a higher accident rate per car kilometer than Japan and the other advanced countries, and congestion is a serious problem.

One of these problems, congestion, has generally been solved in countries throughout the world by enlarging the surface area of roads and parking lots. Even in the West, however, the construction of roads and parking lots cannot keep

up with the number of cars. It is thus inappropriate to expect too much from this solution in Asia, where the infrastructure is less advanced.

Many different strategies have been adopted in an attempt to combat accidents around the world, but the problem continues to grow in seriousness. It is, moreover, inconceivable that methods employed in the West could easily be transplanted to the developing world.

To realize the Asiacar, I should like to make three proposals concerning the development of a system which concentrates on solving the problems of congestion and accidents.

3-1 Automatic driving system

It has often been said that the ultimate form of electric vehicle transportation would be an automatic driving system. In general, this calls to mind fitting cars with functions similar to human sight, enabling them to recognize objects in their path, avoid all obstacles, and drive automatically to their destinations. To do this, however, a car would need the same sort of functions as a robot, and this level of technology is not likely to be developed in the short term.

If we consider more limited automatic driving functions, focusing on only two points -- avoiding accidents and coping as best as possible with congestion -- the technology required becomes much simpler.

First of all, accidents can essentially be prevented by separating the sidewalk from the road to stop people from rushing out into the road and by providing three functions for the cars on the road itself: an ability to avoid collisions with cars in front of them; a system to ensure proper stopping at red lights and stop signs; and a method of keeping them within the proper traffic lane. A method of preventing collision with the car in front is already on the market in the form of the laser radars fitted to some luxury cars. A system to ensure proper stopping at stop signs and red lights can be implemented by attaching a sensor to the car to receive some form of control signal, transmitted as a radio signal or infrared light from the

traffic light, and by causing the brake to be applied automatically when a control signal is received. The function of keeping the car within its traffic lane can also be implemented by sensors in the car which read data transmitted from the roadside.

If the road and car can be given functions to prevent accidents, and if the laser radar can be given the additional function of maintaining a certain distance from the car in front, it would be possible to reduce the interval between cars on the road to between one-third and one-half the present distance. This would allow two to three times as many cars to use the same road, contributing substantially to solving congestion problems.

With these functions in place, the driver would enjoy normal driving. And since accidents would be largely prevented and the distance between cars regulated and reduced automatically on busy roads, the system as a whole could prevent congestion.

If this system were linked to the electric vehicle guidance systems already becoming available, it would be possible to input your destination in advance, and then to be driven there automatically without having to do the driving yourself.

These functions can all be brought together and integrated to form what I call an automatic driving system.

3-2 Car width restrictions

The maximum electric vehicle width throughout the world is 2.5 m. Virtually all vehicles, including big buses and trucks, are manufactured to fit within this limit. For this reason, lanes on high-standard roads are between 3.5 m and 4 m in width. Passenger car widths are distributed around the 1.5 m mark.

Virtually all passenger car lengths are 5 m or less, and many parking lots are built with space sizes of around 2.5 × 5 m.

Here, I would like to suggest a change from the conventional way of thinking and consider making cars narrower, so that one traditional road lane can be used as two lanes. The standard car width could be around 1.2 m, slightly less than

half the present maximum width. If this were technically possible, it would yield large benefits in terms of both car construction and road capacity.

First of all, today's two-lane roads with just one lane in each direction could be four-lane roads with two lanes in each direction, greatly increasing traffic capacity. In developing countries, there are many places where it is difficult for cars coming in opposite directions to pass each other, but if cars were narrower, traffic would be able to flow freely in both directions on roads like that. Two cars would be able to park in a space where only one could park previously. Because the parking space width as well as entry and exit roads could be made narrower, a parking lot could hold three or more times as many cars in the same area.

In light of these benefits, a narrower car width is one of the prerequisites and a fundamental basis for the Asiacar.

When it comes to actually implementing this sort of road system, the biggest problem is deciding what to do about the present cars.

My conclusions on this matter are as follows. First of all, a line could be inserted in the middle of each lane on existing roads to create two lanes. Wide (conventional) cars driving down these roads would straddle the new line, but the narrower Asiacars would be able to use the two new lanes separately, driving down one or other of these. This would result in two cars of different standards using the same roads in different ways, but this is no different from the way in which motorbikes and cars share the same road today. It is unlikely that it would lead to major inconvenience.

When new roads are built, they can be constructed as roads for a mixture of conventional vehicles and Asiacars, or constructed from the start as roads dedicated to Asiacars. Future passenger cars and light trucks can be constructed to the Asiacar standard, but this may be difficult for buses and large trucks. For this reason, trunk roads where this type of traffic is expected to travel should continue to be mixed traffic roads, while all other roads should be constructed specifi-

cally for Asiacars.

3-3 The Asiacar road configuration

Since the width of the Asiacar is restricted, all its dimensions become smaller, with a resulting reduction in weight as well. Roads are currently built on the assumption that they will be used by vehicles with a weight when loaded of up to 20 tons. It is very unusual, however, for vehicles close to this limit to use the roads under normal circumstances. Most traffic consists of passenger cars or light trucks with a weight of around one ton. Thus, our present roads are extremely wasteful, since the same roads that accommodate light vehicles must be constructed with weight specifications for vehicles 20 times as heavy.

To improve this situation, the Asiacar can be restricted to a total loaded weight of, say, two tons. Road weight specifications can then be greatly reduced, cutting construction costs significantly.

Road cross-sections can be either flat structures with the road laid directly on the ground, or elevated structures with the road raised on stilts. Since flat structures are inexpensive to construct, this structure is employed almost universally. Since in the Asiacar system only half the width is required for each traffic lane, however, and weight specifications need be only one-tenth those of conventional roads, I estimate that elevated roads for Asiacars could be constructed for just one-fifth the cost of a conventional elevated road.

The cities of Asia are all of very densely populated. Building new roads in this situation means relocating the present occupants, a major problem in any country.

Since the cost of constructing elevated roadways is low in the Asiacar system, the standard procedure in densely populated areas would be to construct elevated Asiacar roads above existing roads. An Asiacar road of the same width constructed directly above the old road would have twice the number of lanes, as a result of which the total number of traffic lanes would be effectively tripled. Because

the structures involved in the Asiacar road are lightweight, relatively thin supports would be sufficient, and it would be easy to add a second or third layer of dedicated Asiacar roads to create a multi-layered structure. In addition, it would be easy for the structure to incorporate cycling tracks and walkways, thus further improving the local traffic infrastructure. Additional benefits could be derived from using the structures for other services. In the West, power and telecommunications cables are more and more frequently buried underground, but cable ducts could be built into the Asiacar road structures, and even urban utility lines such as gas and water pipes, which are normally buried, could be brought above ground efficiently by constructing spaces for them in the structures. The cost of burying utility facilities is massive, and using above-ground space could cut costs by a factor of 10.

Figure 1 shows one example of a configuration for building a dedicated Asiacar road employing this sort of structure above an existing roadway. This configuration is appropriate for a city center business area where low-rise buildings face each other across an existing road with one lane in each direction plus sidewalks. The use of level 1 is unchanged from the present, but a compound structure involving two additional layers is constructed on top. Level 2 is dedicated to pedestrians and bicycles, very much like the arcades often found in Japan's shopping streets. The top of the structure, level 3, features a dedicated Asiacar road with two lanes in each direction. The area directly above that allotted to sidewalks on the existing road becomes extra space. In this example, it is used for parking.

The buildings on either side of the road still use their existing entrances on the first floor, but because a new pedestrian/bicycle transitway and Asiacar road have been constructed at the same height as the second and third floors, new entrances have been provided on both these levels. This increases the value of these buildings as commercial or business space.

Space for hidden utility facilities and similar ducts is provided above the sidewalks on level 1. This position enables maintenance access from either above or

below. Installation of this type of urban utility infrastructure is continuing at full pitch all over Asia, and structures such as this one which permit installation with great cost savings will be extremely important.

4. Examples of Asiacars

As stated above, the Asiacar is assumed to have a width restricted to about 1.2 m and a loaded weight of no more than two tons. There is no particular restriction on length -- a fact which allows manufacturers some flexibility. The Asiacar is assumed to be an electric car, driven by solar power to the greatest extent possible. With these preconditions, let us look at the basic vehicle and some variations on the form it may take.

4-1 The Basic Asiacar

The basic vehicle in the Asiacar system is a passenger car for use by individuals. Around the world, the most typical car is the sedan with four doors and seating four or five. Japanese statistics show, however, that the average number of car occupants is only 1.5, and in the United States, the figure is as low as 1.2. In Asia, the average number of occupants is a little higher, but it still does not exceed two. For this reason, the basic Asiacar is designed for only two occupants.

Until now, two-seat cars have been mainly sports cars and other niche vehicles. They are also often proposed in visions of the "car of the future." Since it is true that we want to sit side by side when we drive with somebody, in virtually all cases, the two seats are located alongside each other. With this arrangement, the car tends to be fairly wide at the driving seat, requiring an overall width of around 140 cm. This exceeds the 120 cm width restriction which is one of the basic conditions for the Asiacar.

We therefore assume the basic Asiacar configuration to be one with two seats arranged one behind the other. Vehicles with this configuration were made in Messerschmitt, Germany, in the immediate post-war period, but they did not sell in very large numbers. It is unclear whether the reason for this was the seating arrangement or some other aspect

of the vehicles' performance. It is certainly true that this seating arrangement is a deviation from our mental image of a "car." For the electric vehicle-based society, however, the two-seater fore-aft arrangement has definite advantages when considered in terms of congestion and parking problems. It also allows cars to be designed with much lower wind resistance. From the driver's point of view, this arrangement gives better forward vision, especially of the edge of the road, which makes driving much easier. One unexpected result of the arrangement is that more space can be allocated to each passenger, allowing greater comfort and communicating a sense of well-being. Some may worry that a small two-seater car will have a poor ride and insufficient collision safety. This is the case when four seats are squeezed into a tiny car, but if the amount spent on producing a four-seat car is reallocated to a two-seater, a good deal of attention can be devoted to ensuring satisfactory safety and ride.

The conclusion here is that there are very few demerits for the owner of a car with a fore-aft seating arrangement.

Figure 2 shows a sample layout of the basic Asiacar. As the profile in the upper half of the diagram shows, motors are incorporated into each of the rear wheels. The effectiveness of this technology was proved by the IZA car. The batteries are designed as flat panels and mounted under the entire floor area of the car. The controller for modifying motor speed and the automatic-driving control equipment are fitted under the driver's seat. The front hood permits access to the air conditioner and the electric steering equipment, which is part of the automatic driving system. In order to obtain a solar panel area as large as possible, the solar wings marked in the diagram are covered with solar cells. These solar wings also serve the function of providing downforce to promote high-speed stability, and they protect the driver from the bright tropical sun as well.

The lower half of Figure 2 shows the plan of the Asiacar. If the car is 120 cm wide, the passenger space has an effective width of approximately 80 cm. The front seat is 60 cm wide and is positioned in the center,

leaving approximately 10 cm free on either side, enough space to provide some degree of protection against the impact of side collisions. The rear seat is also restricted to about 60 cm by the rear wheels, and it uses all of the space available. Car seats need to provide a width of at least 40 cm per person, but 60 cm is wide enough for two children to sit. The basic concept for this car was as a two-seater, but since in practice, a mother with two children is a very frequent combination, the basic design allows for either two adults or one adult and two children.

Arranging two seats fore and aft without cramping, and ensuring space between the front wheels and bumper, the design requires a minimum length of 320 cm. This is slightly less than the 330 cm maximum length of Japan's minicar standard. It would be extremely easy to make the Asiacar longer if required for safety reasons.

A single door fitted to one side of the car only is sufficient for access, but, also for safety reasons, a second door like that on a hatchback car can be fitted to the back. This would also be used for loading luggage with the back seat folded down.

The specifications for this car and its performance based on the specifications are also shown in the diagram. As can be seen, this design calls for an unloaded weight of 600 kg, including 200 kg for the batteries. The motors produce up to 20 kw each. There is a great deal of scope for selecting the battery configuration, but lead-acid batteries have been chosen here because they are currently the most practical. Tire rolling drag and air drag both exert a significant effect on performance. The figures given here are the best practically achievable values. The efficiency of the solar cells used to charge the batteries is assumed to be 15%, and they have been allotted a total area of three square meters, including the solar wings.

The assumptions concerning this electric vehicle include anticipated performance figures -- a range of 250 km per battery charge around town and 220 km per battery charge when cruising at 100 km/h. The maximum speed would be 130 km, and acceleration from 0 to 400 m would take 18 seconds.

Of these performance figures, the acceleration, maximum speed, and range per battery charge around town are sufficient for the Asiacar to be of practical use. The range when cruising at 100 km/h might be insufficient in some situations, but it is adequate for nearly all circumstances.

The range that can be covered with charging from the solar cells is estimated at 11,000 km in Japan, with its problems of cloudy skies and relatively high latitude. In Thailand and other countries where there are long hours of sunshine and the sun is higher in the sky, 18,000 km or more can be expected. Since the average car in Japan today covers 7,000 km a year, the Asiacar could be used in Japan with the solar cells as its only source of power as long as usage was not abnormal. Thus, its use need not be restricted to more southerly parts of Asia.

The costs involved in this electric vehicle can be considered as the purchase cost and operating cost. Once mass production begins, there is no area in which the Asiacar will be more expensive than a gasoline-powered car. As a result, its cost is directly proportional to its body weight. Japan's minicars currently carry a price of around ¥800,000 for a weight of 650 kg. Using this price as a reference, we can calculate the overall price of the Asiacar, excluding the cost of batteries, as approximately ¥500,000. The solar cells can be expected to cost at least ¥100,000.

Considering that the energy is generated by solar batteries, costs to run the car can be more or less disregarded. Even the price of the batteries is likely to go down to ¥1 per km as they come into mass production. These factors effectively show that the car can run quite in expensively

As you can see from the figures, the basic specifications are adequate to allow for mass marketing of the Asiacar, in terms of both performance and price conditions.

4-2 Expanding the functions in the basic Asiacar passenger vehicle design

In order for the Asiacar to become the mainstay of our urban transportation systems, it must be capable of use for many different functions. First of all,

changes in the basic design can be considered as a means of expanding the range of functions for the passenger car market.

The main area in which the basic Asiacar design is lacking in terms of a passenger car is in the ability to carry more than one passenger. It cannot serve as a chauffeur-driven car (a type which is very popular in Asia).

One simple way of providing transportation for many passengers is to link two or more cars together. Figure 3 (a) shows an example of this. The electric car's acceleration and deceleration can be handled simply by exchanging signals. The steering can also be controlled electrically as part of the power-steering mechanism. All these signals can be picked up as remote control signals. The same function is used to link cars and run them together. Linking two cars together in this way gives a four-person capacity, and linking three cars a six-person capacity.

The ability to link cars together also provides other benefits. A family of four does not need to have two cars permanently linked together. It is quite unusual for three or four family members to travel together, so the family could own one car and hire a second when necessary. Rental system must be set up to ensure that this benefit is available.

Nest, let us consider an example of a chauffeur-driven car. The Asiacar standard allows flexibility in vehicle length. Chauffeur-driven cars can be made in the same way as American limousines by stretching a basic model to create a larger passenger compartment which can have more than one seat. Figure 3 (b) shows the layout of a stretched Asiacar with two seats in the rear. As you can see, the Asiacar always has its seats arranged fore and aft, never side by side. Two seats are often sufficient for a chauffeur-driven car, but if more are required, the design can be stretched further to incorporate the extra seats. The Asiacar passenger compartment is narrow, but since a seat width of 60 cm can be allowed for each occupant, passengers can be extremely comfortable -- and maybe even more so than with a current luxury car.

Since the car's weight will change when it

is stretched, performance would drop if it still used the same motors and batteries as the basic Asiacar. For this reason, the number of batteries and the motor capacity can be increased when the car is enlarged. The area of the solar cells on the roof should also be increased.

Asiacars with the passenger compartment stretched in this way can be used as luxury executive cars, or as taxis.

4-3 Developing trucks from the basic Asiacar

Many different configurations can be considered for using the Asiacar as a truck, depending on the specific use. Several ideas are shown in Figure 4.

Figure 4 (a) shows a basic Asiacar stretched at the rear by 50 to 100 cm, making it the equivalent of a light van. A model of this type would have two seats as usual, and the rear seat could be folded down to increase the cargo space. Increasing the battery weight and strengthening the motors would enable vehicles with this configuration to transport 400 kg-500 kg loads.

Figure 4 (b) shows a pickup version, and (c) shows a wagon version with a raised roof.

When the purpose is distribution in town, load sizes are very often just over a ton. There are also times when a capacity for larger loads is required. In that case a trailer configuration could be recommended. The profile of a trailer setup is shown in Figure 4 (d). Using an electric car as the basis for a trailer offers one major advantage: the trailer itself can be powered in the same way as the car. I refer to this sort of trailer as an "active" trailer.

An active trailer is fitted with the batteries and motors necessary to move the trailer, so that only the steering is left to the tractor car. Since with this configuration, the tractor car does not need the power to actually pull the trailer, it can be quite small. A basic Asiacar could be used as a tractor car with no alteration. All that would be required to connect the two vehicles would be communication cables. This technology would be exactly the

same as that used in 3-2 to link two basic Asiarcars.

One reason for the poor sales of tractor-trailer combinations among conventional vehicles is the skill required for reversing. Hauling two or more trailers is unreasonable. If the trailer itself is self-powered, however, and if it can be driven freely either forwards or backwards, then the problem of reversing is largely solved.

Considered from the perspective of the Asiarcar system, trailer size and weight must fit within the standard. Consequently, each trailer must be no wider than 120 cm and weigh no more than two tons. The length would be about 320 cm, if it were matched to the basic Asiarcar. The load platform would have virtually as much area as this length and width. Since a conventional two-ton truck generally has a load platform of around 310 cm × 160 cm, the Asiarcar trailer could be used for nearly all the same purposes. The trailer weight would be determined by batteries and other equipment, but it would probably be around 800 kg, leaving a load capacity of about 1,200 kg. This is generally sufficient as a unit weight for delivery work around town. It would also be possible to link several trailers together to move earth or other heavy loads or to transport cargo long distances. High-speed cruising is the norm for long-distance transport. At high speeds, air resistance absorbs nearly all the energy. With a trailer setup, the tractor at the front has the job of overcoming nearly all the air resistance, enabling the trailers to run with relatively low power consumption. This means that, Asiarcars in a tractor/trailer setup for cargo transport would be able to run for quite a long distance on one charge.

5. Towards Implementation of the Asiarcar System

The Asiarcar system proposed here is a combination of the road system and the cars to use that road system described in sections 3 and 4. If the Asiarcar system comes into use, it will solve nearly every transportation problem, and it will also meet future demand for cars and transport systems in Asia. It would, however, be very difficult to install this system all at once. The most difficult part of the

proposal involves the automatic driving function. This function is essential for proper accident prevention, but since development of such systems has not yet begun in any advanced country, it will probably be some time before it can be implemented. The proposal to split road lanes into two will also require a considerable experimenting before its widespread implementation. Finally, time will be required to gain a consensus in the region for reconstructing the road network for the Asiarcars.

Manufacturing and marketing and sales of all the different types of vehicle to be used in the Asiarcar system will require some time because of the cost involved.

For this reason, it would be best to set up objectives for the Asiarcar system first, then to achieve those objectives gradually, step by step. The procedure for accomplishing this is shown in Figure 5. First of all, the basic Asiarcar should be developed and brought into use in particular regions. When use of the basic Asiarcar begins to spread, development of Asiarcar versions for specific purposes can start, with each version marketed as soon as it is ready. The basic Asiarcar should initially be used in mixed traffic on ordinary roads, but when a reasonable number of Asiarcars are in use, the process of dividing up road lanes can begin. Step-by-step development will proceed like this until it finally becomes possible to supply the Asiarcar with its automatic driving system.

The factor that must be given the most attention during this process is development of the basic Asiarcar. Considering its role as a future mass market vehicle, the development targets must include low cost, use of easy to obtain materials, and ease of manufacture. To ensure its popularity with the general public, it must also be easy to use and have sufficient attention paid to external design and appearance. Because it will initially be used in mixed traffic, safety in traffic accidents is important. Finally, it must be constructed with sufficient space allowed for installation of the control systems required for automatic driving in the future.

6. Conclusion

This paper proposes an Asiarcar as a

method of solving the four problems facing electric vehicle-based transportation systems; environmental deterioration, energy concerns, accidents and congestion. The Asiarcar can simultaneously permit sustainable development of transportation and transport systems for the Asian region. From the technical point of view, the Asiarcar is extremely desirable for the future of electric vehicle transportation.

The main worry with the proposal is that it is based on downsizing cars. The electric vehicle has traditionally fulfilled the role of a "dream machine," and for this reason, cars have often been built larger than they actually need to be. It is often said that a change in our way of thinking is needed if we are to respond effectively to the serious situation regarding our environment. If large numbers of people can change their way of thinking in an appropriate way, and if they can be satisfied with smaller cars, then the Asiarcar can be a success. To test the public's response, prototypes of the Asiarcar must be produced as soon as possible and evaluated by large numbers of people. This is essential to confirming the Asiarcar's success.

In developing the Asiarcar, the participation of Japan with its store of basic technology and financial power is extremely important. In addition, the Asiarcar system can be applied in the West to solve transportation and transport system problems, so cooperation on a global scale in development and marketing the system must be investigated.

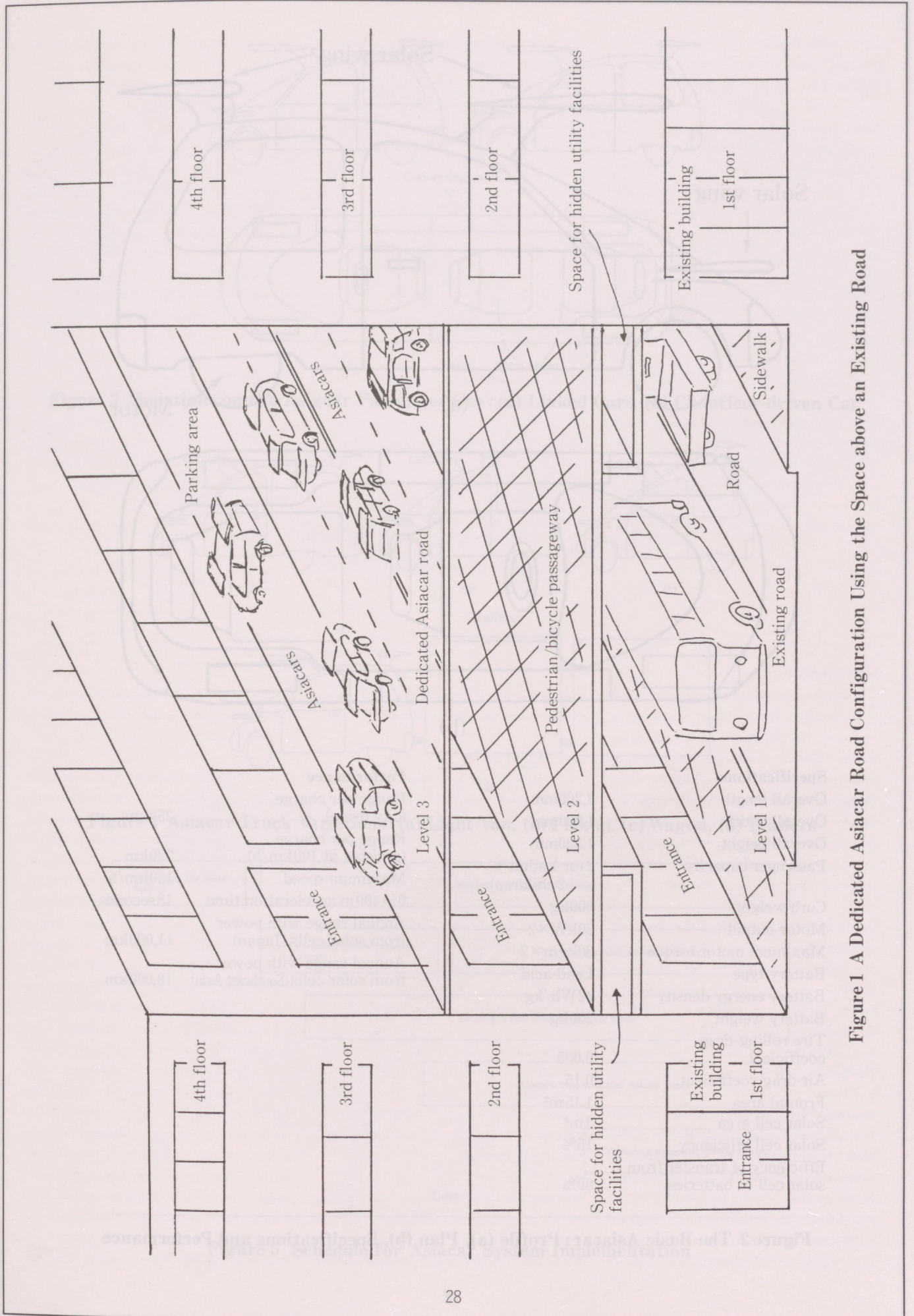
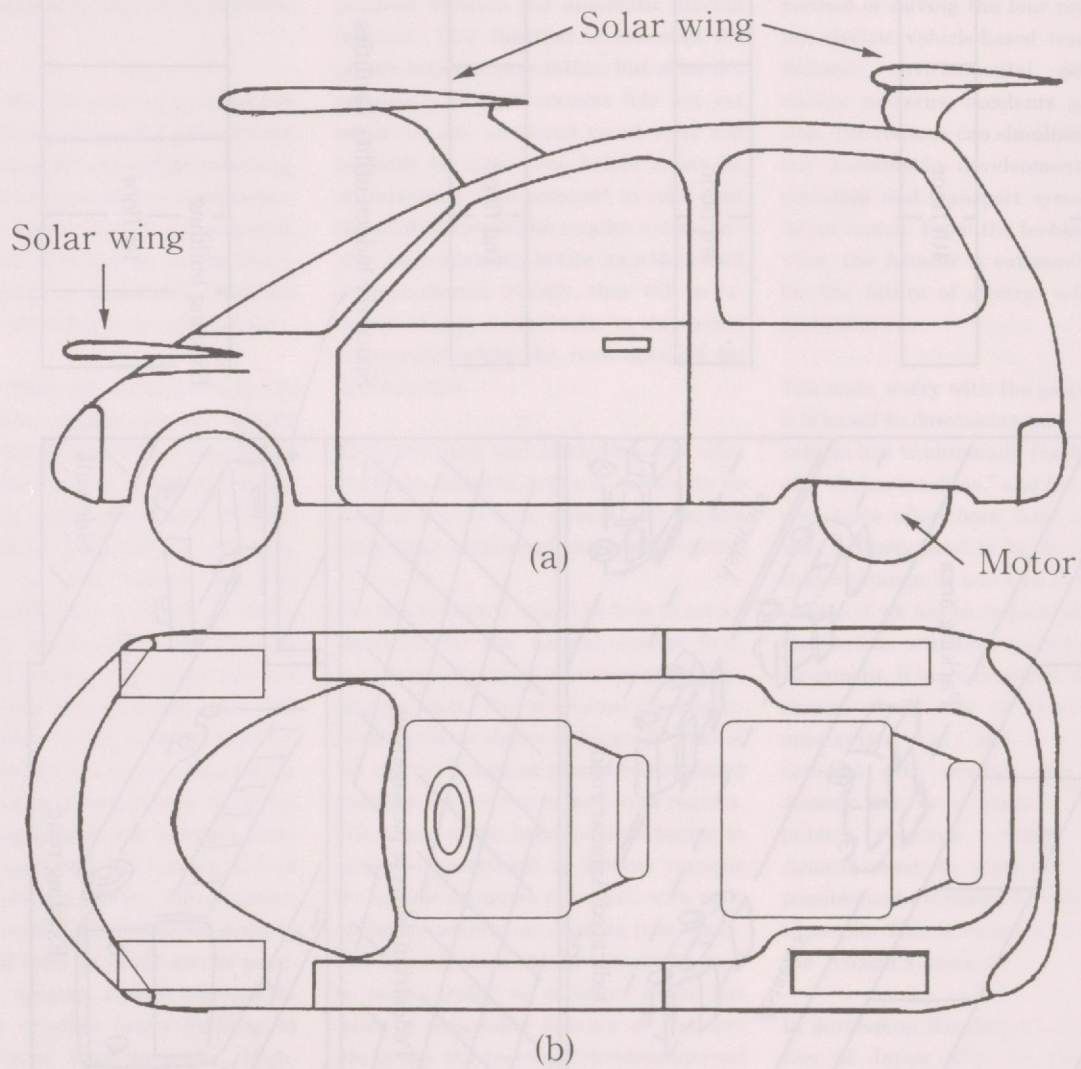


Figure 1 A Dedicated Asiacar Road Configuration Using the Space above an Existing Road



Specifications

Overall length	3,200mm
Overall width	1,200mm
Overall height	1,300mm
Passenger capacity	2 (or 1 adult + 2 children)
Curb weight	600kg
Motor output	20kW × 2
Maximum motor torque	30kgm × 2
Battery type	Lead-acid
Battery energy density	42Wh/kg
Battery weight	200kg
Tire rolling-drag coefficient	0.005
Air-drag coefficient	0.15
Frontal area	1.15m ²
Solar cell area	3m ²
Solar cell efficiency	15%
Efficiency of transfer from solar cell to batteries	80%

Performance

Range per charge (city drive)	250km
Range per charge (cruising at 100km/h)	220km
Maximum speed	130km/h
0→400m acceleration time	18seconds
Annual range with power from solar cells (Japan)	11,000km
Annual range with power from solar cells (Southeast Asia)	18,000km

Figure 2 The Basic Asiacar : Profile (a), Plan (b), Specifications and Performance

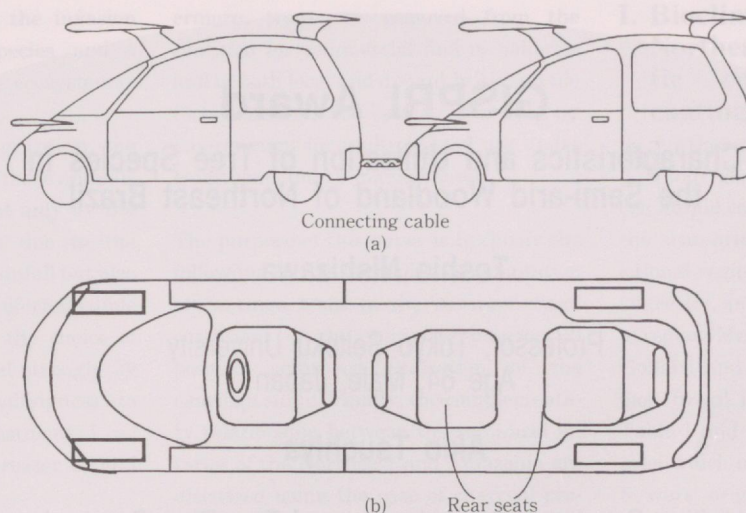


Figure 3 Variations on the Asiacar Passenger Car : (a) Linked Cars, (b) Chauffeur-driven Car

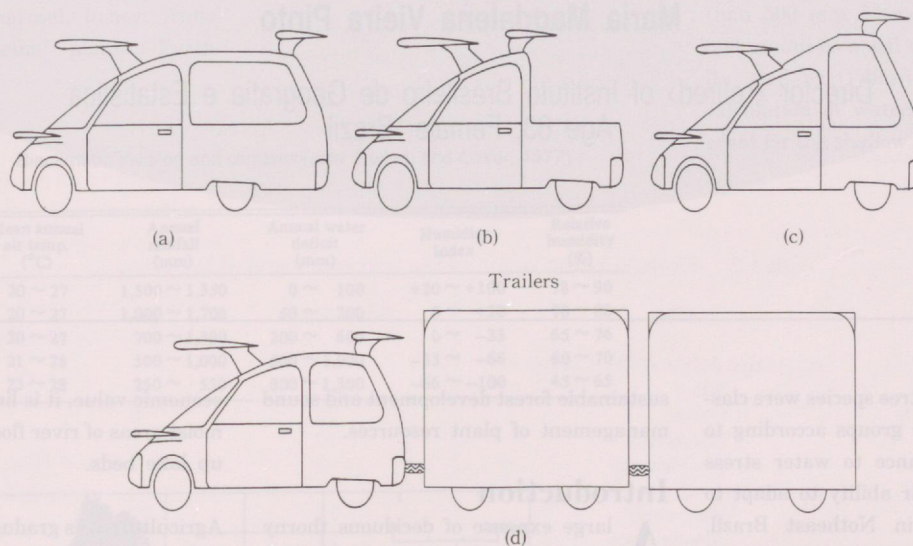


Figure 4 Asiacar Truck Variations : (a) Light Van, (b) Pickup, (c) Wagon, (d) Trailers

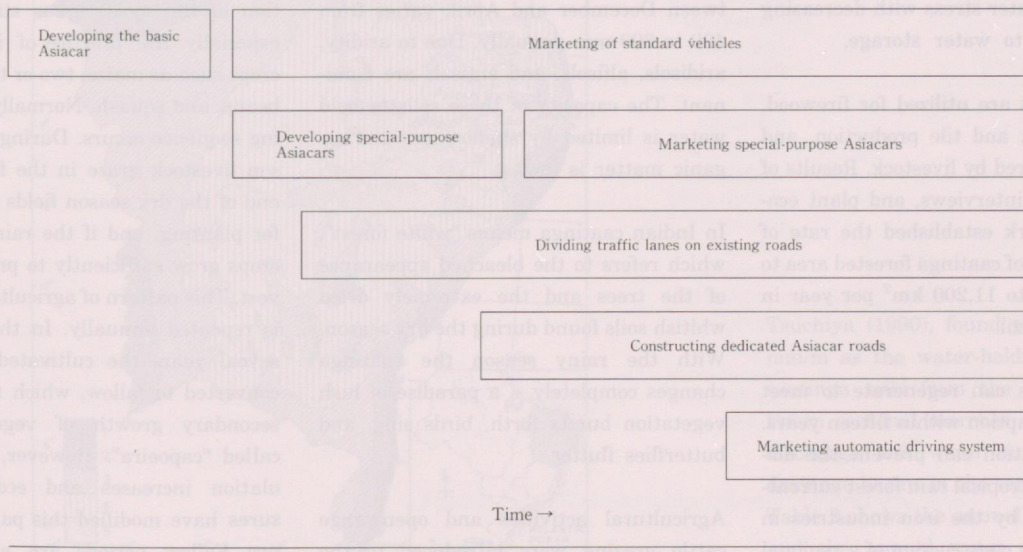


Figure 5 Schedule for Asiacar System Implementation

GISPRI Award

Characteristics and Utilization of Tree Species in the Semi-arid Woodland of Northeast Brazil

Toshie Nishizawa

Professor, Tokyo Seitoku University
Age 64, Male, Japan

Akio Tsuchiya

Visiting Scholar at the Laboratory of Tree-Ring Research,
Age 31, Male, Japan

Maria Magdalena Vieira Pinto

Director <retired> of Instituto Brasileiro de Geografia e Estatística
Age 63, Female, Brazil

Summary

Sixteen caatinga tree species were classified into three groups according to response and tolerance to water stress which reflected their ability to adapt to semi-arid climate in Northeast Brazil. Tolerance within these three groups are closely related to plant succession processes after clear-cutting with increasing tolerance to water stress with decreasing response rate to water storage.

Caatinga trees are utilized for firewood, charcoal, brick and tile production, and are also preferred by livestock. Results of questionnaires, interviews, and plant ecological fieldwork established the rate of disappearance of caatinga forested area to be 5,300 km² to 11,200 km² per year in Northeast Brazil.

Caatinga trees can regenerate to meet human consumption within fifteen years. Such regeneration can prevent the disappearance of tropical rain forest currently being used by the iron industries in Amazonia. The construction of a regional complementary program between Northeast Brazil and Amazonia will lead to

sustainable forest development and sound management of plant resources.

Introduction

A large expanse of deciduous thorny woodland, locally called "caatinga", covers the semi-arid interior of Northeast Brazil. Rainfall, which occurs mostly between December and April, varies from 400 to 800 mm annually. Due to aridity, aridisols, alfisols, and entisols are dominant. The capacity of these soils to hold water is limited by shallowness and organic matter is low.

In Indian caatinga means "white forest", which refers to the bleached appearance of the trees and the extremely dried whitish soils found during the dry season. With the rainy season the caatinga changes completely -- a paradise of lush vegetation bursts forth, birds sing, and butterflies flutter.

Agricultural activities and open-range cattle grazing were introduced to the semi-arid area in the 17th century. Although crop farming provides greater

economic value, it is limited mostly to the moist areas of river floodplains and dried-up lake beds.

Agriculture was gradually transformed in the past two hundred years by the introduction of cash crops, such as cotton and agave. However, subsistence crop cultivation of the moist areas still continues, especially the practice of interplanting crops such as maize, two or three kinds of beans, and squash. Normally, the following sequence occurs. During the dry season livestock graze in the fields. At the end of the dry season fields are prepared for planting, and if the rains arrive the crops grow sufficiently to produce a harvest. This pattern of agricultural land use is repeated annually. In the past, after several years the cultivated fields were converted to fallow, which resulted in a secondary growth of vegetation type called "capoeira". However, recent population increases and economic pressures have modified this pattern of land use. Fallow periods are shortened or eliminated. The result of this overuse, or abuse, is accelerated erosion and de-

pletion of soils, as well as the invasion of less desirable plant species and a general degradation of the ecosystem.

Cattle, sheep and goats graze in the semi-arid interior. Which of these animals are chosen is determined not only by the variable forage production due to the interannual fluctuation of rainfall but also by the composition of the preferred edible floristic species. Moreover, the choice of livestock types is influenced strongly by the individual farmers willingness to undertake the risk of investment, i. e., cattle and sheep require greater capital than goats.

In addition to forage, the caatinga provides farmers with construction materials, fuelwood, charcoal, honey, fruits, fibers, and medicinal plants. Further-

more, trees are removed from the caatinga for commercial fuel in bakeries and in both local and distant brick and tile factories. Thus the caatinga provides an environment for multiple land use under traditional forest management.

The purpose of this paper is to clarify the following: 1) the strategies for adaptation of caatinga trees to the severe natural conditions of the semi-arid interior, 2) possible improved utilization of the caatinga stand. Finally, the complementary relationship between the semi-arid interior of the Northeast and Amazonia are discussed using the case of charcoal production.

I. Bioclimatic divisions of Northeast Brazil and floristic composition of the caatinga stand

Northeast Brazil is often divided into four geographical regions: the eastern humid coastal region (Zona da Mata), the semi-arid interior (Sertao), the transitional region between these two regions (Agreste), and the more humid transitional region (Meio Norte), nearing Amazonia. Golfairi and Caser (1977) divide Northeast Brazil into five bioclimatic regions, Table 1 and Figure 1. The pocket-shaped area which includes Region 4 and Region 5 were originally covered by caatinga vegetation. These regions lie in areas of less than 1,000 mm of annual precipitation and annual water deficits greater than 500 mm. However, the amount of 300 mm/m as a soil water-holding capacity used by Golfairi and Caser for the calculation of water deficit is much too great for the shallow soils in the caatinga.

Table 1. Bioclimatic division and climates (after Golfairi and Caser, 1977).

Region	Mean annual air temp. (°C)	Annual rainfall (mm)	Annual water deficit (mm)	Humidity index	Relative humidity (%)
1	20 ~ 27	1,500 ~ 1,350	0 ~ 100	+20 ~ +100	78 ~ 90
2	20 ~ 27	1,000 ~ 1,700	50 ~ 300	0 ~ +20	70 ~ 80
3	20 ~ 27	700 ~ 1,300	200 ~ 600	0 ~ -33	65 ~ 76
4	21 ~ 28	500 ~ 1,000	500 ~ 1,000	-33 ~ -66	60 ~ 70
5	23 ~ 28	250 ~ 550	800 ~ 1,300	-66 ~ -100	45 ~ 65

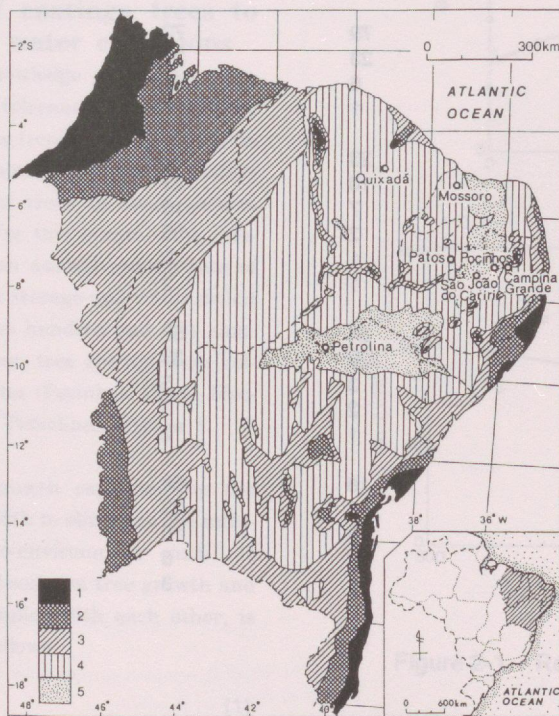


Figure 1. Bioclimatic regions (after Golfairi and Caser, 1977).

Tsuchiya (1990), found the value of 50 mm/m as the water-holding capacity of caatinga soils from the correlation between seasonal marches of the observed discharge and water surplus in three drainage basins in the semi-arid interior. Table 2 shows the annual water storages and the annual water deficit using a water-holding capacity of 50 mm/m at three stations from 1968 to 1987.

Although Campina Grande and Patos are located in the same Region 4 defined by Golfairi and Caser, the annual water deficit differs about 600 mm. While Patos

and Petrolina are located in different regions, their annual water deficits are almost the same. Moreover, the seasonal marches of water balance at both Patos

and Petrolina are also almost the same in spite of different regions.

Table 2. Means of annual water storage and water deficit for twenty years from 1968 to 1987.

Station	Water storage	Water deficit
Campina Grande	181 mm	443 mm
Patos	118	1093
Petrolina	62	1047

The dominant species and the floristic composition of the caatinga stand are affected initially by the natural environment such as water balance and soil condition and also are influenced by human activity. The magnitude of human

impact on the caatinga has increased rapidly in recent years due to population and economic pressure, which results in greater scarcity of mature stands. Trees of the caatinga stand with heights greater than 1 m are described by their floristic

composition for five sites, Table 3. Campo Alegre, located 15 km north of Patos is in Region 4, Pocinhos is in Region 5, as is Nogueira and Virginha, both 40 km east of Petrolina.

Table 3. Floristic composition of the caatinga stand at five sites.

Sites	No. of trunks	(%)
(1) Campo Alegre I (10m x 10m)		
Malva	506	92
Pinhao	25	5
Marmeleiro	10	2
Jurema-preta	3	1
(2) Campo Alegre II (10m x 10m)		
Marmeleiro	79	72
Jurema-preta	23	21
Catingueira	6	6
Mofumbo	1	1
(3) Pocinhos (10m x 10m)		
Jurema-preta	23	52
Catingueira	10	23
Marmeleiro	7	16
Pinhao	2	5
Cipo	1	2
Mestracio	1	2
(4) Virginha (20m x 20m)		
Catingueira	34	57
Jurema-preta	20	33
Faveira	3	5
Pinhao	2	3
Umbuzeiro	1	2
(5) Nogueira (10m x 10m)		
Catingueira	18	58
Pinhao	7	23
Jurema-preta	3	10
Burra-leiteira	2	6
Faveira	1	3

The floristic composition of Campo Alegre I is characterized by caatinga stand of two year regrowth. At Campo Alegre II cattle grazing occurs with selective cutting of trees for charcoal production. Nogueira has low density cattle grazing, whereas in Virgínia only goats and sheep graze. Malva is the most dominant species in Campo Alegre I, compared to Mameleiro and Jurema-preta in Campo Alegre II. For Pocinhos, the Jurema-preta species dominates, followed by Catingueira and Mameleiro. Jurema-preta is one of the dominant species at disturbed sites, it dies out in maturing stands (Hardesty et al, 1988). Catingueira is the most dominant species in both Nogueira and Virgínia. Three sites have five species over one meter of height of which Jurema-preta and/or Catingueira are the most dominant species. However, young Jurema-preta never appear with mature Catingueira, while young Catingueira trees occur with mature Jurema-preta and with other trees. Thus, it can be concluded the sequence that follows clear cutting, species dominate at different phases of caatinga regrowth, the dominant species are Malva and/or Mameleiro, Jurema-preta, and Catingueira despite continuous human activity.

II. Response and stress tolerance of caatinga trees to various water conditions

A better knowledge of response rate and stress tolerance of trees to water conditions in the tropical semi-arid region is important to understand the adaptation of the caatinga trees to their natural environment. For this purpose, the relationship between annual growth rate of trees and water storage and water deficit are studied. Two hundred and fifty samples from sixteen tree species were collected at five sites (Pocinhos, Patos, Mosoro, Quixada, Petrolina), Figure 1.

Annual tree growth expressed by the relative ring width to eliminate the influence of micro-environment such as topography and soils, on tree growth and to compare samples with each other, is expressed as follows:

$$Gr = \Delta r / R \tag{1}$$

Δr : annual tree ring width

R : radius of tree sample in measured direction of Δr

Tsuchiya (1990) expresses the relationship between tree age and tree radius as a linear equation throughout the entire growth period for the two samples of the most dominant tree species: Jurema-preta and Caingueira, 20 and 13 years old, respectively. The Thornthwaite and Mather method is employed to calculate water balance with 50 mm/m as water-holding capacity of soil (Tsuchiya, 1990).

Water storage and water deficit must be summed for the period of tree growth rather than the calendar year or the water year. Hypertrophic growth is found once per year in the rainy season, usually from October to April or May. Thus, the tree growth year is defined by the period from appearance of water storage to just

before the next appearance. However, if water storage is absent throughout a given year, the next year begins only when the water deficit recoonds the minimum value in the year.

Fig. 2-1 and 2-2 show two examples of the relationships between the relative growth ratio (G_r), the annual water storage (W_s), and the annual water deficit (W_d). These relationship are expressed by the following equations:

$$Gr = \alpha W_s + \beta \tag{2}$$

$$Gr = p W_d + q \tag{3}$$

α, β, p, q : parameters

In these equations, the parameters α and β represent the response rate of trees to the annual water storage and annual water deficit, respectively.

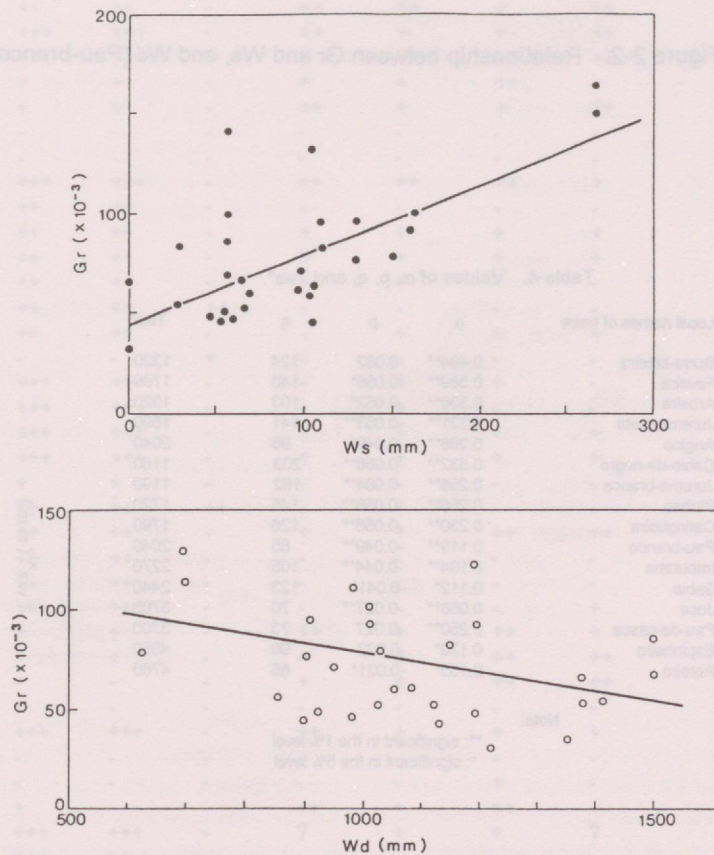


Figure 2-1. Relationship between G_r and W_s , and W_d (Faveira).

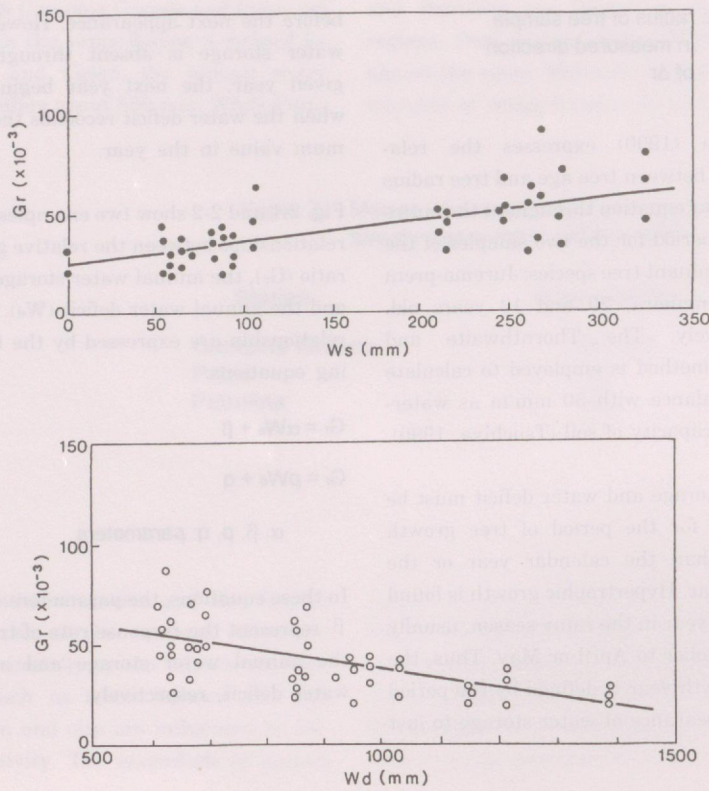


Figure 2-2. Relationship between Gr and Ws, and Wd (Pau-branco).

Table 4. Values of α , p, q, and T_{ws}^* .

No.	Local names of trees	α	p	q	T_{ws}^*
1	Burra-leiteira	0.494**	-0.082	124	1220
2	Faveira	0.389**	-0.056*	140	1790
3	Aroeira	0.336**	-0.052*	103	1920
4	Jurema-preta	0.321**	-0.053**	141	1890
5	Angico	0.288**	-0.049*	98	2040
6	Cabo-de-negro	0.332**	-0.086**	203	1160
7	Jurema-branca	0.258**	-0.084**	162	1190
8	Pinhao	0.256**	-0.058**	146	1720
9	Catingueira	0.230**	-0.056**	126	1790
10	Pau-branco	0.119**	-0.049**	85	2040
11	Imburana	0.104**	-0.044**	105	2270
12	Sabia	0.112*	-0.041*	123	2440
13	Juca	0.068**	-0.027**	70	3700
14	Pau-de-casca	0.250**	-0.027	73	3700
15	Espinheiro	0.133*	-0.022	90	4550
16	Pereiro	0.105*	-0.021*	65	4760

Note:
 **: significant in the 1% level
 *: significant in the 5% level

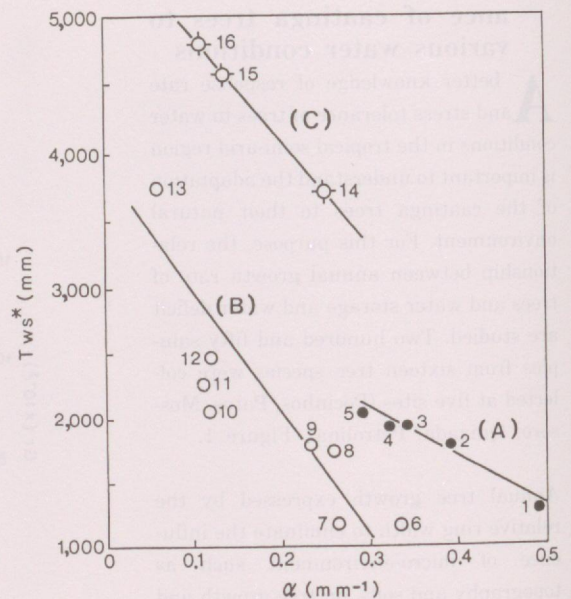


Figure 3. Relationship between α and T_{ws}^* .

Note: Numbers in this figure are the same numbers as in Tab. 4.

Assuming the magnitude of stress tolerance equals water deficit when the relative growth ratio is zero, the stress tolerance to water deficit (T_{ws}) is expressed by the following equation:

$$T_{ws} = W_d = |-q/p| \quad (4)$$

However, the stress tolerance must be standardized as the relative stress tolerance by the common value of q which corresponds to the magnitude of G_r when the water deficit is zero. Therefore, if 0.1 mm is adapted for the common value of q, the relative stress tolerance (T_{ws}^*) is expressed by the following equation:

$$T_{ws}^* = |-q_{0.1}/p| \quad (5)$$

Values of T_{ws}^* for sixteen species are also shown in Table 4. Next, the relationship between two independent parameters, α and T_{ws}^* is found, Figure 3.

Sixteen species are classified into three groups. These three groups are: Group A whose tree species have a small stress tolerance although the response rate is good, Group B varies little from Group A for the stress tolerance, but response rate is large, and Group C, whose response is similar to Group B, but tolerance is greater.

When comparing these results with the floristic composition of caatinga stands at five sites, it can be estimated that the dominant species transit successively from Group A to Group B, and from Group B to Group C. The trees of Group A are

dominant species in the primary stage of plant succession in which pioneer species are included. The trees of Group C are dominant species in the mature stage and the trees of Group B belongs to the transition stage between Group A and Group C.

III. Utilization of the caatinga trees

Trees of the caatinga are utilized for a variety of purposes such as animal grazing, charcoal production, firewood, fencing, and medicine. However, a thoughtless removal of trees often results in land degradation.

Table 5. Utilization and caatinga trees.

Local name of trees	Dietary selection			Human Utilization				
	Cattle	Goats	Sheep	Lumber	Charcoal	Bakeries	Brick	Fencing
Angico	++	++	++	-	++	++	+	++
Arapiraca	+++	+++	+++	-	++	+	+	++
Aroeira	+	+	+	-	+	+	+	++
Bolusu	+	+	+	-	+	+	++	-
Brauna	+	+	+	-	++	+	++	++
Burra-leiteira	-	-	-	-	-	-	-	-
Cabro-de-negro	-	-	-	-	-	-	-	-
Calumbi	+++	+++	+++	-	++	++	++	+
Carqueijo	++	++	++	-	-	-	-	-
Canafistula	++	++	++	-	+	+	+	+
Catingueira	++	++	++	-	+	+	+	+
Espinheiro	+++	++	++	-	+	+	-	-
Faveira	++	++	++	++	-	-	-	-
Imburana (Umburana)	++	++	++	-	-	+	+	+
Joao-mole	-	-	-	+	-	-	-	-
Juazeiro	+++	+++	+++	-	-	+	+	-
Juca	+++	+++	+++	-	-	+	-	-
Jurema-branca	+++	+++	+++	-	+	+	+	+
Jurema-preta	+++	+++	+++	-	+	+	+	+
Mandacaru	+	+	+	-	-	-	-	-
Malva	+++	++	++	++	-	-	-	-
Marmeleiro-branco	++	++	++	-	+	+	++	++
Maria-dura	++	++	++	-	-	-	-	-
Mofumbo	++	++	++	-	-	-	-	-
Mororo	+++	+++	+++	-	-	-	-	+
Pau-branco	+	+	+	-	++	+	++	+
Pau-de-casca	+	+	+	-	+	+	++	++
Pereiro	-	-	-	-	+	+	++	++
Pinhao	-	-	-	-	-	-	-	-
Quebra-facao	++	+++	+++	-	++	+	+	+
Quipa	-	-	-	-	-	-	-	-
Rompe-jibao	-	-	-	-	-	-	+	-
Sao-joao	+	+	-	-	++	+	++	+
Sabia	++	+++	+++	-	?	+	+	?
Uricui	+++	++	++	-	-	-	-	-
Xiquexique	+	+	+	-	-	-	-	-

Index: Dietary selection
 +++:highly preferred
 ++:somewhat preferred
 +:slightly preferred
 -:never preferred

Utilization
 ++:most utilized
 +:utilized
 -:not utilized

Therefore, sound forest management, based on a knowledge of the ecological characteristics of trees, must be practiced to help sustain the caatinga stand. Response rate and stress tolerance of trees as a function of soil water conditions are important factors in sustaining caatinga trees. Partition rates of chemical elements

among trees, soil, and bed rock are also important to understand the transfer of nutrients from soil to the trees (Masuda, et al., 1989). Moreover, greater knowledge of utilization of caatinga trees aids in sound forest management.

Dietary selection by grazing animals such

as cattle, goats, and sheep as well as the human utilization of caatinga trees were surveyed near Petrolina in 1990. Moreover, a survey of firewood utilization for bakeries was also conducted for both Campina Grande and Patos in 1988 (Nishizawa et al., 1989).

Table 6. Comparison of three surveys on dietary selection by livestock.

Local Name	Name of researcher	Dietary selection		
		Cattle	Goats	Sheep
Angico	Hardesty, et al.(H)	++	++	++
	Nishizawa, et al.(N)	NE	NE	NE
	Saito, et al.(S)			
Brauna	H			
	N	+	+	+
	S	E	E	NE
Catingueira	H	EP	EP	EP
	N	++	++	++
	S	E	NE	NE
Jurema-branca	H			
	N	+++	+++	+++
	S	NE	E	E
Jurema-preta	H	EP	EP	EP
	N	+++	+++	+++
	S	NE	E	E
Malva	H			
	N	+++	++	++
	S	NE	E	E
Mandacaru	H			
	N	+	+	+
	S	E	NE	NE
Marmeleiro	H			
	N	++	++	++
	S	E	E	E
Pau-branco	H	P	NP	NP
	N	+	+	+
	S			
Pinhao	H			
	N	-	-	-
	S	NE	NE	NE
Sabia	H			
	N	++	+++	+++
	S	E	E	E
Xiquexique	H			
	N	+	+	+
	S	E	E	E
Index: (Hardesty, et al.)	(Nishizawa, et al.)	(Saito, et al.)		
EP:extremely palatable	+++:highly preferred	E:edible		
P:palatable	++:somewhat preferred	NE:nonedible		
	+:slightly preferred			
	-:never preferred			

Both questionnaires and interview surveys with farmers, and bakery operators were employed. Table 5 shows dietary selection by grazing animals as well as human utilization of thirty six species of caatinga trees near Petrolina. Seven species, Arapiraca, Calumbi, Juazeiro, Juca, Jurema-preta, and Mororo, are most preferred by cattle, goats, and sheep. Comparatively,

seven species, Burra-leiteira, Cabo-de-negro, Joao-mole, Pereiro, Quipa, and Rompe-jibao, are normally rejected by the same livestock.

Table 6 shows the results of three surveys on dietary selection by livestock. Hardesty, et al. (1988) surveyed five species at two sites located in Sobral and Quixada,

and Saito, et al. (1988) conducted a survey of eleven species at Sao Joao do Cariri.

Catingueira is classified as extremely palatable (EP) and somewhat preferred (++) by the three types of animals as stated by Hardesty et al. and Nishizawa et al., respectively. However, Saito et al. identified catingueira as a non-edible tree

for goats and sheep. In spite of this finding we observed goats eating very young foliage of catingueira at Fazenda Virgínia as did cattle at Fazenda Nogueira. Catingueira is one of the first trees to produce new leaf growth with the arrival of seasonal rains, and is the foliage eagerly sought by livestock. As the rains begin, the foliage releases within a few days a strong pungent smell which livestock find offensive, and consequently ignore their leaves until they dry and fall once the dry season arrives. This characteristic ensures that the Catingueira foliage is available for animal consumption during the dry season (Hardesty, et al., 1988). Pfeister and Malechek (1986) state that Catingueira is relatively unpalatable as green foliage. Thus, animal preference of Catingueira depends on the season. Jurema-preta, one of the most common trees in the early succession of the caatinga stand is identified as extremely palatable (EP) and somewhat preferred by livestock. Hardesty et al. and Nishizawa et al., respectively. However, Saito et al. identified Jurema-preta as a non-edible tree for cattle. Marmeleiro is a principle species preferred by livestock according to Nishizawa et al., but Pfeister et al. (1986) states that livestock mainly browse on it during relatively lesser dry seasons.

In the semi-arid interior of Northeast Brazil both temporal and spatial variations in rainfall cause pronounced fluctuations in the quality, quantity, and distribution of available foliage as well as changes in the floristic composition with successive plant stages. Therefore, the dietary selection by livestock reveals differences from place to place and seasonally.

Near Petrolina, seventeen species are identified as used for charcoal production, and twenty-one firewood at bakeries, twenty for firewood at brick and tile manufactures, seventeen for fencing. Fifteen species of caatinga trees are commonly used by all of the above, Table 5.

Almost all the bakeries in Campina Grande and Patos, except three that also use supplementary electric ovens, use firewood bake bread. Total consumption of firewood is approximately six-hundred tons per month in Campina Grande (population 300,000) and fifty tons per

month in Patos (population 70,000). Trees for firewood use by bakeries mainly consist of two species, Jurema-preta and Catingueira. There is a little difference in the composition for firewood of these two

species used by bakeries in Campina Grande and Patos, Table 7. In Campina Grande Catingueira is the most dominant species followed by Jurema-preta. On the other hand, in Patos, Jurema-preta is most dominant followed by Catingueira.

Table 7. Tree species for firewood used by bakeries in Campina Grande and Patos.

Tree species	Campina Grande		Patos	
	Frequency	%	Frequency	%
Jurema-preta	51	34	12	33
Catingueira	69	46	10	28
Pereiro	19	13	3	8
Aroeira	4	3	4	11
Juazeiro	3	2	3	8
Other species	3	2	4	11

Almost all bakeries in Campina Grande purchase firewood through brokers from the Cariri region where human population is sparse, and thus human impact on the caatinga stand has been comparatively small. However, bakeries in Patos purchase firewood directly from fazendas located near the city, and thus human impact is relatively greater.

Other species, such as Angico and Calumbi, are generally preferred by bakeries in Petrolina, while Catingueira and Jurema-preta are also used by the bakeries. However, there are some differences between species composition preferred by bakeries in the region around Petrolina and the interior of the Paraíba state.

Dominant tree species for firewood used by bakeries vary also from place to place as in the case of dietary selection by livestock. Although fencing materials are generally changing from wood to concrete, several types of traditional fences are still constructed from caatinga trees (Barrows, 1985, Ribaski, 1986).

Many of the trees from the semi-arid interior of Northeast Brazil are used as stated above, not all are useful species, not are they always available in any region because floristic composition of the caatinga stand varies as related to a stage of plant succession and the magnitude of human impact.

IV. Deforestation associated with increased firewood consumption and charcoal production

The utilization of caatinga trees is becoming increasingly problematic in Northeast Brazil, especially with the increasing population and changing lifestyles. For example, recently new types of bread are being introduced, which indicated a change in the traditional dietary patterns. This change has caused an increase in the number of bakeries and consequently deforestation of the caatinga stand for firewood used by the bakeries has increased.

Along with changes in dietary patterns, housing construction materials have gradually improved. Even in the rural areas, houses with mud walls and thatched roofs are changing to brick walls and tiled roofs. Therefore, consumption of firewood at brick and tiles factories has also increased.

More accurate estimates of deforestation due to firewood and charcoal consumption are necessary to better understand associated problems as well as suggesting better methods of sustainable development and sound management of the caatinga stand.

The rate of deforestation per month can be expressed as follows:

$$Adr = Mar/rirsPr \quad (6)$$

Mar: consumption mass of firewood

(kg/month)
 Pr: mass of trunks and branches
 (kg/100km²)
 r_t: utilization rate of trunks and
 branches
 r_s: rate of mass of useful species
 for firewood to total mass of
 the stand

Further, P_r is expressed as follows:

$$P_r = N(D)W_t(D) \quad (7)$$

where N(D) is the tree density in a unit of the stand which is usually expressed by number of trees with breast height diameter D in 100 m² and W_t(D) is the weight of the trunks and branches of trees with breast height diameter D.

Hayashi (1981, 1988) has proposed the following empirical equations of N(D) and W_t(D),

$$N(D) = 217 \exp(-0.42D) \quad (8)$$

$$W_t(D) = 0.206D^{2.223} \quad (9)$$

Accordingly, total mass of trunks and branches with the magnitude of D from D₁ to D₂ per 100 m² is calculated with the following equation:

$$\int_{D_1}^{D_2} N(D)W_t(D)dD = 44.7 \int_{D_1}^{D_2} D^{2.223} \exp(-0.42D)dD \quad (10)$$

Although a diameter of firewood log is seldom larger than 10 cm, it ranges roughly from 5 cm to 8 cm. Assuming that D₁ and D₂ are 5 cm and 8 cm, respectively, the total mass is calculated at approximately 690 kg per 100 m² by Equation (10).

The magnitude of r_t and r_s in Equation (6) varies with the floristic composition which differs by the stage of plant succession and the magnitude of human impact.

Consequently, assuming further that two pair of r_t and r_s are as follows:

in the first pair of parameters

$$r_t = 0.6, r_s = 0.6$$

in the second pair of parameters

$$r_t = 0.4, r_s = 0.4$$

A_{dr} in Equation (6) is expressed as follows:

in the first case

$$A_{dr} = (1/248)M_{dc} \quad (11)$$

in the second case

$$A_{dr} = (1/110)M_{dc} \quad (12)$$

By substituting the firewood consumption of 6.0 × 10⁵ kg per month by bakeries in Campina Grande into Equations (11) and (12) yield the values of 2.4 × 10⁵ m² per month and 5.5 × 10⁵ m² per month as A_{dr}, respectively.

The deforestation area per year is approximately 2.9 km² and 6.6 km² in the first and second pair of parameters, respectively.

If the consumption of bread per person for all of Northeast Brazil, with a population of about forty million, is assumed to be the same rate as in Campina Grande, and the firewood for bakeries is also assumed to be from the caatinga stand, then total deforestation area for firewood only from bakeries would be 312 km² for the first parameter and 715 km² for the second.

The deforestation of caatinga trees caused by charcoal production is also a great concern of ours. Deforestation area can be estimated for charcoal production by employing the Equation (6), which was also employed above with firewood for bakeries.

Generally, one unit mass of charcoal is produced from about two unit mass of freshly cut green caatinga wood (Hayashi, 1988). The Equation (6) for charcoal production is then converted to the following:

$$A_{dc} = M_{dc}/r_t r_s P_r = 2M_{dc}/r_t r_s P_r \quad (13)$$

where M_{dc} is charcoal production (kg/year)

The charcoal production is roughly 500,000 tons per year in Northeast Brazil. Therefore, about 1,000,000 tons of green wood is consumed for charcoal production.

Employing Equations (11) and (12), the deforestation area per year is approximately 4,000 km² and 9,000 km² in the first and second pair of parameters, re-

spectively.

Caatinga trees are also utilized for firewood for brick and tile factories. Although no scientific data is available for firewood use at brick and tile factories, rough estimates from factory managers suggest that the area deforested for brick and tile production is about 1,000 from 1,500 km² per year.

Combining all of the above uses, the total deforestation area of caatinga trees associated with firewood and charcoal production in the semi-arid interior of Northeast Brazil is estimated in the range of 5,300 km² to 11,200 km² per year.

V. Conclusions and a proposal

The response rate and stress tolerance, which indicate the adaptabilities of caatinga trees to the semi-arid interior, are classified from the measurements of tree growth of 16 plant species. Moreover, the characteristics of their adaptabilities are classified into three tree groups, A, B, and C as associated with plant succession after clear-cutting.

Trees for animal grazing and human utilization are found not only in the mature stage (Group C) of plant succession, but also in the primary stage (Group A) and the transitional stage (Group B). Trees belonging to Group A, such as Aroeira and Jurema-preta, require about fifteen years to reach maturity. There two tree species, plus others, reach sufficient size for firewood and charcoal production in less than ten years. Trees in Group B normally have sufficient growth for firewood and charcoal production within fifteen years.

The area covered by the potential caatinga stand is about 930,000 km². It is assumed today that only about one-fourth of the potential caatinga stand still remains. Therefore, an area of about 230,000 km² is still available for firewood and charcoal production.

As stated above, the most useful caatinga trees provide sufficient firewood and charcoal production for a continuous recycling period of fifteen years. Thus, continual use of the caatinga stand allows for regrowth of trees, if careful forest rehabilitation programs are implemented.

Moreover, it is possible to supply about 400,000 tons of charcoal from the caatinga area than is presently consumed. In view of Amazonian deforestation, as for example in Carajas, this potential supply of charcoal from the Northeast could be utilized at the iron factories instead of

from the rain forest of Amazonia. Naturally, areas need to be preserved for biodiversity, and over-exploitation and mismanagement of forests must be avoided in both regions. Moreover, the complementary relationship of geographical characteristics in two or more regions,

such as the Northeast and Amazonia, can play an important role in the resolution of the environmental problems if applied with the sustainable development programs and sound management of plant resources.

Acknowledgments

The writers wish to express their sincere gratitude to SUDENE, IBGE, and CNPq. We would like to also thank Dr. Keith Muller, Kent State University, for his academic discussions and fruitful suggestions.

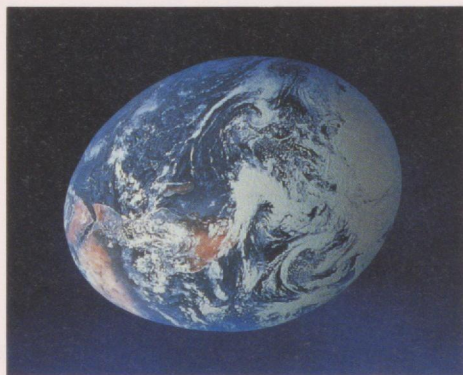
References

- Barros, S. (1985): Cercas Sertanejas-Tracos ecologicos do sertao pernambucano, Secretaria de Educacao, Departamento de Cultura, Fundacao Joaquim Nabuco, Recife, 81p.
- Golfairi, L., and R. L. Caser (1977): Zoneamento Ecologico da Regiao Nordeste para Experimentacao Florestal, Centro de Pesquisa Florestal de Regiao do Cerrado, Serie Tecnica No. 10, 116p.
- Hardesty, L. H., T. W. Box and J. C. Malechek (1988): Season of cutting affects biomass production by coppicing browse species of the Brazilian caatinga, *Journal of Range Management* 41 (6), 447 - 480.
- Hayashi, I. (1981): Plant communities and their environments in the caatinga of Northeast Brazil, *Latin American Studies* No. 2, 65 - 79.
- Hayashi, I. (1988): Changing Aspect of Caatinga Vegetation in Semi-arid Region, Northeast Brazil, *Latin American Studies* No. 10, 61 - 71.
- Masuda, F., T. Nishizawa, and Y. Sakamoto (1989): Element partition among tree, soil, and basement rock in thorny shrub in Northeast Brazil: A preliminary note, *Ann. Rep., Inst. Geosci., Univ. Tsukuba* No. 15, 88 - 91.
- Nishizawa, T., and M. M. V. Pinto (1988): Recent Changes in Firewood, and Charcoal Production and Their Affects on Desertification, *Latin American Studies* No. 10, 121 - 131.
- Pfeister, J. A., and J. C. Malechek (1986): Dietary Selection by Goats and Sheep in a Deciduous Woodland of Northeastern Brazil, *Journal of Range Management* 39 (1), 24 - 28.
- Pfeister, J. A., J. C. Malechek, and D. F. Balph (1988): Foraging Behavior of Goats and Sheep in the Caatinga of Brazil, *Journal of Applied Ecology* 25, 379 - 388.
- Ribaski, J. (1986): Avaliacao do Uso dos Recursos Florestais em Imoveis Rurais na Regiao de Ouricuri, PE, *Boletim de Pesquisa* No. 31, EMBRAPA, 37p.
- Saito, I., and H. Maruyama (1988): Some Types of Livestock Ranching in Sao Joao do Cariri on the Upper Paraiba Valley, Northeast Brazil, *Latin American Studies* No. 10, 103 - 120.
- Tsuchiya, A. (1990): Hypertrophic Growth of Trees of the Caatinga Plant Community and Water Balance, *Latin American Studies* No. 11, 51 - 70.

Appendix

Local and scientific names of caatinga trees.

1	Angico	<i>Anadenanthera macrocarpa</i> Benth
2	Arapiraca	<i>Pithecollobium foliolosum</i> Benth.
3	Aroeira	<i>Astronium urundeuva</i> Engl.
4	Bolusu	(unknown)
5	Braúna	<i>Schinopsis brasiliensis</i> Engl.
6	Burra-leiteira	<i>Sapium cicatricosum</i> Pax et K. Hoffm.
7	Cablo-de-negro	(unknown)
8	Calumbi	<i>Mimosa malacocentra</i> Mart.
9	Carqueijo	<i>Calliandra depauperata</i> Benth.
10	Canafistula	<i>Cassia excelsa</i> Schrad.
11	Catingueira	<i>Caesalpinia pyramidalis</i> Tul.
12	Espinheiro	<i>Piptadenia viridiflora</i> Benth.
13	Faveira	<i>Cnidoscolus phyllacanthus</i> Muell. Arg. Pax et Hoff.
14	Imburana (Umburana)	<i>Bursera leptophloeos</i> Mart. (unknown)
15	João-mole	(unknown)
16	Juazeiro	<i>Ziziphus joazeiro</i> Mart.
17	Jucá	<i>Caesalpinia ferrea</i> Mart. ex Tul.
18	Jurema-branca	<i>Piptadenia stipulacea</i> Ducke
19	Jurema-preta	<i>Mimosa hostilis</i> Benth.
20	Mandacaru	<i>Cereus jamacaru</i> DC.
21	Malva	<i>Gaya aurea</i> St. Hil
22	Marmeleiro-branco	<i>Croton argirophyloides</i> Muell. Arg.
23	Maria-dura	(unknown)
24	Mofumbo	<i>Combretum leprosum</i> Mart. et Eichi.
25	Mororó	<i>Bauhinia cheilantha</i> Steud.
26	Pau-branco	<i>Fraunhoferia multiflora</i> Mart.
27	Pau-de-casca	<i>Tabebuia spongiosa</i> Rizzini
28	Pereiro	<i>Aspidosperma pyrifolium</i> Mart.
29	Pinhão	<i>Jatropha mutabilis</i> Baill.
30	Quebra-fação	<i>Phisocalymma scaberrimum</i> Pohl
31	Quipá	<i>Opuntia palmadora</i> Br. et Rose
32	Rompe-jibão	<i>Erythroxylum</i> sp.
33	São-joão	<i>Cassia excelsa</i> Schrad.
34	Sobiá	<i>Mimosa caesalpiniiifolia</i> Benth.
35	Uricuri	<i>Cocos coronata</i> Mart.
36	Xiquexique	<i>Pilosocereus gounellei</i> Byl. et Rowl.



Inquiries ●

To the Secretariat, 21st-Century Earth Award:
3-1-4-1004, Tsukiji, Chuo-ku, Tokyo 104, Japan
Phone 03-3545-6897/ FAX 03-3545-9769