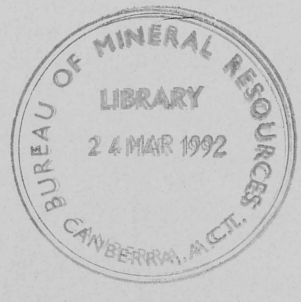

SUSTAINABLE DEVELOPMENT: ENERGY AND MINERAL RESOURCES IN THE CIRCUM-PACIFIC REGION AND THE ENVIRONMENTAL IMPACT OF THEIR UTILISATION

PROGRAM AND ABSTRACTS

9-12 March 1992
Queen Sirikit National Convention Centre
Bangkok, Thailand

Bureau of Mineral Resources, Geology and Geophysics
Australia

Record 1992/16

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MONDAY 9 MARCH 1992

2.00-2.30 ***OPENING CEREMONY***
OPENING ADDRESS - HRH THE PRINCESS OF THAILAND

PERSPECTIVES OF SUSTAINABLE DEVELOPMENT

2.30-3.00 ***KEYNOTE ADDRESS: CHALLENGES OF SUSTAINABLE DEVELOPMENT IN EXPANDING ECONOMIES - H.E. ANAND PANYARACHUN, PRIME MINISTER OF THAILAND***

TEA/COFFEE BREAK

3.30-4.00 *Coping with Global Environmental Change: The Role of Science*
M G K Menon, President ICSU and Minister of State for Science and Technology of India

4.00-4.30 *Understanding the Life Support System: Challenge for the Earth Sciences*
Bill Fyfe, Uni Western Ontario, Canada

4.30-5.00 *The Meaning of Sustainable Supply for Mineral and Energy Resources*
David Kear, Brian Fisher and **Roye Rutland**, UNACSTD and Department of Primary Industries and Energy, Australia

5.00-6.30 *RECEPTION*

TUESDAY 10 MARCH 1992

THE BASIS FOR SUSTAINABLE SUPPLY

MINERAL RESOURCES OF THE PACIFIC REGION

8.30-9.00 *Metal Demand and Economic Development in the Asia-Pacific Region*
Allen L Clark, East-West Center

9.00-9.30 *The Mineral Potential of the Pacific Basin and its Margins*
Brian Skinner, Yale University

9.30-10.00 *Minerals Availability in the Pacific Region*
Rodney Rosenkranz, US Bureau of Mines

10.30-11.00 *Mineral Resources of the Pacific Ocean Floor*
Masamichi Fujimori, Deep Ocean Minerals Association, Japan

11.00-11.30 *Building Materials and Industrial Minerals in the Pacific Region*
David Lock, Australian National University

11.30-12.00 *Petroleum Resources in the Pacific Region*
Ken Drummond, Mobil Oil Canada and **George Pinckney**, Mobil Oil Indonesia

LUNCH

ENERGY RESOURCES OF THE PACIFIC REGION

1.30-2.00 *Coal Resources of the Pacific Region*
Jack Medlin, USGS (presented by Maurice J Terman, USGS)

2.00-2.30 *Coal Resources of China*
Mao Bangzhuo, China National Administration of Coal Geology

2.30-3.00 *Ocean Thermal Energy Conversion (OTEC): A Stirring Giant*
Andrew R Trenka, Division of Energy Resources, Pacific International Center for High Technology Research

TEA/COFFEE BREAK

3.30-4.00 *Geothermal Resources of the Pacific Region*
David Kear and W A J Mahon, Geothermal Energy (NZ)

4.00-4.30 *Hydro Power Potential in the Pacific Region and its Trends of Development from the Viewpoint of Developing Countries*
Swarng Champa, Deputy General Manager - Hydro Power and Transmission System Development, Electricity Generating Authority of Thailand

4.30- 5.00 - SPECIAL PLENARY ADDRESS- SUSTAINABLE DEVELOPMENT OF ENERGY AND MINERAL RESOURCES: A JAPANESE PERSPECTIVE - Mr Goro Mori, Chairman, Japan Mining Engineering Center for International Cooperation

WEDNESDAY 11 MARCH 1992

ENVIRONMENTAL FACTORS AFFECTING SUSTAINABLE DEVELOPMENT

8.30-9.00 *Natural Hazards as Factors in Sustainable Development*
William Hooke, NOAA, USA

9.00-9.30 *The Environmental Effects of Development in Asia*
Prinya Nutalaya, Asian Institute of Technology, Thailand

9.30-10.00 *The Mekong Hydropower Potentials and Possible Development Strategies*
Interim Committee for Coordination of Investigations of the Lower Mekong Basin

TEA/COFFEE BREAK

10.30-11.00 *Mitigating Environmental Damage in Extraction of Minerals*
(to be confirmed)

11.00-11.30 *Sustainable Development of Non-Living Resources : A Program for East Asian Coastal and Offshore Areas*
Guillermo Balce, Mathias Lueg and He Qixiang, CCOP, Thailand

11.30-12.00 *Developments Affecting Mineral Resource Utilisation in Asia and the Pacific*
(to be confirmed)

LUNCH

1.30-2.00 *Environmental Impacts of Resource Development in China and Strategies for Their Mitigation*
Kong Deyong and **Ma Chi**, State Science and Technology Commission, National Research Centre for Science and Technology for Development, PRC

2.00-2.30 *The Oceanic Environment of the Pacific: Overview of Significance of Dynamic Systems of the Pacific Ocean in Controlling Regional Impacts of Climate Change, Sea-Level Change, and Pollution*
Michael Hall, NOAA, USA

2.30-3.00 *The Record of Natural Climatic Change in the Pacific Region and its Significance for Greenhouse Scenarios*
Jim Bowler, Museum of Victoria

TEA/COFFEE BREAK

3.30-4.00 *The Record of Natural Sea-Level Change in the Pacific Region and its Significance for Greenhouse Scenarios*
Peter Davies, **Peter Roy** and Bruce Thom, Uni of Sydney, Australia

4.00-4.30 *Current Prognoses of Climatic Change and its Effects in the Pacific Region*
R R Brook, W K Downey and M J Manton and **John Zillman**, Bureau of Meteorology, Australia

***4.30-5.00 - SPECIAL PLENARY ADDRESS - SUSTAINABLE DEVELOPMENT OF ENERGY AND MINERAL RESOURCES: AN AUSTRALIAN PERSPECTIVE** (to be confirmed)*

5.30-7.30 *WORKSHOP*
Coordination and Application of Resource and Environmental Data for Sustainable Development

THURSDAY 12 MARCH 1992

SCIENTIFIC AND TECHNICAL STRATEGIES

8.30-9.00 *Overview of NOAA's Program for Research Monitoring and Cooperation in the Pacific Region*
Ned Ostenso, NOAA, USA

9.00-9.30 *Potential Contributions of International Geoscience Programs Towards Sustainable Development of Resources*
Robin Brett, IUGS

9.30-10.00 *Strategic Research and Exploration as the Essential Basis for Sustaining Resource Supply*
Peter Cook and A J Reedman, British Geological Survey

TEA/COFFEE BREAK

10.30-11.00 *Trends in Material Usage: Implications for Sustainable Development*
Donald G Rogich, US Bureau of Mines, USA

11.00-11.30 *Asia and the Pacific: Scenarios of Future Energy Mix*
Budi Sudarsono, ESCAP

11.30-12.00 *Research and Technology Opportunities for Minimising the Environmental Impacts of Energy Use*
Alf Ekstrom, CSIRO, Australia

LUNCH

ECONOMIC FACTORS AND STRATEGIES

1.30-2.00 *Economic Definition of Sustainability and Intergenerational Equity*
Brian Fisher, Australian Bureau of Agriculture and Resource Economics

2.00-2.30 *Economic Analysis: Cost Benefits in Sustainable Development*
R Weiher, NOAA, USA

2.30-3.00 *Can World Growth in Energy Demand be Satisfied by Sustainable Energy Systems?*
Hoesung Lee, Institute of Energy Economics In Korea

TEA/COFFEE BREAK

3.30-4.00 *Sustainable Development of Energy and Mineral Resources in Indonesia*
John Katili and Amanda Katili, Ministry of Mines and Energy, Indonesia

4.00-4.30 *Policy and Strategy Options for Sustainable Development in Asia*
K C Jechoutek, World Bank, Washington D.C.

4.30-5.30 *SUMMATION*

COPING WITH GLOBAL ENVIRONMENTAL CHANGE: THE ROLE OF SCIENCE

M G K Menon

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

Professor M G K Menon, President of ICSU, 51 bld de Montmorency, 75016 Paris FRANCE

UNDERSTANDING THE LIFE SUPPORT SYSTEM: CHALLENGE FOR THE EARTH SCIENCES

W S Fyfe

The condition of humankind is related to the availability of modern technologies for Energy, Agriculture, Materials, Transport ... and the state of the environment. All such technologies require basic Earth resources and all have environmental impact. The great questions facing us all include:

. how will we supply adequate nutrition (not just calories) for the next 5 billion?

. how will we provide the basic systems for health-sanitation-education-hope for the 100 million children who arrive each year (given present vast illiteracy and poverty)?

. how will we protect the basic life-support systems (air-water-soil ...) of Earth?

The life support systems include all mass-energy fluxes that influence the biosphere. We must understand their magnitude and fluctuations in space and time. At present, we of the rich worlds have become aware of man induced changes to critical parts of the systems including:

. changing atmospheric chemistry and air quality (the global greenhouse, ozone depletion, changes in clouds and aerosols even above the stratosphere, acid rain)

. changes in water quantity and quality. Changes in the use of water and the impacts of reduction in continental runoff with potential influence on ocean bioproductivity and ocean circulation.

. massive soil erosion and soil deterioration, deforestation and desertification ...

. the impacts of urban development and massive introduction of xenobiotic chemicals

. and the loss of biodiversity.

While awareness has increased, the time has come for action at all levels, local and global. Energy systems must move to sustainable solar and geothermal. Technologies must become holistic with built in preparation for recycling. But if we are to preserve the planet for future generations then all people must understand the life support system. Perhaps Earth Scientists have the most fundamental appreciation of such systems. A question we must all consider is: "will I leave Earth in a condition better than when I arrived for my planetary experience?".

W S Fyfe, Department of Geology, The University of Western Ontario, London, Ontario, Canada

THE MEANING OF SUSTAINABLE SUPPLY FOR MINERAL AND ENERGY RESOURCES

R W R Rutland, B Fisher and D Kear*

Overall global demand will continue to grow over the next few decades as a result of global population growth and increasing demands in developing countries. Demand for individual commodities may increase or decrease as a result of changes in costs of production, substitution, recycling, technological advances, or environmental concerns.

Fossil fuel resources differ intrinsically from other minerals in their potential for long term supply; but the total resources of both fossil fuel accumulations and conventional mineral deposits are finite. One measure of sustainability of supply is the stock of Economic Demonstrated Resources (EDR - that part of total resources which has been identified by exploration and drilling and which can be extracted economically under current conditions) and its relation to annual production.

The stock of EDR is renewable, and supply sustainable, at least for the next several decades either by discovery of new economic resources or transfer from the large pool of known but currently sub-economic resources - as a result of technological advances or of price rises induced by scarcity.

One important goal of sustainable development is the maintenance of the stock of EDR at high resource/production ratios, by the discovery of new economic resources. Meeting this goal requires access to prospective areas for vigorous and innovative exploration programs based on comprehensive up-to-date geoscientific research. It also requires appropriate economic policy instruments to encourage development consistent with good environmental practice.

Population growth increases the demand for resources but, as a result of competing land use claims, it may also reduce the areas available for exploration, and for waste disposal.

In this context, the environmental effects of resource use and especially the burning of fossil fuels - should be recognised as global problems. The focus of policy needs to be on finding multilateral solutions to these problems and in particular ensuring that demand for resources is met by the most efficient suppliers.

The key to sustainable development, and sustainable supply, beyond the middle of the next century lies in the development of non-polluting energy sources. These will permit the extraction of commodities from low grade materials and also remove the most significant environmental impact of resource use.

R W R Rutland, Executive Director, Bureau of Mineral Resources, Geology and Geophysics, GPO Box 378, Canberra, ACT, 2601, Australia

METAL DEMAND AND ECONOMIC DEVELOPMENT IN THE ASIA-PACIFIC REGION

Allen L Clark

Metals demand in the Asia-Pacific region continues to increase at a high rate relative to other regions internationally. Overall world demand led by the OECD countries for the basic metals (iron/steel, aluminum, copper, lead and zinc) all show declining rates, whereas demand for the same metals shows an increasing rate, led by the Newly Industrialised Economies (NIEs) and the ASEAN nations. Metal demand in the Soviet Union, China and India remain major uncertainties in the region. China's demand for basic metals has steadily increased although a minor decline occurred in 1990-1991.

For both producing and consuming nations of the Asia-Pacific region the proposed 'decoupling' of total world metal consumption and economic growth has critical ramifications with regard to mineral investment, security of supply and long-term prices. However, analysis of demand in the Asia-Pacific region shows that a 'decoupling' of total world metal demand will not occur by the year 2015. Although the 'decoupling' effect may exist in the OECD nations, the metal demand of the developing nations will increase markedly because of a strong positive correlation between per capita income and per capital metal consumption, which is expected to persist to the year 2015 and beyond.

Economic growth with sustainable development in the Asia-Pacific region, with respect to metals, will require a balance of the material composition of products, in which a decline in metals demand will result from materials-saving technology, efficiency, and materials substitution, and a changing product consumption of the economy which increases metals demand as a result of an intersectoral shift in the product mix. Additionally, change in GDP, intensity of use, exchange rates and world debt, energy cost, the age patterns of minerals, and technological factors will all impact metal demand patterns.

Allen L Clark, Director, Minerals Policy Program, East-West Center, Resources Programs

THE MINERAL POTENTIAL OF THE PACIFIC BASIN AND ITS MARGINS

Brian J Skinner

History suggests four factors will serve as guides in assessing future uses of metals: First, the number of mineral commodities mined will increase as technology grows; second, use rates of newly mined metals will increase despite recycling because of population growth and industrialisation; third, individual countries will be less and less able to supply all needed materials through internal production (none do so today); and fourth, the time when we must learn to find new deposits beneath thick blankets of sedimentary rocks, and learn to find and mine deposits on the ocean floor, grows even closer.

The Pacific, the countries in the basin, and those around its margin, will become increasingly important as producers of metallic minerals. When and how this will happen has more to do with politics and economics than with geology, because the geologic potential is large.

The Pacific holds the greatest geologic promise for submarine deposits of all the world's marine realms. The promise, still largely untested, arises for three reasons: First, the geologic complexity of the subduction-controlled western and northern borders suggests the presence of interesting polymetallic deposits. Five such mineralised areas (Jade Field in the Okinawa Trough, the Woodlark, Lau, Manus, and North Fiji Basins) have already been identified. The second reason involves the many fragments of crust that form submerged plateaus in the Pacific. These interesting masses have varied origins and have been barely tested, but equivalent masses accreted onto continental margins contain interesting deposits. Presumably their submarine relatives do too. The third reason is the huge sea-floor fields of metal-rich ferromanganese nodules. Interest has faded, temporarily, in these nodules, but they contain such huge resources of metals their day will surely come.

The island nations and the mainland borders of the Pacific are so geologically complex; it is difficult to generalise about the metallic potential beyond the fact that the potential is large. Geology suggests that metals for which the region is already famous - tin, tungsten, gold, silver - are the most likely targets, but the copper, lead, zinc potential is very high too. Geology (plus climate) also suggests a high potential for bauxite and chromite.

Brian J Skinner, Professor of Geology and Geophysics, Yale University, New Haven, Connecticut 06511, USA

MINERALS AVAILABILITY IN THE PACIFIC REGION

Rodney D Rosenkranz

The mission of the US Bureau of Mines is to help ensure that the nation has an adequate and dependable supply of minerals to meet its defense and economic needs at acceptable environmental, energy and economic costs. To fulfil this mission, the Bureau conducts a number of research and information programs. An important component of the information program, the Minerals Availability Program (MAP), collects information on major mines, deposits and processing operations, worldwide. This information is then analysed to determine the adequacy of supply for key minerals.

This paper provides a description of major components of the Minerals Availability Program including:

. Minerals information included and data collection methods;

. Data bases used to store this information;

. Methods used to develop cost data;

. Data analysis techniques; and

. Products from the system including issue analyses, tables and graphs, formal reports, and automated computer data.

Many of the countries in the Circum-Pacific region currently consume and/or produce significant quantities of minerals and contain large mineral resources for future production. Circum-Pacific countries accounted for over 50% of the world's production of copper, gold, silver, tin and tungsten in 1990. These countries also contain significant mineral reserves for future production. This paper provides examples of the types of data collected by the Minerals Availability Program for Circum-Pacific countries and how the data are analysed to determine resource potential.

Rodney D Rosenkranz, Deputy Chief, Western Field Operations Center, US Bureau of Mines, Spokane, WA

MINERAL RESOURCES OF THE PACIFIC OCEAN FLOOR

Masamichi Fujimori

The development of deep sea mineral resources will play a very important and significant role in the future development of industry. The demand for nickel, cobalt, manganese and other rare metals is rapidly increasing with the strong growth of high-tech industries.

Deep sea mineral resources such as manganese nodules, polymetallic massive sulfide deposits, cobalt-rich-crusts are very promising as a good source of stable supply.

Therefore, an international management system which would ensure orderly exploitation of these resources would contribute greatly to the development of the world economy and improvement of people's lives, not to mention solving the resource problems of individual countries such as Japan.

Of the various development projects regarding deep sea mineral resources conducted by DOMA, R&D on mining manganese nodules was transferred to an organisation newly established in 1982, the Technology Research Association of Manganese Nodules Mining System, and exploration has been carried out by the Deep Ocean Resources Development Company Ltd, (DORD) with public and private capital. DOMA is presently conducting basic studies on the exploration and mining of cobalt-rich-crusts (CRC) and mineral resources on continental shelf surrounding Japan. It has also started the development of metallurgical processing of the manganese nodules.

DOMA is comprised of 35 major companies in the fields of trade, non-ferrous metal smelting, steel, ship-building and heavy machinery, shipping, electric cables and others. Technical personnel from these firms participate in the projects as needs arise. Similar firms are participating in the Technology Research Association of Manganese Nodules Mining System and DORD.

In December 1987, DORD registered as Pioneer Investor and had the exclusive right to carry out pioneer activities in the pioneer area in accordance with Resolution II of the United Nations Convention on the Law of the Sea.

Masamichi Fujimori, Chairman, Deep Ocean Minerals Association, Kato Building, 5-4 Uchikanda 1-Chome, Chiyoda-Ku, Tokyo 101, Japan

BUILDING MATERIALS AND INDUSTRIAL MINERALS IN THE PACIFIC REGION

David Lock

The production and trade of both building materials and industrial minerals is characterised by the high volumes of material utilized, and its low unit value. The cost of transport for such low-value building materials and basic (not value-added) industrial minerals makes the development and supply of these products location sensitive. It relies upon low transport costs, and this generally means a close vicinity to consumers. Countries of the Pacific Basin have a natural advantage in ensuring supply of these materials through ready access to seaborne transport.

The geologic structure of the Pacific Basin dictates an inequitable distribution of key industrial minerals between countries. Only by international trade will some countries obtain important mineral resources necessary for maintaining agricultural and industrial production, and providing for further development. The supply of fertilizer minerals to the western Pacific region from North America is an example. For many countries in the Pacific Basin, an assessment of the longterm supply of industrial minerals and building/construction materials cannot be done in isolation, and inventories will have to be considered in terms of regional availability, accommodating key factors such as transport costs, and trading arrangements. To overcome scarcity, there is considerable potential for technical adaptation of other substitute industrial mineral resources. Examples from North America and the new Europe for the utilization and recycling of waste materials are being quickly adopted.

Technical capacity will maintain its dominant role as a factor in ensuring the supply of industrial minerals for sustained development for many countries of the Pacific Basin, and for ensuring minimal and acceptable levels of environmental impact. A strong foundation of technical knowledge and skill will be necessary for more innovative responses to environmental requirements in the planning for resource supply, its mining and processing, and the development of new materials. In many countries this has become a key area for government assistance.

Resources for building and construction materials present unique problems in ensuring their supply, and in the extent of their environmental impact. Due to their very low cost and the large volumes involved, sand, gravels and crushed aggregate must be mined and processed close to, or within urban centres of population. Their extraction is generally limited to quarry operations which can have a high environmental impact in high density population areas. In addition, many large urban centres in the Pacific Basin are located on the coast, and often at the confluence of large rivers. Although such locations can present abundant resources combined with access to shipborne transport, their extraction can have a high impact upon sensitive estuarine and coastal environments.

Careful planning by government is necessary to ensure future supply of these materials at acceptable pricing, and at an acceptable environmental cost. This involves coordinating land use (cost of land, consideration of environmental sensitivity, use after rehabilitation), urban planning (transport corridors, trafficability, noise abatement, public health), managing environmental impact, and ensuring the environmental recovery of affected areas. Countries with a high rate of economic growth, and burgeoning urban centres must be particularly aware of these aspects for the future supply of building and construction materials.

Dr David E Lock, Research School of Pacific Studies, Australian National University, GPO Box 4, Canberra ACT 2601, AUSTRALIA

PETROLEUM RESOURCES IN THE PACIFIC REGION

George Pinckney and Kenneth J Drummond*

The petroleum habitat of basins of the Pacific rim is directly related to the consequences of plate tectonics. Active subduction and collision have created many thick sedimentary basins around the Pacific margin. Sedimentary basins of the Pacific include the rift and drift sequences of the Australian margin and the subduction related fore-arc, inter-arc and back-arc basins of the Pacific margin. Major productive basins of the Pacific rim include continental breakup, rift and drift basins as Gippsland and Carnarvon of the Australian margin, accretionary continental margin basins of China, fore-arc basin of southwest Ecuador-northwest Peru as the Talara, back-arc basins of Sumatra, foreland shelf deltaic basins as Kutei and Brunei, and subduction related basins of Southern California basins, Talara, and Sumatra. Oil and gas occurs in Paleozoic and Mesozoic sediments in those basins associated with the older continental margins as Australia and Eastern China. Most of the producing strata of the Pacific rim is Tertiary in age, with by far the most important reservoirs being in the Miocene.

The productive areas of the Pacific rim have cumulative production to the end of 1990 of 59 billion barrels of oil and 83 trillion cubic feet of gas. Estimated remaining reserves are 53 billion barrels of oil and 322 trillion cubic feet of gas. The total discovered resources, cumulative production and reserves, of 112 billion barrels of oil and 405 trillion cubic feet of natural gas, represent 7% of the World's discovered oil and 7% of the World's discovered gas. The total petroleum resources in the Pacific Basin is not sufficient to ensure sustainable development too far into the future and exploration will be needed to find the undiscovered potential, which could exist. Current published estimates (US Geological Survey, Geological Survey of Canada) of future undiscovered potential for the Pacific Rim have a mean expected value of 95 billion barrels of oil and 773 trillion cubic feet of natural gas.

For the Western Pacific Region, cumulative production is 36 billion barrels of oil and 43 trillion cubic feet of natural gas, with remaining reserves of 43 billion barrels of oil and 311 trillion cubic feet of natural gas. Future undiscovered potential for the Western Pacific basins is 76 billion barrels of oil and 656 trillion cubic feet of gas. There are still many relatively unexplored sedimentary basins in the Western Pacific region, which could have considerable potential for the future.

George Pinckney, Mobil Oil Indonesia, Jakarta, Indonesia, and Kenneth J Drummond, Mobil Oil Canada, Calgary Canada

COAL RESOURCES OF THE PACIFIC REGION

Jack Medlin

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

Jack Medlin, US Geological Survey

A BRIEF INTRODUCTION TO COAL RESOURCES IN CHINA

Mao Bangzhuo

In this paper the author gives some major figures concerning Chinese coals.

Then, the coal-forming history in China is introduced, from the earliest 'stone-like coal' which formed during Cambrian and Silurian periods all the way down to Tertiary lignite.

The theme of this paper is the Chinese coal resources; it discusses disequilibrium distribution, complete rank, good and bad aspects of coal quality and various usages of Chinese coals.

Finally, the paper discusses prospects for the Chinese coals.

Mao Bangzhuo, China National Administration of Coal Geology, Zhuozhou, Hebei 072752, China

OTEC: A STIRRING GIANT

Andrew R Trenka

Ocean Thermal Energy Conversion (OTEC) is a giant among the renewable energy technologies that is poised to enter the arena of commercial competition.

In recent years, experimental plants to demonstrate the OTEC concept have been constructed and tested in the US and Japan. Significant progress has been made on the design and testing of components for both closed- and open-cycle systems, and a hybrid-cycle system has been conceived that could produce both electrical power and fresh water using off-the-shelf technology. As the capability of producing fresh water increases, the economics of OTEC become more favourable. The design and construction of an open-cycle net power producing experiment (NPPE) is being performed in Hawaii by the Pacific International Center for High Technology Research (PICHTR) as a critical step toward commercialisation.

The multiple products available from OTEC, including electricity generated without fossil fuels, fresh water, air-conditioning capability, mariculture potential, and its environmental benefits, make OTEC an attractive alternative that could be currently competitive in many remote locations. The need for larger seawater pipes and turbines, and methods of financing OTEC plants in nations with marginal economies are challenges that must be addressed for the widespread utilisation of OTEC.

Andrew R Trenka, Division of Energy Resources of the Pacific, International Center for High Technology Research

GEOTHERMAL RESOURCES OF THE PACIFIC REGION

*David Kear * and W A Mahon*

The use of geothermal steam for electrical generation and other energy developments is increasing - the current global capacity being well in excess of 5000 MW. Some 85% of present production is in the Circum-Pacific Region, which has by far the greatest potential of the World. The general requirements for a successful development include:

. the presence of young rhyolitic, or at least andesitic, rocks;

. temperatures of over 200 C, and preferably 275-300 C;

. adequate permeability, and a supply of water from meteoric or reinjection sources;

. acceptable water chemistry, or some heat exchange system;

. environmentally acceptable conditions for testing the fields, each of which will typically be of 50 to 300 MW size, spaced perhaps 25 km apart;

. an overall engineering development plan, including perhaps water separation and gas extraction plant design, corrosion studies, reservoir modelling, waste water reinjection, cooling system(s), and even volcanic risk;

. general social and environmental acceptability, which may limit the choice of fields for exploitation; and

. an enlightened financing package which will allow least-cost staged development to proceed, with only minor interruptions, along a carefully designed path with regular attainment goals and checks.

Major developments at Wairakei (New Zealand) and The Geysers (USA) have now lasted for over 30 years, and are expected to last for more than another 25 years. There has been general acceptability from environmental/social points of view, particularly following the modern trend towards universal reinjection of waste fluid. There is some inevitable decline in temperature, pressure, and ground surface with time, but production can be maintained through a replacement well program, probably requiring deeper future drilling - the concept of 'mining heat'. Shutting down fields has always shown an immediate tendency to return to natural conditions. Thus, a dynamic view of sustainability implies that geothermal power developments are at least as sustainable as any other renewable energy resource.

David Kear, Consultant, Ohope, and W A J Mahon, Scientific Director, Geothermal Energy NZ Ltd, Auckland, New Zealand

HYDRO POWER POTENTIAL AND ITS DEVELOPMENT TRENDS FROM THE VIEWPOINT OF DEVELOPING COUNTRIES

Swarng Champa

This paper will present an assessment of world hydro resources and potential, available for exploitation, which have been considered as one of the clean and renewable sources for electric energy development. Trends of development are also discussed. Urging for further development of the water resources which are still remaining for exploitation should have been undertaken by taking properly the environmental affects into consideration as well as the reasonable financing of the project, otherwise, the developing countries can not afford it. The developed countries and the financing institutions should be aware of these aspects, and not throw all the burdens on the developing countries.

Swarng Champa, Deputy General Manager - Hydro Power and Transmission System Development, Electricity Generating Authority of Thailand

NATURAL HAZARDS AS FACTORS IN SUSTAINABLE DEVELOPMENT

William H Hooke

Worldwide losses from natural disasters tripled from the 1960s to the 1980s, reaching $50B US in CY 1990. During the same period, insured losses quintupled. This trend does not represent any change in the geophysical hazard so much as it reflects population growth combined with cultural preferences which increase our vulnerability (growing population, increasing urbanisation, concentration along coasts and fault lines, etc.).

To stem this trend, the United Nations have declared the 1990s an International Decade for Natural Disaster Reduction (IDNDR). The Decade is largely the responsibility of a Scientific and Technical Committee, chaired by Dr James Bruce, former Director of Canada's Atmospheric Environment Service (AES). They have identified the following goal:

> By the year 2000, all countries, as part of their efforts for sustainable development, should have in place:
> - a comprehensive national assessment of risk, due to natural hazards, built into national development plans.
> - mitigation plans
> - ready access to global, regional and national warning systems.

The United Nations has also established a special High-Level Council, chaired by Miguel de la Madrid Nurtado, former President of Mexico, to oversee the IDNDR. HRH Princess Chulabhorn Mahidol of Thailand, and Mrs Marilyn Quayle of the United States, among others, serve on the Council.

The IDNDR has endorsed eleven demonstration projects. Examination of these even by short title, serves to highlight the breadth of effort:

. improve prediction of tropical cyclones
. volcano hazard reduction
. minimise earthquake vulnerability
. develop disaster data bases
. education, research, and training activities
. improved risk assessment
. low-cost, hazard-resistant structural design
. technology transfer
. public health projects
. research and training international centers
. instability of megacities.

National and regional entities are encouraged to participate in the IDNDR as well as develop domestic/regional programs.

The United States has two such entities presently: a FCCSET interagency governmental Subcommittee for Natural Disaster Reduction (SNDR), and a National Academy of Sciences Committee. Both have been active.

The SNDR has established priorities for research in this area, addressing: our understanding of the nature of the geophysical hazard; the engineering aspects of natural disaster reduction; and sociological and economic factors. The framework addresses as well the needs for improved application of this knowledge in engineering practice within the United States.

On the international side, the United States is participating in the IDNDR broadly. The United States is working closely with Japan, addressing the science under a US-Japan bilateral agreement, and addressing its application through joint help to developing countries, following an agreement by President Bush and Prime Minister Miyasawa.

All nations are preparing for a World Conference on Natural Disaster Reduction, to be held in 1994.

William J Hooke, Deputy Chief Scientist, National Oceanic and Atmospheric Administration, US Department of Commerce, Washington, D.C. 20230, USA

THE ENVIRONMENTAL EFFECTS OF DEVELOPMENT IN ASIA

Prinya Nutalaya

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

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THE MEKONG HYDROPOWER POTENTIALS AND POSSIBLE DEVELOPMENT STRATEGIES

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Interim Committee for Coordination of Investigations of the Lower Mekong Basin

MITIGATING ENVIRONMENTAL DAMAGE IN EXTRACTION OF MINERALS

Mineral extraction in the past has sometimes had strongly negative environmental impacts and this influences public perceptions at present. However, mining practices today generally recognise the need for rehabilitation and restoration of mines; and effective methodologies are well established. Provided the reclamation is planned from an early stage the cost is not high - perhaps 10% of overall cost.

International Development Agencies have recognised that it is difficult to attract private investment to meet the costs of effectively addressing the environmental considerations in respect of mining in developing countries; and that such costs may need to be met by development assistance rather than by way of incentives and subsidies. The World Bank has developed its own environmental guidelines and environmental impact procedures; and it has carefully identified a range of measures that could be taken to mitigate the negative impacts of mining.

Complete restoration of the original environment is evidently impossible: the objective must be conservation and environmental modification to the maximum public utility and benefit. Frequently rehabilitation returns the land in better condition, or in more useable forms than before mining.

The temporary environmental impacts can usually be restricted to very small areas. The greatest environmental challenges occur in mountainous areas of high rainfall where careful management is required to avoid significant impact in natural drainage systems (e.g. in Papua New Guinea). The monitoring of environmental impacts require that there be appropriate base-line studies.

Examples are given of rehabilitation in highly populated areas in Germany and in sparsely populated areas in Australia. A fine example in Thailand of careful planning to minimise environmental impacts is the Mae Moh mine.

In general, if appropriate environmental management is undertaken, mining can be seen as temporary land-use which can be undertaken as part of a multiple land-use strategy.

The Business Council for Sustainable Development and the Australian Mineral and Energy Environment Foundation are recent international and national initiatives, respectively, concerned with promoting environmentally sound and sustainable development.

SUSTAINABLE DEVELOPMENT OF NON-LIVING RESOURCES: A PROGRAM FOR EAST ASIAN COASTAL AND OFFSHORE AREAS

G R Balce, He Qixiang and Mathias Lueg*

During the past 25 years, CCOP has flourished as an agent of development for East Asian countries, particularly in energy, mineral resources, and infrastructures such as ports, harbours and submarine pipelines.

The advent of the sustainable development principle, in recent years, has added a new dimension to CCOP's task. It has adopted a working philosophy that "to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs is to know what endowment there is, take only that part which is needed, and leave the rest undisturbed or enhanced in availability for future generations to enjoy".

This philosophy translates to a sustainable development strategy which involves: (1) maximisation of information and their use; (2) assessment of resources and needs; and (3) application of integrated resource management techniques with special emphasis on environmental protection.

Based on these strategies, CCOP is launching a five-year program for the East Asian coastal zone and offshore areas. The components of the program are: (1) data acquisition, compilation and data base development; (2) coastal and offshore process monitoring and impact analysis; (3) resource and development needs assessment; and (4) promotion of integrated resource management.

This program revolves around three activity sectors, namely: energy, minerals and coastal zone. The energy sector focuses on oil and gas; while the mineral sector focuses on hard minerals for capital formation and sustenance of raw material requirements of the rapidly growing economies of the region. The coastal zone sector is geared towards management of nearshore and coastal areas in the light of natural processes and foreseeable impacts of human intervention.

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DEVELOPMENTS AFFECTING MINERAL RESOURCE UTILISATION IN ASIA AND THE PACIFIC

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

ENVIRONMENTAL IMPACTS OF RESOURCE DEVELOPMENT IN CHINA AND STRATEGIES FOR THEIR MITIGATION

*Kong Deyong and Ma Chi**

The purpose of this paper is to give a brief introduction to the present status of resource development and the environmental protection in China; the interaction between national economic development and environmental protection; the strategies for its mitigation; and the national policy and government efforts to address such issues.

The strategic consideration that resource development should be in coordination with social, economic and ecological development in the country is stressed in particular.

In policy matters, macro regulation for the national economy is emphasised.

Equal attention is paid to both development and conservation, with gradual adjustment of the energy structure and extensive application of modern science and technology to improve the efficiency of utilisation of resources.

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THE OCEANIC ENVIRONMENT OF THE PACIFIC: OVERVIEW OF SIGNIFICANCE OF DYNAMIC SYSTEMS OF THE PACIFIC OCEAN IN CONTROLLING REGIONAL IMPACTS OF CLIMATE CHANGE, SEA LEVEL CHANGE, AND POLLUTION

Michael Hall

Understanding the dynamics and thermodynamics processes of the Pacific Ocean has tremendous implications for climate.

The Pacific Ocean undergoes a strong and significant interannual variability with a time scale of two to three years. The variability appears to be a function of the internal dynamics of the ocean-atmosphere system of the Tropical Pacific region. The variations are communicated by the atmosphere to the extra tropics.

On timescales of a decade and longer, evidence from both deep ocean cores and ocean-atmosphere models suggests that a deep circulation cell in the Pacific is intimately tied to climate variability, including the uptake of CO_2. This cell, driven by the cooling and sinking of water strongly influences the transport of heat to high latitudes and has been tied to rapid changes of the climate system coming out the last ice age.

Michael Hall, NOAA, USA

THE RECORD OF NATURAL CLIMATIC CHANGE IN THE PACIFIC REGION AND ITS SIGNIFICANCE FOR GREENHOUSE SCENARIOS

Jim Bowler

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

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THE RECORD OF NATURAL SEA-LEVEL CHANGE IN THE PACIFIC REGION AND ITS SIGNIFICANCE FOR GREENHOUSE SCENARIOS

Peter S Roy and Bruce G Thom*

Throughout geological and historic time, sea level has both risen and fallen. During the last glacial maximum, c.20,000 years ago, the sea was more than 100m lower than present. since then sea level has risen in response to melting of the vast ice sheets of the northern hemisphere, in some places reaching at or above its present position 5,000 to 6,000 years ago, whilst in others it continues to rise relative to subsiding coastal lands.

The general response of coastal landforms - sand barriers, deltas, coral reefs and atoll islands - is to prograde when sea level is stable or falling and to erode when it rises. Storms and other violent events are usually instrumental in causing incremental changes. In recent geological times, the most dramatic environmental transitions occurred during the Postglacial Marine Transgression when sea levels, rising at c.10mm yr, caused rapid landward shifts in shoreline position. Since then, coastlines have become more stable or have accreted.

One of the predicated consequences of the greenhouse effect is for sea levels to rise at an accelerated rate over the next 100 years of so. Future warming of the atmosphere is expected to lead to thermal expansion of the oceans and further melting of glacial ice masses. In addition, changes in atmospheric circulation patterns could lead to the generation of more frequent and intense storms. Coastal communities that are particularly at risk from future environmental changes include those where: (1) overpopulation has crowded farmers into marginal habitats, such as coastal swamps; (2) communities have become heavily dependent on imported technology and basic commodities/resources at the expense of self reliance, as on atoll islands; and (3) overcrowding in coastal cities has so stretched support facilities that a coincidence of natural disasters could trigger collapse and widespread social disintegration.

Greenhouse-induced sea level trends in the foreseeable future will probably be no more rapid than occurred naturally in the past. Inevitably, they will cause erosion and inundation of coastal lowlands and salinisation of water tables, but these impacts, while tragic for communities such as atoll island dwellers, are amenable to demographic or engineering solutions. More immediate and serious problems are associated with extreme events such as cyclones and floods, not necessarily because of any increase in their frequency or severity, but rather because of changes to coastal communities that make them less able to deal with natural disasters than previously. Disaster relief and rebuilding now require massive injections of scarce resources including foreign aid - a situation that can only worsen as greenhouse effects increase the rate of environmental change. Strategies to mitigate disasters are as important as controlling greenhouse effects.

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CURRENT PROGNOSES OF CLIMATE CHANGE AND ITS EFFECTS IN THE PACIFIC REGION

J W Zillman, R R Brook, W K Downey and M J Manton*

The threat of climate change resulting from enhancement of the atmosphere's natural greenhouse effect by increasing concentrations of carbon dioxide and other products of human activities was identified by the Brundtland Commission as one of the great challenges of sustainable development. Its significance lies both in the direct impacts of future major climate change should it occur and, even more immediately, in the strategies that individual governments and the international community adopt to prevent or reduce it.

The mechanisms responsible for the present patterns of climate on earth are complex and only partially understood. The processes through which increasing emissions of greenhouse gases into the atmosphere might modify the present climate patterns are equally complex and it is not yet possible to predict these changes, especially at the regional and local level, with any real confidence.

A number of climate modelling groups around the world are, however, working very actively on the problem and, through initiatives such as the Intergovernmental Panel on Climate Change (IPCC), several comprehensive and up-to-date assessments of current knowledge are now available. In particular, it is now possible to compare the predictions of geographical patterns of climate change from a range of climate models as a guide to what might be possible on various time-frames for particular emission scenarios. These predictions may be used to devise a series of climate change scenarios as a basis for impact assessment for the Pacific region. This paper surveys a range of recent results drawing particularly on material recently assembled by the Science and Impacts Working Groups of the IPCC.

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OVERVIEW OF NOAA'S PROGRAM FOR RESEARCH, MONITORING, AND COOPERATION IN THE PACIFIC REGION

Ned A Ostenso

As the Earth Systems Agency of the United States, the National Oceanic and Atmospheric Administration has the mission to observe, understand, and develop predictions for the global environment. NOAA has extensive programs in the Pacific Ocean because of its importance in the global commons as a major source of fishery harvest, its valuable non-living resources including minerals, and because it is a breeding place for forcing functions driving the climate of the whole Earth.

NOAA's research in the Pacific is based on an extensive observing network of satellites, buoys, land stations, and ships. This network provides data for the study of the environment and for predictions of natural hazards such as tsunamis and tropical storms, and longer term perturbations including El Nino. Interdisciplinary studies of the physics, chemistry, and biology of the ocean are revolutionising our understanding of variability of Pacific living marine resources, providing better stock predictions for management. Through applied research we are discovering fisheries products which allow utilisation of new stocks such as the pollock. We are also becoming aware of the importance of human-induced perturbations from overfishing to the increase of carbon dioxide in the atmosphere, and how these perturbations affect the common resources of the Pacific.

NOAA is involved in research in the relatively unexplored areas of the earth's environment, such as the Arctic and deep sea hydrothermal vents. Just as our basic research on ocean-atmosphere interactions has paid off in a predictive capability for El Nino, we hope that research in these areas will bring an enhanced understanding of the energy and thermal budgets of the earth. NOAA's research provides a better understanding of the Earth system which allows us to be more efficient in the sustainable use of the marine resources that are the foundation of civilisations in the Pacific basin.

Dr Ned A Ostenso, Office of Oceanic and Atmospheric Research, NOAA

POTENTIAL CONTRIBUTION OF INTERNATIONAL GEOSCIENCE PROGRAMS TOWARD SUSTAINABLE DEVELOPMENT OF RESOURCES

Robin Brett

The International Union of Geological Sciences (IUGS) is the largest organisation in the world concerned with international coordination and cooperation in the geological sciences. Ninety five countries are members of the Union, and individuals who belong to the 30 affiliated organisations number in the tens of thousands. IUGS' Commissions on Fossil Fuels, Environmental Geology, and Geoscience Teaching and Training are all concerned with sustainable resource development and extraction and the education of the public, as are a number of affiliated organisations including the Society of Economic Geologists, the International Association of Hydrogeologists, and the International Association of Engineering Geology.

IUGS through its committees in member countries is in a good position to influence governments and to identify sound policies for sustainable development of mineral, fossil fuel, and water resources. Most countries now lack such policies, and a myriad of agencies are involved with regulating the industries but lack coordination. The world geological community has the obligation not only to do the research and development to find more resources and to lessen environmental compromise but also to educate the general public, administrators, and politicians on sound resource policy. Otherwise policy will be made by those having limited knowledge of resource problems.

Worldwide population growth makes sustainable development increasingly more difficult to achieve.

The world's geological community has a special opportunity to influence leaders this year as the huge United Nations Conference on Environment and Development will be held in Rio de Janeiro in June. There decision-makers, including national leaders, will gather to attempt to arrive at global policies on environmental issues, including sustainable resources.

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STRATEGIC RESEARCH AND EXPLORATION AS THE ESSENTIAL BASIS FOR SUSTAINING RESOURCE SUPPLY

P J Cook and A J Reedman*

Geological Surveys must maintain the capacity to react to short term needs for technical advice on issues such as resources, environmental protection and geological hazards. However, for most of their activities, whether in research, geological mapping or monitoring, Surveys must take a long term strategic approach. As the time scales involved are commonly longer than those of Governments, Surveys must have a dual approach of persuasive arguments in support of their long-term objectives whilst at the same time producing 'deliverables' such as maps, databases and publications on a continuing basis throughout the project.

The time involved between commencing a program of mapping and carrying out a successful exploration program can be many years. The international program of the British Geological Survey, funded by the Overseas Development Administration, aptly illustrates the necessarily long-term nature of resource-oriented programs. For example, the British Geological Survey mapping of the Precambrian shield of Bolivia commenced in 1976 and was completed in 1986 but it was not until 1989 that significant company exploration activity began. Nor is it always possible for us to forecast the use to which our strategic mapping programs will be put. The geological mapping of the volcanoes in Kenya was undertaken by the Kenyan Geological Survey and British universities in the 1950s and 1960s; this provided the basis of an ongoing major program of exploration for geothermal energy in which the British Geological Survey has been involved since 1985, a use never foreseen by the original mappers. The tin granite project in Southeast Asia evolved over the ten years of its existence from a relatively academic exercise into a project which is economically highly relevant both onshore and offshore.

Indeed the use of a long-term program commonly changes during the life of that program. As an example of this, the regional geochemical survey of Britain commenced in 1973 as a program to stimulate mineral exploration. However, in recent years it has increasingly become environmentally oriented and now provides a basis for assessing 'natural contamination' such as high radon or heavy metals and also a baseline against which future man-made contamination whether through mining, urban development or waste disposal can be measured. It is likely that major geochemical projects such as the British Geological Survey Sumatra mapping project could evolve in the same way, with a major impact on land use planning. Therefore paradoxically the strategic approach of Surveys must also be tempered by a degree of pragmatism and opportunism involving 'deliverables' and 'marketing', in order to ensure the maintenance of strategic programs which are so essential to the long term sustainability of the resource base of all countries.

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TRENDS IN MATERIAL USAGE: IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT

Donald G Rogich

This paper analyses current trends in material use in the U.S., as an analog for a developed economy, and considers the implications of this pattern of materials use for sustainable development. This is done by examining the physical flows of the major material inputs to the economy in a disaggregated fashion in relation to a closed system model. Additionally, some changes in the materials use pattern over time are examined. In doing this it is hoped that some light is shed on an otherwise formidable problem. Materials, as defined, includes all material which is used in the economy for other than fuel or food purposes.

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ASIA AND THE PACIFIC: SCENARIOS OF FUTURE ENERGY MIX

Budi Sudarsono

A study on the energy policy implications of increased fossil fuel burning had been conducted for the Asia Pacific (ESCAP) region. The results of the study relating to Asia Pacific developing countries are reviewed and the scenarios regarding the energy mix reassessed, because of prevailing relatively low level of oil price and hence less optimism for sustained energy conservation efforts. It was found that the business as usual scenarios for the year 2000 could be at least 2100 MTOE instead of 1904 MTOE and for 2010 could well be at least 3300 MTOE instead of just under 3000 MTOE, and that, although regional countries would place greater reliance on coal for power generation, the share of oil in Asian countries outside China and India would remain nearly 50% even beyond 2010. The share of nuclear power in electricity generation would remain small unless advanced countries provided an example by switching from fossil to nuclear in response to global warming concerns.

Mr Sudarsono, Secretariat of the Economic and Social Commission for Asia and the Pacific (ESCAP)

RESEARCH AND DEVELOPMENT OPPORTUNITIES FOR MINIMISING THE ENVIRONMENTAL IMPACTS OF ENERGY USE

Alf Ekstrom

Although savings can be made, it seems unlikely that the application of known technologies and energy conservation measures would be sufficient to achieve ecological sustainable development with respect to carbon dioxide and other greenhouse gases produced as a result of the use of fossil energy. It would be necessary for developed countries to very substantially reduce their per capita consumption of fossil energy, and for developing nations to lower their planned industrial development.

New research opportunities in the energy reduction/conversion and the mineral processing areas will be discussed. As industrial R&D is usually undertaken to decrease the cost of a product to gain a competitive advantage resulting in an increased market share and sales, such improvements will only reduce greenhouse emissions if consumption also declines, or at least remains constant.

In the final analysis, any serious attempt to reduce global greenhouse gas emissions raises global, economic, political and social questions. Solutions to these global problems must be an integral part of any attempt to address this problem. Sustainable development cannot be achieved only by devising new R&D programs.

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SUSTAINABILITY AND INTER-GENERATIONAL EQUITY

Brian Fisher and Vivek Tulpule*

In recent years there has been a growing awareness about the potential long term costs of depleting the world's natural resources. Reflecting this concern, questions about our responsibility towards the welfare of future generations are now being raised with greater force. One possible goal is to strive for a situation where the economic growth path for the world ensures that each successive generation is at least as well off as the preceding one. The question then becomes what institutional framework and natural resource policy is consistent with achieving that goal.

The exploitation of each new ore body generates new wealth but at the same time depletes part of the known resource base. Part of this new wealth will be diverted to new investment. Such new investment could be in the form of capital goods, or, it could take the form of increased information about more efficient technical processes and the location of new resource rich areas. Typically, the most efficient investment mix will depend on the relative net productivity of different types of assets. For example, if the increase in net productivity provided by additional mineral resources or improvements in technology is high it might pay to invest more in exploration and research. In this paper the importance of taking the welfare of future generations into account when formulating resource industry and investment policies is emphasised and some important issues related to the design of such policies are discussed.

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ECONOMIC ANALYSIS: COST BENEFITS IN SUSTAINABLE DEVELOPMENT

Rodney Weiher

The notion of 'sustainability', sustainable growth, or sustainable development has infiltrated discussions of long run economic policy, as well as environmental policy. Sustainability is currently much too vague a concept to rely upon as an exact guide to policies aimed at economic growth, much less lending itself to quantification and estimation of costs and benefits to compare alternative policies.

The challenge for economists is to develop a definition of sustainable development that is not only robust - one that will be appropriate over a wide range of circumstances - but that has operational meaning, predictive capability, and properties that can be replicated.

A well developed theory and body of empirical literature on the problem of optimising development of both renewable and non-renewable natural resources over time in market economics is at hand. Major analytical advances have been made in the central economic problems of environmental protection - externalities - and there is a dual connection between environmental and sustainability issues.

This paper discusses sustainable development as essentially an intergenerational equity problem and asks which concepts and tools from the disciplines of traditional natural resource and environmental economics can be borrowed to turn the discussion of cost benefits of sustainable development options away from one that is rather normative and moral in tone to one dominated by positive - that is predictive - economics. Economic concepts such as substitutability, rents, technological change, cost benefit analysis and valuation of non-market environmental goods are discussed in the context of sustainable development.

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CAN WORLD GROWTH IN ENERGY DEMAND BE SATISFIED BY SUSTAINABLE ENERGY SYSTEMS?

Hoesung Lee

- ABSTRACT NOT AVAILABLE AT TIME OF PREPARATION -

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SUSTAINABLE DEVELOPMENT OF ENERGY AND MINERAL RESOURCES IN INDONESIA

John A Katili and Amanda N Katili*

Economic development in Indonesia depends to a certain extent on its position as the largest LNG exporter in the world, the producer of 660,000 barrels of oil per day and the supplier of minerals such as nickel, gold, copper, coal, bauxite, tin and some industrial minerals.

In the last decade the need to balance economic development and environmental quality has created important comprehensive policies on mineral development encompassing exploitation, extraction, transportation and utilisation as well as on environmental protection. Examples of government policies to promote sustainable development comprise energy mix, a degree of control of foreign and national participation in energy and mineral development, environmental impact analysis, resources editing and accounting.

This paper reviews the potential of mineral and energy resources in Indonesia and how these resources are being developed to increase revenue from export earnings by taking into account the concept of sustainable development.

Problems regarding environmental methodologies will also be discussed.

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POLICY AND STRATEGY OPTIONS FOR SUSTAINABLE ENERGY DEVELOPMENT IN ASIA

Karl G Jechoutek

During the 1990s, more than 300,000 MW of new power generating capacity is likely to be added in Asia, most of it in the developing countries of the Region. About 60% of the generating capacity in the year 2000 in Asia will be fired by coal, oil, and natural gas, 10% will come from nuclear power, and the remainder from hydroelectricity. Similarly, the industrial and transport sectors of Asian countries will increase their consumption of fossil fuels at least in line with economic growth, again driven by developing countries.

The patterns of energy development imply a large increase in coal use, and a strong growth of electricity use from all sources. The sustainability issues arising from the projections are (i) an increase in emissions from the burning of fossil fuels, (ii) the difficulty of demand-side management in economies growing from a low base, (iii) the declining local acceptability of large hydroelectric and nuclear facilities, (iv) the transport and air pollution bottlenecks appearing in large Asian cities, (v) the need for the application of suitable technology and policies to mitigate adverse environmental effects, and (vi) the increasing financial difficulties of many public-sector energy supply institutions.

Strategies available for the achievement of sustainability include (i) energy pricing policies that allow efficient market-oriented prices, (ii) institutional and regulatory reform in the energy sector to allow private involvement for financial sustainability and operating efficiency, (iii) formulation and application of appropriate standards of air and water quality, (iv) mitigation of the anticipated emissions increase through fuel switching, clean coal technologies, and higher energy supply efficiency, (v) creation of incentives to encourage energy efficiency and conservation where economically justified, (vi) selection of hydroelectric sites with minimal resettlement and habitat destruction effects, and (vii) implementation of integrated urban strategies to improve energy-related air pollution.

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