Ayubowan from Sri Lanka! Ohayo! Greetings!

私は古くからの友人であり、日本の崇拝者です
Watashi wa furuku kara no yūjindeari, Nihon no sūhai-shadesu
I am an old friend and admirer of Japan. Domo Arigatogozaimasu -Thank you for inviting me, especially Prof. Arimura. It is a privilege to address to brilliant young minds at the world-renowned Waseda University. The post-Covid world seeks to achieve sustainable development & SDG in the 21st century – including economic prosperity, social progress and environmental protection. The Balanced Inclusive Green Growth (BIGG) path shows the way forward. Let us ACT NOW, TOGETHER

Sustainable development & Economic Policy - balanced inclusive green growth (BIGG)

Professor Mohan Munasinghe
www.mohanmunasinghe.com https://www.researchgate.net/profile/Mohan-Munasinghe/research
Chairman, Munasinghe Institute for Development (MIND) and MIND Group, Colombo
2021 Blue Planet prize Laureate
Vice Chair, IPCC-AR4 who shared the 2007 Nobel Prize for Peace
Honorary Senior Advisor to the Govt. of Sri Lanka
Distinguished Guest Professor, Peking University, China

Invited Lecture delivered at the Research Institute for Environmental Economics & Management (RIEEM), Waseda University, 4 October 2022.

This short lecture will cover sustainable development, sustainomics, the balanced inclusive green growth (BIGG) path.

It is brief summary of the first two lectures in the 15 or 30 hour compressed or full graduate course on Sustainomics & Sustainable Development, offered by MIND. The course text is:
Mohan Munasinghe, "*Sustainability in the 21st Century: applying Sustainomics to implement the SDG*" Cambridge University Press, 2019.

Sustainomics-BIGG Framework, Concepts and Principles
- Global issues causing unsustainability
- Making development more sustainable (MDMS) - Climbing the mountain
- Sustainable development triangle - Harmonization and integration
- Transcending boundaries – Innovation and fresh ideas
- Full cycle application of integrative tools – implementation: from data gathering to practical policy

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WHICH ? key global issues block Sustainable Development

- Poverty, inequality & other bad socioeconomic trends
- Resource shortages (energy, water, food, etc.)
- Financial sector collapse and wealth concentration
- Unexpected shocks including pandemics, human-made & environmental disasters
- Conflict, insecurity & shift towards more multipolar world
- Weak leadership & poor decisionmaking
- UNETHICAL, unsustainable values (greed, corruption, violence, etc.)
- Unmanaged trade and special interests
- CLIMATE CHANGE is ultimate threat multiplier, worsening all other issues

Multiple threats are inter-related and synergistic BUT stakeholder interests are divergent. Responses uncoordinated. Weak leadership. People must push leaders to take more decisive action, especially at mid-level - city mayors & company CEOs, & community leaders

Robust, integrated, & comprehensive strategy needed

Poverty & Hunger : 2021

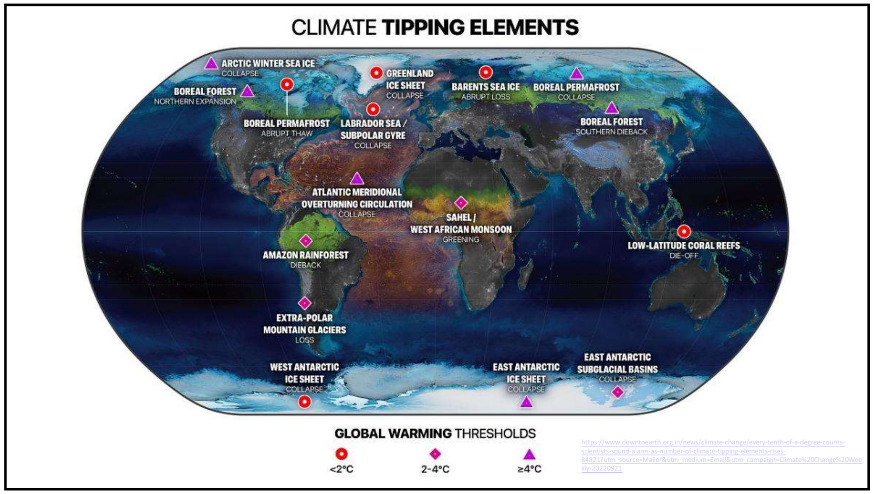
Almost 900 million hungry people: 1 in every 9, mainly in Africa & Asia.
China is the exception: raising 900 millions out of poverty from 1980's

9 KEY GLOBAL RESOURCE SYSTEMS:
In 4 systems, sustainability limits already exceeded by humans

1. Biosphere integrity: species extinction, biodiversity loss
2. Biogeochemical flows: phosphorus, nitrogen cycles
3. Land-system change: e.g. deforestation, desertification
4. Climate change
5. Stratospheric ozone depletion
6. Ocean acidification
7. Freshwater use
8. Atmospheric aerosol load: microscopic particles
9. New pollutants: organic & radio-active materials, nano-materials, micro-plastics

Limit exceeded – dangerous
Within limit - safe

Biosphere Integrity (1) & Climate (4) are core limits. Exceeding them will shift the Earth System into a unpredictable, dangerous state Stockholm Resilience Center 2015



IPCC – Summary of Some Key Findings

NOW: Global warming is proven - human emissions of GHG have disturbed the climate system

- With very high confidence, total radiative forcing of the climate now is unprecedented in several thousand years, due to rising concentrations of GHG (CO2, CH4 & N2O).
- Humans activities since 18th century is main cause of net warming of Earth's climate, over last 50 years. In past 150 years mean temp. rise is >1C and sea level rise is around 20cm.

FUTURE: continuing climate change will cause great & irreversible harm – poor will suffer most

- Proj. temp rise by 2100 is >3C & sea level rise >50cm. Temp. rise >1.5 exceeds safe adaptive capacity of natural & human systems: emissions to peak by 2025, half 2030, net zero 2050.
- Poor countries & poor groups are most vulnerable to warming, sea level rise, precipitation changes & extreme events. Socio-economic sectors, ecological systems, & health will suffer, UNJUST/UNFAIR
- Adaptation and mitigation measures are available, but must be urgently implemented

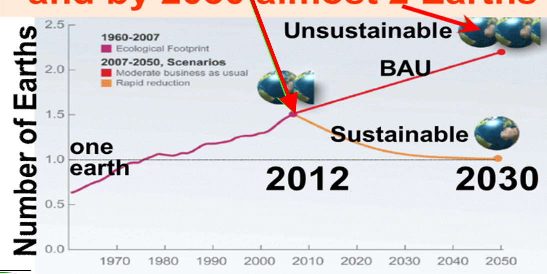
Sustainable development is best way to limit climate change

We can make development more sustainable (MDMS) by integrating climate change adaptation and mitigation policies into sustainable development (SD) strategy and implementing the SDG

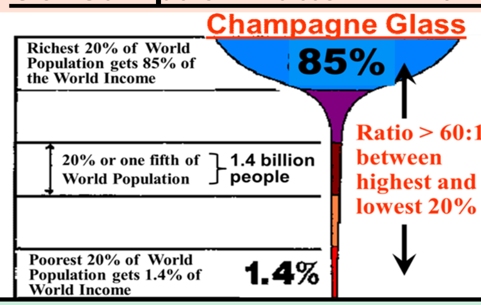
HOW? Resource limits, inequality block sustainability

a) Ecological footprint of humans

We needed 1.5 Earths in 2012 and by 2030 almost 2 Earths



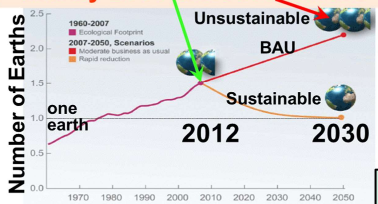
b) Unethical, Unfair, World Consumption Pattern ~ 2010



- World military expenditures ~$2 trillion >>>> Aid to help poor ~$160 billion
- 1% richest own more wealth than remaining 99% of world population
- 1% richest emit 175 times more GHG per capita, than poorest 10%
- 2000 billionaires gained 20% ($11.4 trillion) after Covid-19 in 2020. Billions hungry

a) Ecol. Footprint of Humanity

we needed 1.5 earths in 2012; and by 2030 almost 2 Earths



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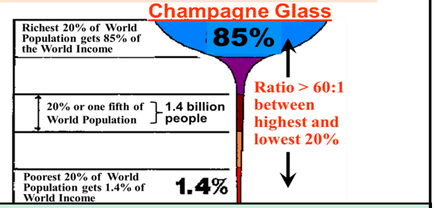

- -1% richest own more wealth than remaining 99% of world population
- -1% richest emit 175 times more GHG per capita, than poorest 10%
- -2200 billionaires gained 20% ($11.4 trillion) after Covid-19 in 2020. Billions starved

When the rich already use more than one planet, where are the resources to help the poor, esp. after CC. So we have 75 yrs of unmet goals & broken promises 1947-2022

- 1947 - UN Universal Declaration of Human Rights (UDHR) (eg.Art.25.1)
- 1992 - UN Rio Earth Summit: Agenda 21, UNFCCC
- 2000 - UN Millennium Development Goals (MDG)
- 2015 - UN Agenda 2030, Sust. Dev. Goals (SDG), Paris CC Accord

UDHR (1947) included all the basic elements of modern SDG (2015)!

Global Sustainable Development requires good alignment of all productive assets

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Head in the clouds?

Financial Markets	Econ. Growth
Productive Economic Assets	
Bio-geo-physical Resource Base	

Feet firmly on the ground?

Sound financial markets and economic growth should be based on the true value of the productive economic asset base. In turn the value and use of economic assets should closely reflect the state of natural (bio-geo-physical) resources

Poor leadership focused on financial data & disconnected from assets in the real world

Financial Markets

Asset Bubbles Fin. crises

Productive Economic Assets

Triple crisis bubbles driven by greed – enjoy now & pay later: 1

A few get rich quickly, many innocents pay a heavy price afterwards

Poor leadership focused on financial data & disconnected from assets in the real world

Financial Markets | Econ. Growth

Asset Bubbles Fin. crises Poverty-Inequality

Productive Economic Assets

Triple crisis bubbles driven by greed – enjoy now & pay later: 2

A few get rich quickly, many innocents pay a heavy price afterwards

Poor leadership focused on financial data & disconnected from assets in the real world

Financial Markets | Econ. Growth

Asset Bubbles — Fin. crises — Poverty-Inequality

Productive Economic Assets

Climate change — Environmental Externalities — Pandemics

Bio-geo-physical Resource Base

Triple crisis bubbles driven by greed – enjoy now & pay later: 3

A few get rich quickly, many innocents pay a heavy price afterwards

Poor leadership focused on financial data & disconnected from assets in the real world

Human Values/Choices

Govt. Bailouts/yr ~2 trillion (10^{12}) — Aid/yr ~$160 billion (10^{9})

Financial Markets | Econ. Growth

Asset Bubbles — Fin. crises — Poverty-Inequality

Productive Economic Assets

Climate change — Few billion $ — Environmental Externalities — Pandemics

Bio-geo-physical Resource Base

World Military Expenditures: ~ $2 trillion in 2021 during Covid

Billionaires gained 20% ($11.4 trillion) in 2020. Billions hungry

Triple crisis bubbles driven by greed – enjoy now & pay later: 4

A few get rich quickly, many innocents pay a heavy price afterwards

WHAT? are key concepts to move forward towards a 21st Century Earth Eco-Civilization for a better future

Addressing Complex, Multiple, Inter-linked Sustainable Development issues with the Integrated Transdisciplinary

SUSTAINOMICS Framework

To find the

Balanced Inclusive Green Growth (BIGG) path

Sustainomics was presented at 1992 Earth Summit in Rio de Janeiro. In past 30 years it has been applied worldwide & taught widely.

Sustainomics and BIGG will facilitate implementation of the UN 2030 Agenda and 17SDG

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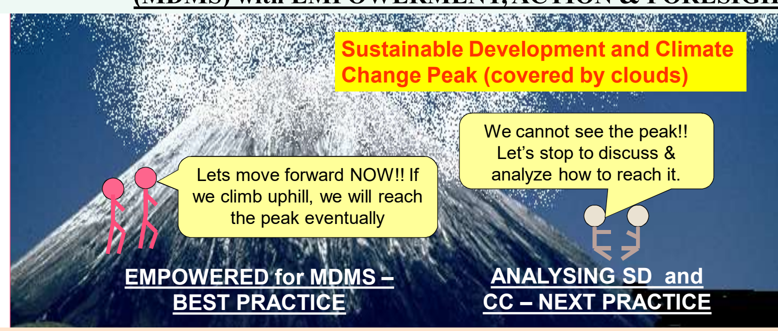
Core Concept 1: Climb the mountain - Making Development More Sustainable (MDMS) with EMPOWERMENT, ACTION & FORESIGHT

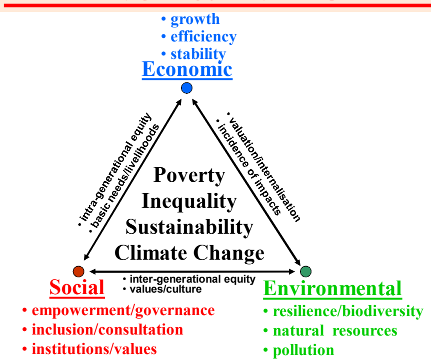


Making development more sustainable (MDMS) is a very practical step-by-step strategy, because unsustainable activities are easy to identify, like energy & water waste and deforestation. MDMS tells us to eliminate them NOW, at the personal, city, company, national & global levels!

Business: Corp. Social Responsibility (CSR+), ESG, Sustainability Accounting, Triple Bottom Line, etc.

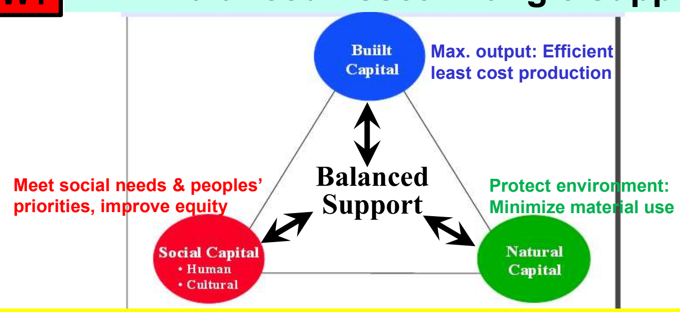
- Corporate Social Responsibility (CSR) - considering wider social interests by being accountable for operational impacts on customers, suppliers, employees, shareholders, communities and environment.
- Sustainability Accounting & Reporting includes generation, analysis, use and reporting of economic, environmental and social information (monetised where possible) to improve corporate management and performance, using:
- Triple Bottom Line, which recognizes that the environmental & social consequences of corporate actions are as important as monetary gains,- seeking to measure & report on outcomes. GRI has launched new sustainab. reporting standard, replacing G4 guideline.
- Shared Value - making profits, with benefits to environment & to society through shared sources of value common to firm & society.
- Impact Investment – investing to benefit society & environment
- Integrated External Engagement goes beyond CSR with concern for a wide range of stakeholders deeply into business decision making at every level.

Core Concept 2: Harmonise the SD Triangle for BALANCE & INTEGRATION



Sustainable Development Triangle – harmonising key elements and interconnections (corners, sides and centre) Source: Munasinghe [1992], Rio Earth Summit

HOW? Will Balanced Asset Triangle support SD



Balancing economic, natural and social capital enhances SD: Key role of Social Capital: ignored, undervalued (eg. digital tech.+social media impact)

- At individual level, it is built on personal networks that help us greatly in our private and professional lives.
- At community and national levels, it: is the invisible glue that binds society together – involving values- ethics, culture, behaviour, and social linkages.

Avoid Investment Imbalance: Materialistic growth, private profit-driven, extreme market forces, corruption, oligopolistsic capitalism, and inequality destroys vital Social and Natural Capital

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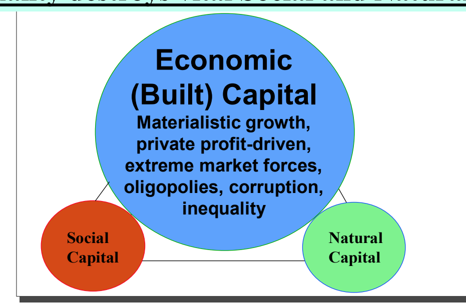


Source: Munasinghe (1992), Rio Earth Summit

People can help reduce harm to Natural & Social Capital, which is mainly undervalued, invisible (facilitated by social media etc.)

- Individuals: personal networks that help us greatly in our private & professional lives.
- Communities: invisible glue binding society (values- ethics, culture, behaviour, social links)

Key Role of Social Capital: Civil Society & Values

Examples of Civil Society Response: 2004 Tsunami - Sri Lanka versus 2005 Hurricane Katrina - New Orleans, USA

Event	Deaths	GNP/capita
2004 Tsunami – Sri Lanka	~35,000 (1 in every 570 people)	~ USD 1,000
2005 Hurricane Katrina - USA	~1850 (1 in every 200,000 people)	~ USD 35,000

Core Concept 3: Transcend Boundaries of SD with INNOVATION & FRESH IDEAS

- Values – replace unsustainable, unethical values
- Disciplinary – complex issues need all disciplines
- Space – spans local to global scales
- Time – spans days to centuries
- Stakeholder – need to include all stakeholders
- Operational – full cycle from data to application

Transcend Unsustainable Values - Build essential ethical and moral values especially among YOUTH

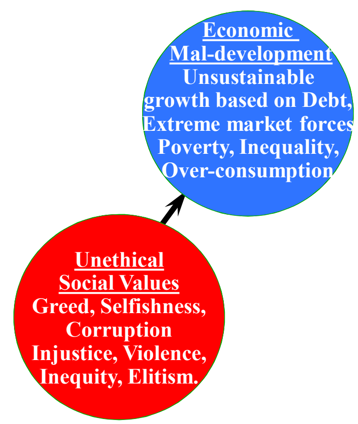
- Greed, selfishness and violence are unsustainable
- Selflessness, altruism, enlightened self-interest, and respect for other humans and nature will make development more sustainable

Examples: Ethical Dimensions of Climate Change 2006
Interfaith Declaration on Climate Change 2009

We must replace Unethical values that drive Unsustainable Development: 1

Source: Adapted from Munasinghe (1992), Rio Earth Summit

We must replace Unethical values that drive Unsustainable Development: 2



Source: Adapted from Munasinghe (1992), Rio Earth Summit

We must replace Unethical values that drive Unsustainable Development: 3

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Source: Adapted from Munasinghe (1992), Rio Earth Summit

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Transcend disciplines to address SD issues

Diverse SD Issues

- social justice, equity, values & culture
- institutions and governance
- markets and prices
- technologies and management
- biological and physical resource base

SUSTAINOMICS
Transdisciplinary Analysis

Disciplines

Philosophy
Sociology
Ethics
Law
Politics
ECONOMICS
Finance
Management
Engineering
Ecology
Natural Sciences

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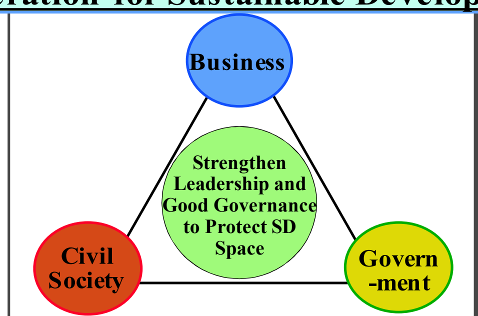
Source: Munasinghe (2002), Int. J. of Sust. Dev.

Transcend Stakeholder Boundaries to build Cooperation for Sustainable Development



Source: Munasinghe (1992), Rio Earth Summit

Show leadership & build interactions among govt., civil soc. & business to improve local, national & global governance

Core Concept 4: Full cycle application of integrative tools, from data gathering to practical policy IMPLEMENTATION

Many practical analytical tools and policy options are available to build integrated SD strategy (global to local levels)

Many case studies and best practice examples are available involving the practical applications of sustainomics tools

Full Cycle - Operations

ACTION		ACTOR
Observations and Data	Seamless Cycle	Observers
Concepts and Ideas		Thinkers & Philosophers
Models & Analyses		Scientists & Analysts
Interpretation of Results		Translators & Communicators
Plans & Policies		Decision Makers
Practical Applications		Implementing Agents
Impacts (SD triangle)		Assessment Experts

Each stage of activity has a tendency to become compartmentalised

Source: Munasinghe (2002), Int. J. of Sust. Dev.

Choosing Appropriate SD Indicators

- Social
- Environmental
- Economic
- Institutional

many indicators are available; thus correct choice is critical for specific task at hand

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Sustainomics-BIGG Framework, Concepts and Principles

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- Full cycle application of integrative tools – implementation: from data gathering to practical policy
- Optimisation and durability – harmonizing the SD triangle
- Balanced inclusive green growth (BIGG)

Problem: Integrating across 3 SD dimensions - Optimality & Durability Approaches

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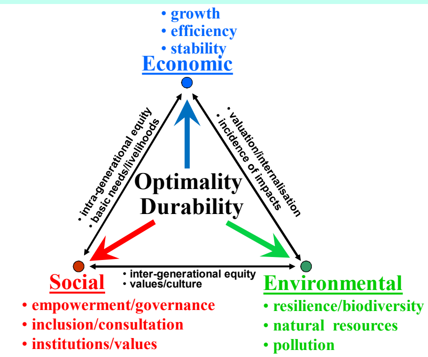

Economic approach focuses on optimality - maximum growth
Environmental & social approaches use durability – overall system health

Problem: Reconciling Diverse Definitions of Sustainability

Economic view focuses on optimality - maximum growth
Environmental & social views use durability – system health

Economic: Maximum flow of income that could be sustained indefinitely, without reducing stocks of productive assets. Economic efficiency ensures both efficient resource allocation in production and efficient consumption that maximises utility.

Ecological: Preserving the viability and normal functioning of natural systems, including system health ability to adapt to shocks across a range of spatial and temporal scales. Defined by a comprehensive, multiscale, hierarchical, dynamic measure describing system resilience, vigour and organization.

Social: Maintaining the resilience of social systems and limiting their vulnerability to sudden shocks. Involves building social capital to strengthen cohesion, protecting cultural diversity and values, and improving inclusion and participation - especially of poor and disadvantaged groups.

Optimal Development Paths (Economic)

Maximize welfare (or utility), subject to non-decreasing stock of productive assets (or welfare itself). A simple example of maximization of the flow of aggregate welfare (W), cumulatively discounted over infinite time (t), is:

$$\text{Max} \int_0^\infty W(C, Z).e^{-rt}\, dt.$$

Here, W is a function of C (the consumption rate), and Z (a set of other relevant variables), while r is the discount rate.

C depends on the production rate of the economy, which in turn depends on stocks of various assets. Side constraints may be imposed to satisfy sustainability needs – e.g., non-decreasing consumption or stocks of productive assets (including natural resources).

Integration via Economic Optimisation subject to Sustainability Constraint

Maximum flow of income (or consumption) that could be sustained indefinitely, without reducing stocks of productive assets. Economic efficiency ensures both efficient resource allocation in production and efficient consumption that maximises utility.

Define: $A = E + N + S$

Total assets = Economic capital + Natural capital + Social capital

Weak Sustainability Constraint: $dA/dt > 0$

Strong Sustainability Constraint: $dE/dt > 0$; $dN/dt > 0$; $dS/dt > 0$

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Durable Development Paths (Ecological)

Focus mainly on sustaining the quality of life – e.g., by satisfying environmental, social and economic sustainability requirements. They permit growth, but are not necessarily economically optimal. There is more willingness to trade off some economic optimality for the sake of greater safety, in order to stay within critical economic, environmental and social limits.

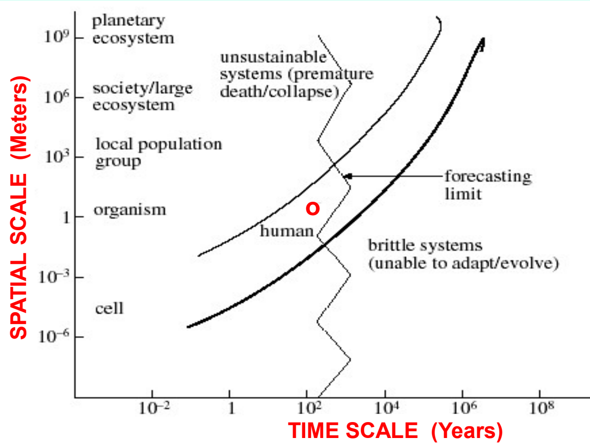
A simple durability index (D) for an organism or system is its expected lifespan (in a healthy state), as a fraction of the normal lifespan:

$D = D(R,V,O,S)$;

where durability (D) is a function of resilience (R), vigour (V), organization (O), and the state of the external environment (S) – especially in relation to damaging shocks.

Durable paths seek to increase diversity and adaptive capacity, while reducing risk.

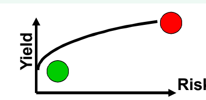
Space-Time Norms for Durable Ecological & Social Systems



Source: Munasinghe (1994)

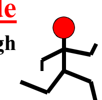
Optimality and Durability: Simple Examples

Two modes are complementary – tradeoffs possible on Balanced Inclusive Green Growth path, depending on the situation



Optimal Mode

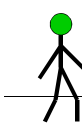
Olympic 100m sprinter – willing to take high risk and make extreme effort to minimise running time (single indicator) for one special event



Maximum yield
Highest risk
Examples:
Iskill (Voldemart) 2B+ loss at JP Morgan.
Leeson – Bearings Bank

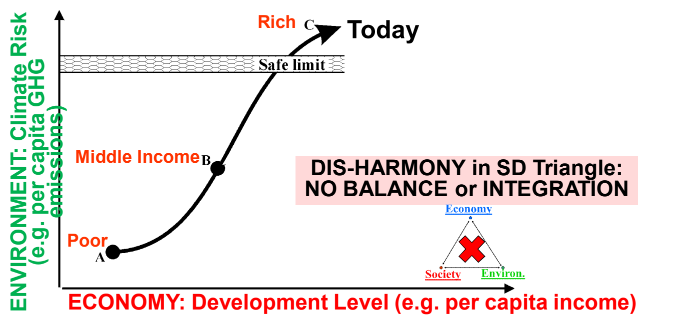
Durable Mode

Middle aged walker – undertakes regular, low risk exercise for overall health (multiple indicators), over many decades



Moderate yield
Lower risk

WHAT? **Urgent changes are needed restore present unsustainable global systems that may collapse** BIGG Path



Source: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*, 15:121-4.

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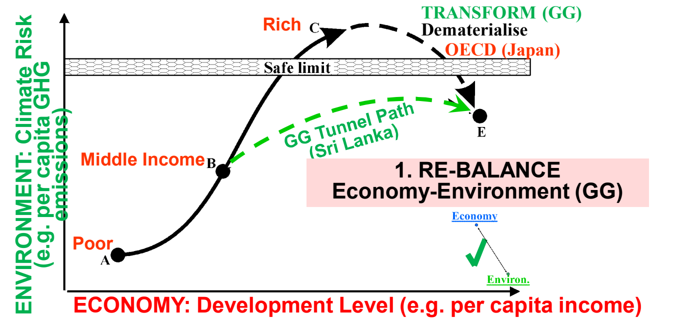
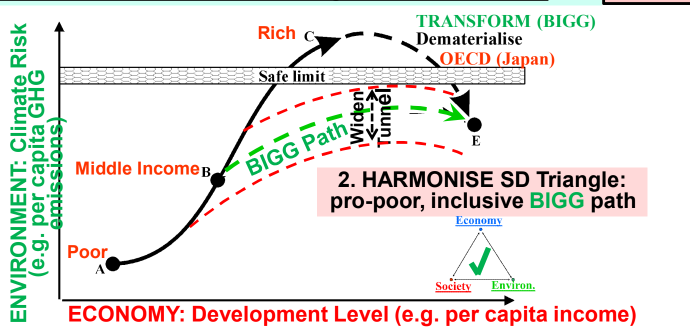
Green Growth (GG) balances Environmental Harm & Economic Development for partial Sustainability BIGG Path



Source: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*,

Innovation will facilitate Green Growth tunnel & transformation path - applies to all kinds of resources like water, food & energy.

Balanced Inclusive Green Growth harmonizes economic, environmental & social goals for full SD BIGG Path



Source: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*,

Framework for Balanced Inclusive Green Growth (BIGG) will help to implement SDG post-Covid - works for food, water & energy, etc.

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Transdisciplinary integrative analytical tools & economic policy applications

- Sustainable Development Goals (SDG, targets & indicators)
- Sustainable Pricing Policy
- Supply/Value Chain, Life Cycle Analysis: Sustainable Consumption & Production

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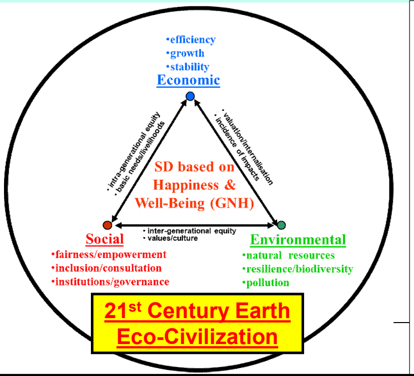
FRAMEWORK: 21st Century Earth Eco-Civilization with ethical values focusing on Happiness & Well-Being (GNH) - not just material consumption (GNP) eg., Bhutan



Global Vision 2030

Social: meet basic needs of all human beings especially the poor & vulnerable, ensuring peace, harmony, social justice & security.

Environmental: respect nature & reduce humanity's global ecological footprint to less than one planet earth.

Economic: build a sustainable economy that is prosperous and resource-efficient, but respects critical environmental and social sustainability constraints.

UN 2030 Agenda and 17 Sustainable Development Goals Universally Accepted by All Countries in 2015

Universal-Comprehensive-Integrated-Leaving no one behind

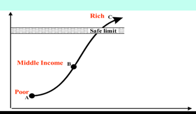
All Countries endorsed SDG & 2030 Agenda at 2015 UN summit

SDG is framework to monitor progress -- must be prioritised to meet each country's needs

BIGG applications: 7-Clean Energy // 12-Sust. Cons. & Prod.

BIGG path - sustainable energy pricing policy: manage energy use to meet economic goal

Economic efficiency – max. growth: high price reflects long-run incremental cost of scarce energy e.g., rising energy supply costs etc.



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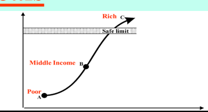
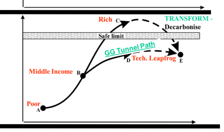
BIGG path - sustainable energy pricing policy: manage energy use to meet economic & environmental goals

Economic efficiency – max. growth: high price reflects long-run incremental cost of scarce energy e.g., rising energy supply costs etc.



Environmental protection – green energy: higher price includes (internalises) external environ. harm e.g., add air pollution taxes, carbon taxes, etc.



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BIGG path - sustainable energy pricing policy: manage energy use to meet economic, environmental & social goals

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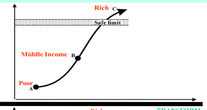
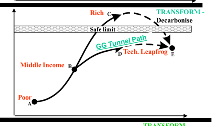
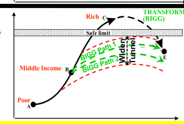
Economic efficiency – max. growth: high price reflects long-run incremental cost of scarce energy
e.g., rising energy supply costs etc.



Environmental protection – green energy: higher price includes (internalises) external environ. harm
e.g., add air pollution taxes, carbon taxes, etc.



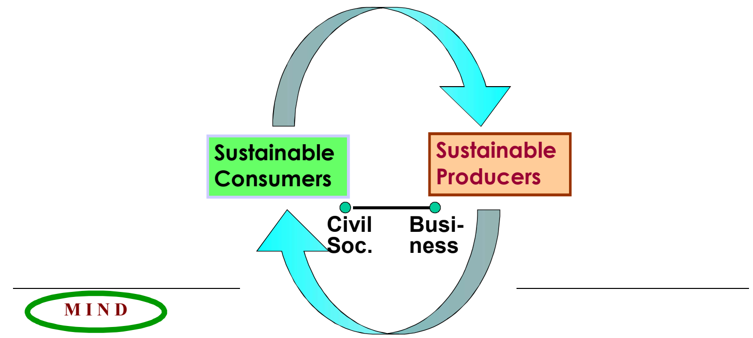
Social equity – affordable energy: subsidised prices to meet the basic energy needs of the poor
e.g., low lifeline prices for minimum use by poor



Raising energy prices will meet economic and environmental goals, but NOT social equity goal, because high price will deprive poor of basic energy needs. Block pricing structures that include a subsidized minimum use block for poor homes, provide a practical compromise among conflicting goals.

BIGG: Linking Sustainable Cons. & Producers (SDG12) to create Sustainable Markets and Culture

Promoting sustainability leadership by small groups of pioneering consumers and producers



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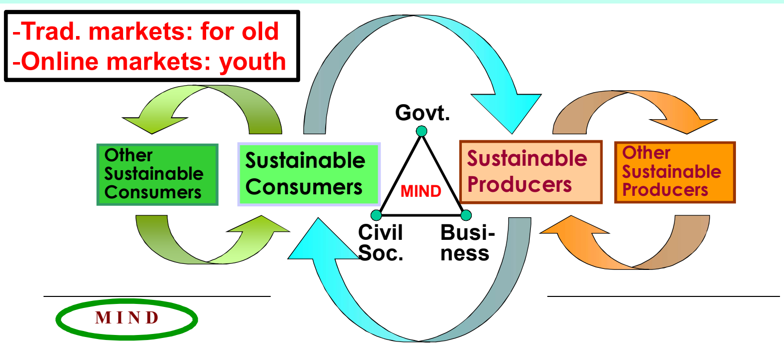
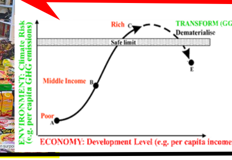


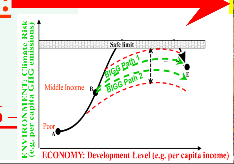
BIGG: Sustainable Consumption Change behaviour for sustainable lifestyles

1/3rd World food production lost or wasted in homes: USA - 50% & Europe - 30%. Yet over 800 million people are starving.



Food for a Week: Affluent Family
Unsustainable – must transform/dematerialise towards sustainablity: SDG12 – sust. cons. & prod.

Food for a Week: Poor Family
Unsustainable, Unethical: tunnel to prosperity: SDG 1&6 – poverty, inequality



BIGG : Changing Values and promoting sustainability by Appealing to the Heart – Focus on Youth

Prosperity
People
Planet
SustainoMusica
Music for Sustainability

Launched in 2012 at Rio+20 World Summit

https://www.youtube.com/watch?v=mHhmBneWjeQ

SustainoMusica is an **international consortium of musicians and music lovers** who believe that music and song constitute an universal language that can be used effectively to communicate the message of sustainability to everyone on the planet. We are confident that our **new music of sustainability will appeal to the heart, especially to empower and motivate young people.** We feel that this parallel approach will have greater appeal than the messages of science and policy, which are aimed mainly at the mind. **Music and song will help to make sustainability a practical and living reality, by harmonizing people, planet and prosperity, to achieve peace and happiness.**

BIGG: Sustainable Production - Ideas from Workshops on Business Sustainability for CEOs & Sen. Managers of top Multinationals

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1. Sustainability & triple bottom line is wave of future.
2. Resource use efficiency is win-win starting point.
3. Ethical values are key to long term sustainability.

Recent Examples:

- BASF, Germany (Chemicals)
- TESCO, UK (Supermarkets)
- Unilever, Coca Cola, Reckit-Benkeiser, Johnson SC, Danone, Nestle (Retail)
- OPEC (Energy, Oil and Gas)
- Petrobras, Brazil (Energy, Oil and Gas)
- Sime Darby, Malaysia (Plantations Conglomerate)
- Novozymes, Denmark (Biotechnology)
- Vale, Brazil (Mining)
- Siemens, Shanghai Electric Group (Heavy Industry)
- Taylor, Portugal (Wine Producer)

BIGG: Sustainable Production - life cycle analysis of CO2 emission hot spots along the supply/value chain

	Raw material production	Manufacture & processing	Logistics distribution transport	Retail	Consu-mer use	Recycling & disposal
Tea (Sri Lanka)	7%	2%	4%	47%	28%	12%
Orange Juice (Brazil-UK, freshly squeezed)	28%	19%	47%	5%	1%	0%

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Source: Adapted from Munasinghe et al. (2009)

BIGG: Sustainable Production - life cycle analysis of CO2 emission hot spots along the supply/value chain

	Raw material production	Manufacture & processing	Logistics distribution transport	Retail	Consu-mer use	Recycling & disposal
Tea (Sri Lanka)	7%	2%	4%	47%	28%	12%
Orange Juice (Brazil-UK, freshly squeezed)	28%	19%	47%	5%	1%	0%
Milk (UK, National Tesco)	76%	5%	4%	10%	3%	1%
Garments (Sri Lanka)	65%	10%	2%	6%	12%	5%

Same analysis applies to resources: energy, water, land, etc.

Sustainomics-BIGG Framework, Concepts and Principles

- Global issues causing unsustainability
- Making development more sustainable (MDMS) - Climbing the mountain
- Sustainable development triangle - Harmonization and integration
- Transcending boundaries – Innovation and fresh ideas
- Full cycle application of integrative tools – Implementation: from data gathering to practical policy
- Optimisation and durability – harmonizing the SD triangle
- Balanced inclusive green growth (BIGG)

Transdisciplinary integrative analytical tools & economic policy applications

- Sustainable Development Goals (SDG, targets & indicators)
- Sustainable Pricing Policy
- Supply/Value Chain, Life Cycle Analysis: Sustainable Consumption & Production
- SD analysis (macro level)
- Action impact matrix (AIM)
- Green accounting (SEEA-SNA)
- Integrated models (IAM, CGE, etc.)
- SD analysis (micro level)
- Cost-benefit analysis (CBA) and economic valuation, multi-criteria analysis (MCA)
- Issues-policy transformation map (IPTM)

BIGG: SD Analysis at the Macroeconomic/Sectoral Level (general equilibrium analysis)

1. Macroeconomic/Sectoral Modeling
2. Environmental and Macroeconomic Analysis
3. Poverty/Income Distributional Analysis

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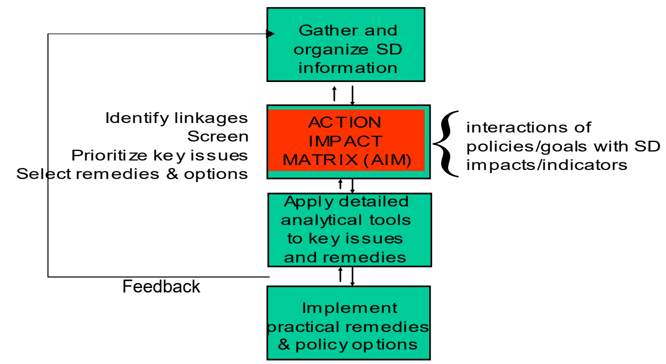
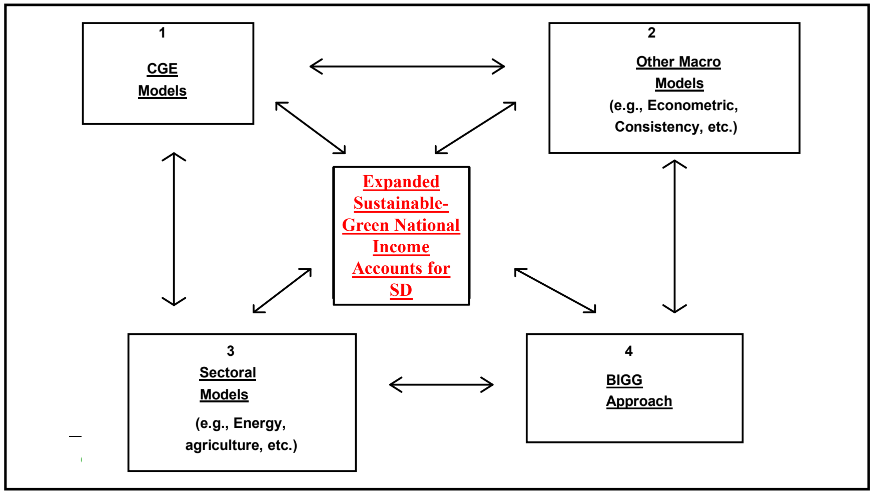
Some Key SD Modelling Objectives & Approaches

- **Utilitarian:** Optimize discounted welfare or consumption/income over time
- **Equity (intra-generational):** Ensure income distribution at any given time will not become less equitable over time
- **Equity (inter-generational):** Ensure per capita income will not fall over time
- **Strong sustainability:** Ensure aggregate stock of productive assets (assuming full substitutability), will not decrease over time
- **Weak sustainability:** Ensure stocks of critical types of (non-substitutable) productive assets will not decrease over time
- **Durability:** Maintain resilience and decrease vulnerability of socioeconomic and ecological systems to withstand shocks within desirable limits
- **Steady state:** Maintain consumption/income & resource use at constant levels
- **Combinations of above:** e.g., Utilitarian with strong sustainability constraint

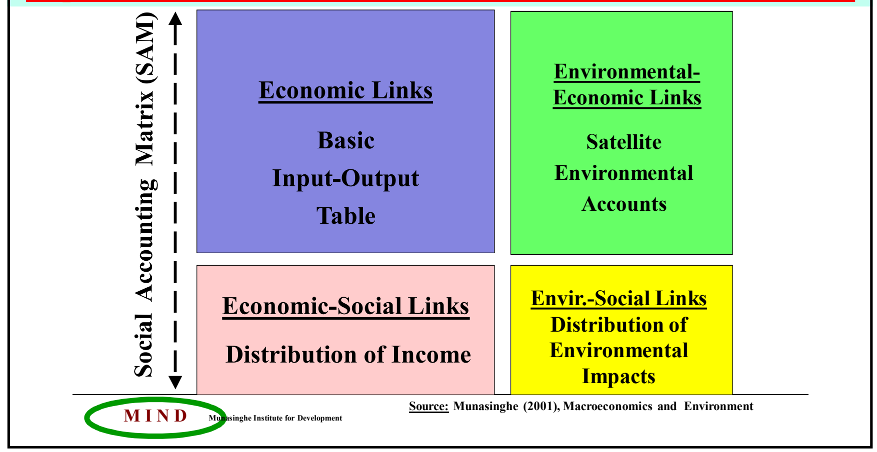
Action Impact Matrix (AIM)

key link from data gathering to practical policy application





Expanded Sustainable-Green National Income Accounts for SD



Environmental-Macroeconomics: more complex concepts

- Timing and sequencing of economic policies to make development more sustainable
- Extending conventional IS-LM Analysis to include the environment

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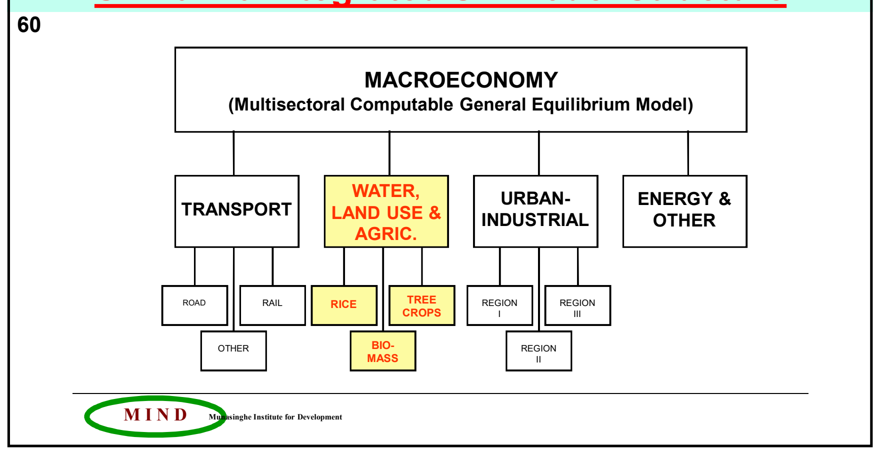
Sri Lanka Integrated SD Model Structure



BIGG Application

SRI LANKA PRESIDENTIAL EXPERT COMMITTEE (2019)

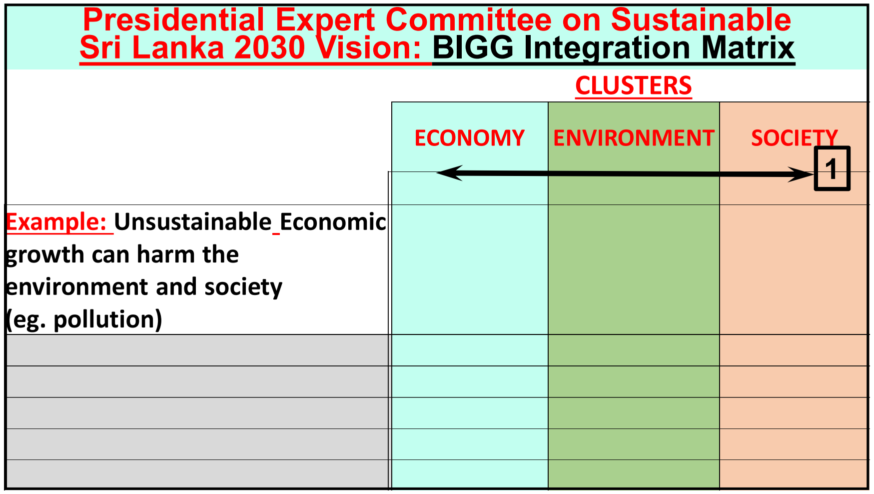
Chairman: Mohan Munasinghe

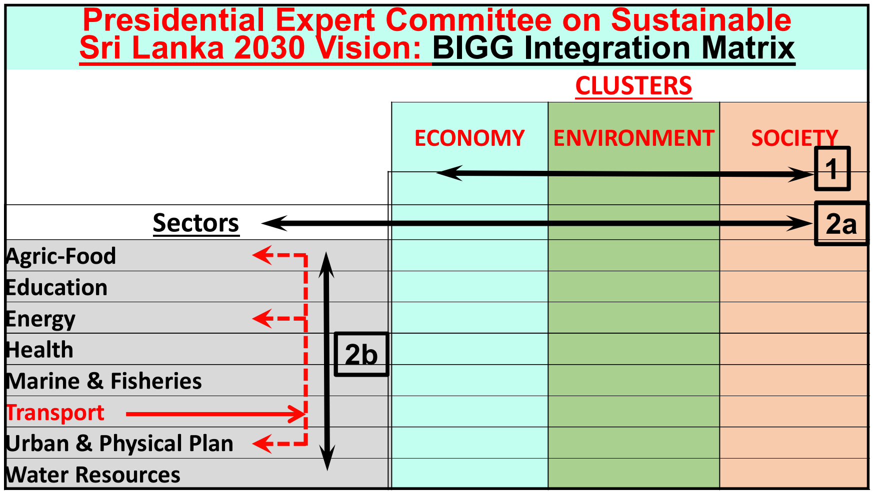
Report: "Sustainable Sri Lanka 2030 Vision & Strategic Path"

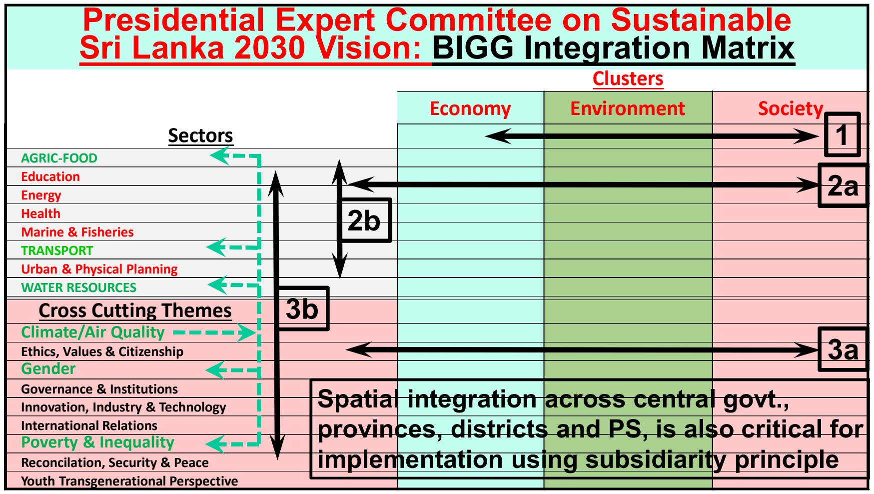
"By 2030 Sri Lanka hopes to become a sustainable, upper middle income, Indian Ocean hub with

1. **an economy that is prosperous, competitive and advanced;**
2. **environment that is green and flourishing; and**
3. **society that is inclusive, harmonious, peaceful & just.**

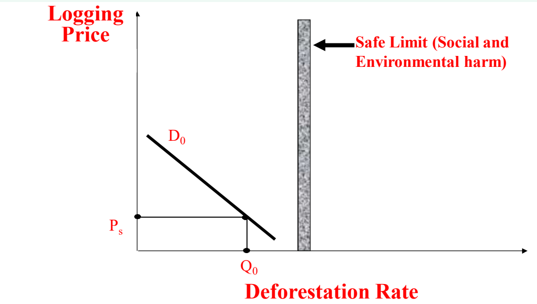
We seek Balanced Inclusive Green Growth (BIGG).





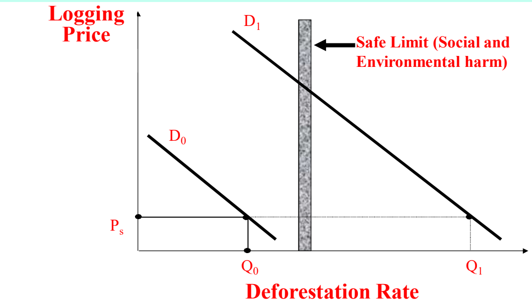


Correcting price distortions reduces environmental harm from deforestation: 1



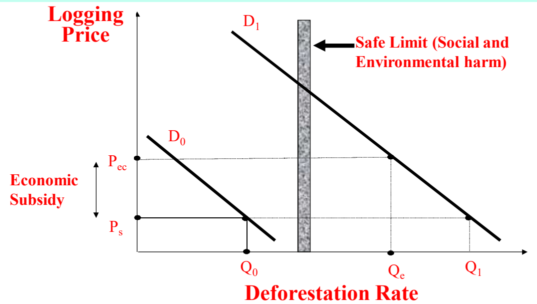
1. Low growth economy has demand D_0 . Deforestation rate Q_0 is below the safe limit even at subsidised price $P_{s.}$

Correcting price distortions reduces environmental harm from deforestation: 2



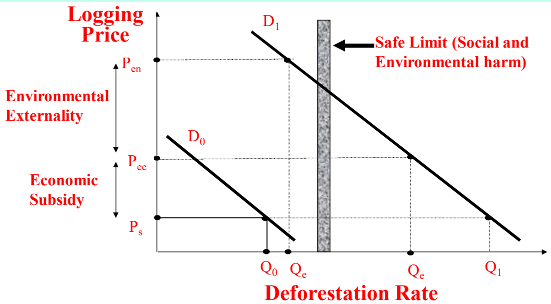
1. Low growth economy has demand D_0 . Deforestation rate Q_0 is below the safe limit even at subsidised price $P_{s.}$
2. Macroeconomic reforms stimulate demand growth to D_1 & deforestation Q_1 far exceed safe limit.

Correcting price distortions reduces environmental harm from deforestation: 3



1. Low growth economy has demand D_0 . Deforestation rate Q_0 is below the safe limit even at subsidised price $P_{s.}$
2. Macroeconomic reforms stimulate demand growth to D_1 & deforestation Q_1 far exceed safe limit.
3. First increase in logging price (P_{ec}), eliminates economic subsidy & reduces deforestation to Q_{ec} .

Correcting price distortions reduces environmental harm from deforestation: 4



1. Low growth economy has demand D_0 . Deforestation rate Q_0 is below the safe limit even at subsidised price $P_{s.}$
2. Macroeconomic reforms stimulate demand growth to D_1 & deforestation Q_1 far exceed safe limit.
3. First increase in logging price (P_{ec}), eliminates economic subsidy & reduces deforestation to Q_{ec} .
4. Second logging price increase (P_{en}), adds environmental externality cost and reduces deforestation to Q_{en} (within safe limit).

BIGG: Transdisciplinary Integrative Approaches & Analytical Tools

1. Core Concepts and Principles & BIGG path – Lecture 2
2. Optimisation and Durability
3. SD Analysis (Macroeconomic/Sector)
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5. Green Accounting (SEEA-SNA)
6. Integrated Models (IAM, CGE, etc.)
7. SD Analysis (Project/Local)

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Sustainable Development Analysis

(partial equilibrium analysis at the project level)

1. Economic/Financial Assessment (Cost-Benefit Analysis)
2. Environmental Assessment (EA)
3. Social Assessment (SA)
4. Technical Assessment (TA)

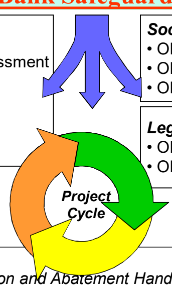
Choice of appropriate SD and SDG indicators is vital for SD Assessment

Donor Agency Comprehensive EA Procedures to Protect Multiple Stakeholders: World Bank Safeguard Policies and Guidelines

Environmental Policies
- OP 4.01 Environmental Assessment
- OP 4.04 Natural Habitats
- OP 4.36 Forestry
- OP 4.09 Pest Management
- OP 4.39 Safety of Dams

Social Policies
- OD 4.30 Involuntary Resettlement
- OD 4.20 Indigenous Peoples
- OP 4.11 Cultural Property (draft)

Legal Policies
- OP 7.60 Disputed Areas
- OP 7.50 International Waterways



Guidelines
Pollution Prevention and Abatement Handbook
Occupational Health and Safety Guidelines
Environmental Assessment Sourcebook (and updates)
WB Participation Sourcebook (1996)
Electronic Resettlement Guidebook
BP 17.50 Bank Disclosure Policy

Sustainable Development Analysis

(partial equilibrium analysis at the project level)

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Cost-benefit analysis (CBA): single value method - money

Decision making criteria:

(1) Net present value (NPV) = PV(Benefits) – PV(Costs)

where $PVB = \sum_{t=0}^{T} Bt\ /\ (1+r)^t$; $PVC = \sum_{t=0}^{T} Ct\ /\ (1+r)^t$.

Bt and Ct are the project benefits and costs in year t, r is the discount rate, and T is the time horizon. Both benefits and costs are defined as the difference between what would occur *with and without* the project being implemented.

(2) Internal rate of return (IRR) is that value of discount rate which makes PVB = PVC

(3) Benefit-cost ratio (BCR) = PVB/PVC

(4) Least cost solution (LCS) is used if two projects yield the same benefits (PVB)

Accepting projects: NPV > 0 ; IRR > r ; BCR > 1
Ranking projects: Higher NPV, IRR, BCR is better. For LCS, lower PVC is better

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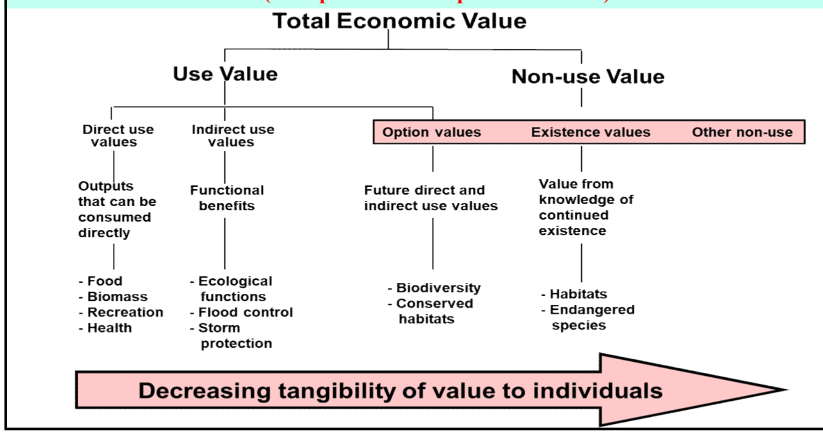
Cost-benefit analysis (CBA) - continued

For a purely financial analysis (private entrepreneurs viewpoint), B, C, and r are defined in terms of market or financial prices. This situation corresponds to the ideal economic world of perfect competition, where numerous profit-maximizing producers and utility-maximizing consumers achieve a Pareto-optimal outcome.
However the real world is imperfect, with distortions due to monopoly practices, externalities, and interference in markets (e.g., taxes), which cause market prices for goods and services to diverge from their economically efficient values. Therefore, the economic efficiency viewpoint requires use of shadow prices (or opportunity costs) to measure B, C and r.
Basically, the shadow price of a given scarce resource is given by the change in value of economic output caused by a unit change in the availability of that resource. Practical techniques for measuring shadow prices include removing taxes, duties and subsidies from market prices
All significant environmental impacts and externalities need to be valued as economic benefits and costs.

Source: Munasinghe (1975, 1992)

Economic Value of Environmental Assets – Different Categories

(examples from a tropical rain forest)



Techniques for economically valuing environmental impacts

Valuing multiple, interdependent environmental services across range of stakeholders, is most useful, but more difficult.

	TYPE OF MARKET		
BEHAVIOUR TYPE	Conventional market	Implicit market	Constructed market
Actual Behaviour	Effect on Production Effect on Health Defensive or Preventive Costs	Travel Cost Wage Differences Property Values Proxy Marketed Goods Benefit Transfer	Artificial market
Intended Behaviour	Replacement Cost Shadow Project		Contingent Valuation

Source: Munasinghe (1992), Rio Earth Summit

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Methods for economically valuing environmental impacts

Effect on production. An investment decision often has environmental impacts, which affects the quantity, quality or production costs of various outputs that may be valued readily in economic terms.
Effect on health. This approach is based on health impacts caused by pollution and environmental degradation. One practical measure related to the effect on production is the value of human output lost due to ill health or premature death. The loss of potential net earnings (ie. human capital method) is one proxy for foregone output, to which the costs of health care or prevention may be added.
Defensive or preventive costs. Often, costs may be incurred to mitigate the damage caused by an adverse environmental impact. For example, if the drinking water is polluted, extra purification may be needed. Then, such additional defensive or preventive expenditures (ex-post) could be taken as a minimum estimate of the benefits of mitigation.
Replacement cost and shadow project. If an environmental resource that has been impaired is likely to be replaced in the future by another asset that provides equivalent services, then the costs of replacement may be used as a proxy for the environmental damage – assuming that the benefits from the original resource are at least as valuable as the replacement expenses. A shadow project is usually designed specifically to offset the environmental damage caused by another project. For example, if the original project was a dam that inundated some forest land, then the shadow project might involve the replanting of an equivalent area of forest, elsewhere.
Travel cost. This method seeks to determine the demand for a recreational site (e.g. number of visits per year to a park), as a function of variables like price, visitor income, and socio-economic characteristics. The price is usually the sum of entry fees to the site, costs of travel, and opportunity cost of time spent. The consumer surplus associated with the demand curve provides an estimate of the value of the recreational site in question.

Source: Munasinghe, 1992.

Methods for economically valuing environmental impacts

Property Values. When relatively competitive markets exist for land, real estate prices may be decomposed into components attributable to different characteristics like house and lot size, air and water quality. The marginal willingness to pay (WTP) for improved local environmental quality is reflected in the increased price of housing in cleaner neighborhoods. This method has limited application in developing countries, since it requires a competitive housing market, as well as sophisticated data and tools of statistical analysis.
Wage differences. As for property values, this method attempts to relate changes in the wage rate to environmental conditions, after accounting for the effects of all factors other than environment (e.g. age, skill level, job responsibility, etc.) that might influence wages.
Proxy marketed goods. This method is useful when an environmental asset has no readily determined market value, but a close substitute exists which does have an accurate price. In such a case, the market price of the substitute may be used as a proxy for the value of the environmental resource. *Benefit transfer.* Value of the same resource in another comparable location is adjusted and used.
Artificial market. Such markets are constructed for experimental purposes, to determine consumer WTP for a good or service. For example, a home water purification kit might be marketed at various price levels, or access to a game reserve may be offered on the basis of different admission fees, thereby facilitating the estimation of values.
Contingent valuation. This method asks questions about how much persons might be willing to pay for an environmental asset, or how much compensation they would be willing to accept if they were deprived of that resource. CVM is more effective when the respondents are familiar with the good or service (e.g. water quality) and have adequate information to make choices. CVM, prudently applied, could provide estimates of value helpful in decision-making, especially if other valuation methods fail.

Source: Munasinghe, 1992.

BIGG: Transdisciplinary Integrative Approaches & Analytical Tools

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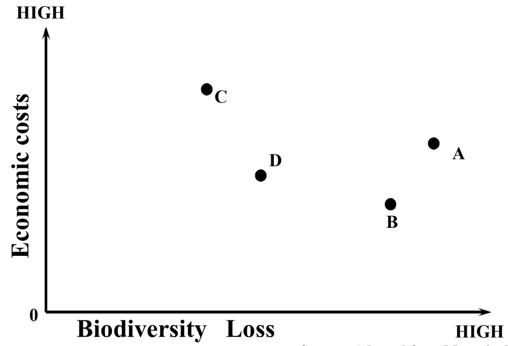
If Valuation Fails - Multi-criteria Analysis (MCA)
Example of Hydroelectric Dam Project – 1 (Data)



Source: Adapted from Munasinghe (1992).

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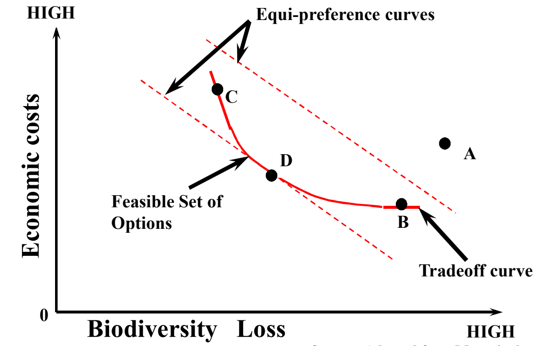
If Valuation Fails - Multi-criteria Analysis (MCA)
Example of Hydroelectric Dam Project – 2 (Theory)



Source: Adapted from Munasinghe (1992).

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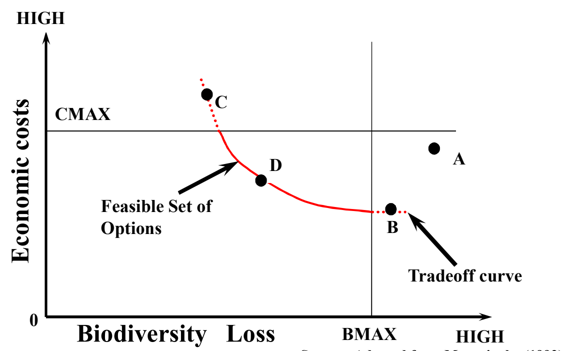
If Valuation Fails - Multi-criteria Analysis (MCA)
Example of Hydroelectric Dam Project – 3 (Practice)



Source: Adapted from Munasinghe (1992).

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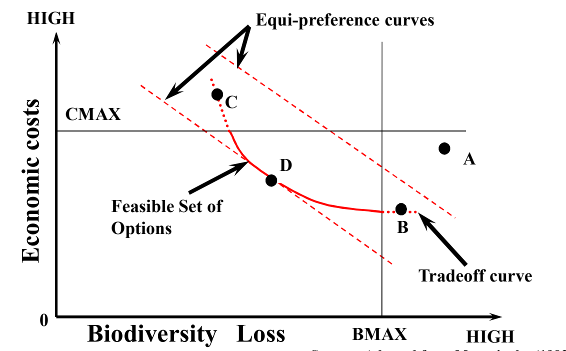
If Valuation Fails - Multi-criteria Analysis (MCA)
Example of Hydroelectric Dam Project – 4 (Overview)



Source: Adapted from Munasinghe (1992).

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BIGG: Transdisciplinary Integrative Approaches & Analytical Tools

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9. **Issues-policy transformation map (IPTM)**

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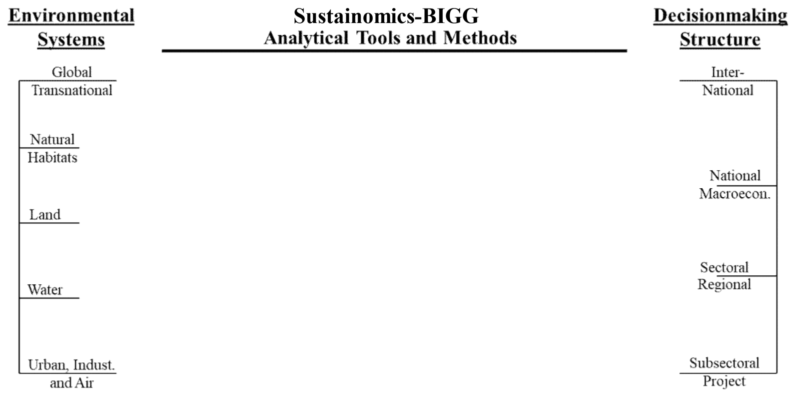
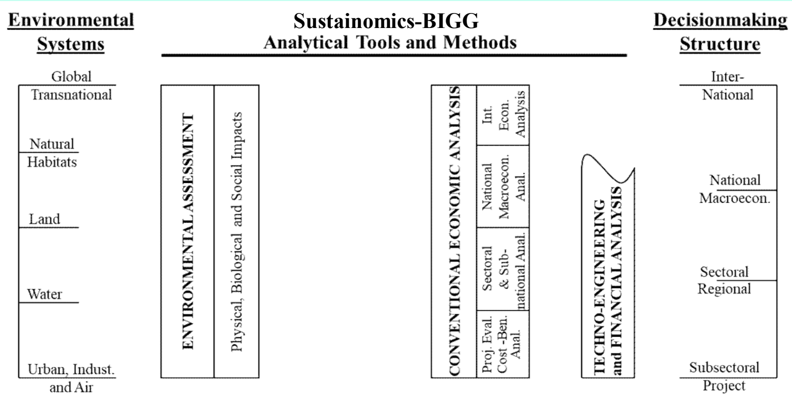
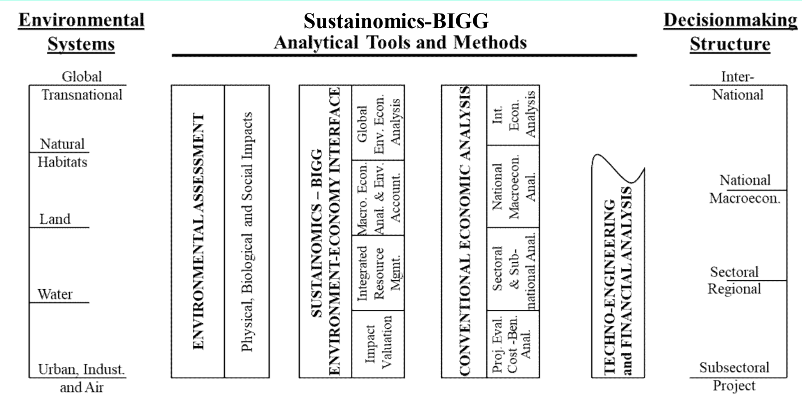
Issues-Policy Transformation Mapping (IPTM: Inserting Environmental (& Social) concerns into CBA and Conventional Economic Decisionmaking - 1



Issues-Policy Transformation Mapping (IPTM: Inserting Environmental (& Social) concerns into CBA and Conventional Economic Decisionmaking - 2



Issues-Policy Transformation Mapping (IPTM: Inserting Environmental (& Social) concerns into CBA and Conventional Economic Decisionmaking - 3



Social concerns may be included in decision making using a similar approach

Sustainomics-BIGG application at project/micro level

Multicriteria SD Assessment of small hydro schemes using economic, social and ecological indicators

Morimoto R., and Munasinghe M. (2005) "Small hydropower projects and sustainable energy development in Sri Lanka", *Int. Journal of Global Environmental Issues*, Vol.4.

Transdisciplinary research: engineering, mathematics, computer science, physics, chemistry, water resources, hydrology, biology, ecology, soil science, sociology, economics, demography, etc.

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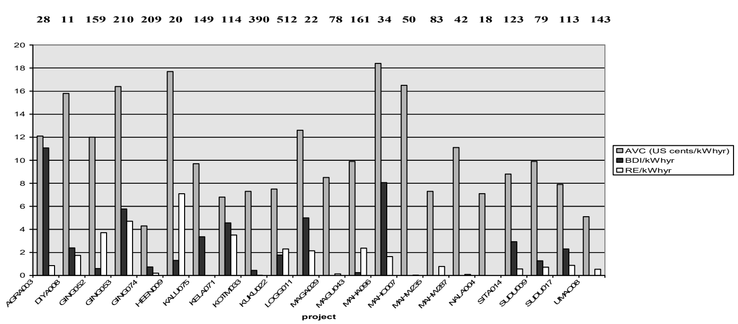
Overview of study

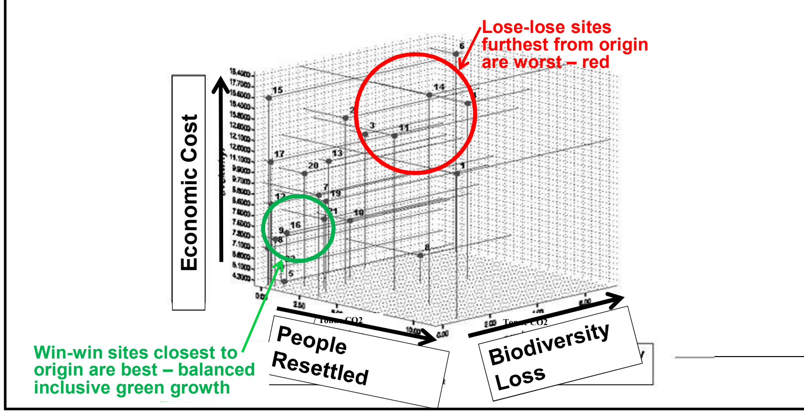
- Energy affects all three dimensions of sustainable development.
- Review of linkages between potential impacts of energy production and consumption on sustainable development.
- Multi-criteria analysis used to assess the role of small hydroelectric power projects in sustainable energy development.
- 3 key variables (measured per unit of GHG avoided per year):
  Economic - electricity supply costs,
  Social - numbers of people displaced (resettled),
  Environmental - biodiversity loss
- Analysis helps policy-makers compare and rank project alternatives more easily and effectively.
- The multi-criteria analysis, which includes environmental and social variables, supplements and balances cost benefit analysis which is based on economic values alone.

Economic, social & ecological indicators: Sri Lanka small hydro projects

Av. gen. costs (AVC), biodiv. index (BDI), & resettled people (RE) by hydro project. All indices are per tonne CO2 avoided per year. People resettled and biodiv. index are scaled by multipliers 10^{-5} and 10^{-9} respectively. Values at top of graph show annual energy generation in gigawatt hours (GWh).



BIGG: 3-D MCA of SD indicators for small hydro sites



Focus on Climate Change: IPCC Assessment Process

Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by WMO and UNEP

Five assessment reports already completed. Sixth in process. IPCC progressively improved our understanding of climate change:

1. Climate Change 1990
2. Climate Change 1995
3. Climate Change 2001
4. Climate Change 2007
5. Climate Change 2014
6. Climate Change 2022 to be released soon

IPCC reports review most recent and key scientific information. They are meant to be policy relevant but NOT policy prescriptive.

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IPCC Received 2007 Nobel Prize for Peace after the Fourth Assessment Report (AR4), which focused on the integration of climate change with sustainable development policies and relationships between mitigation and adaptation.

Three Main Working Groups produce 3 reports:

I. Science of Climate Change

II. Impacts, Adaptation and Vulnerability

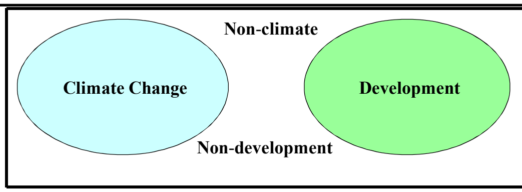
III. Mitigation

Synthesis Report

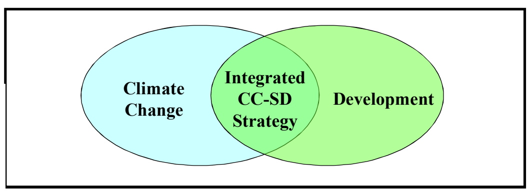
Task Force on National Greenhouse Gas Inventories

IPCC Reports benefit by selecting authors from wide range of countries, and multiple disciplines. Key cross-cutting theme reports also prepared – eg., SD report for TAR. We achieve consensus with many discussions & multiple reviews. Clarity in dissemination improved with preparations of two key summaries of each report: Technical Summary and Policymakers Summary.

Integration of CC Policies into overall SD Strategy needed over a decade of determined & patient pushing by developing country experts in the IPCC.



Former Viewpoint: pre-1992



Modern Viewpoint: post-2000 (TAR +)

Munasinghe, M. 2000. Development, Equity and Sustainability: IPCC Guidance Paper, IPCC, Geneva https://www.researchgate.net/publication/292616215_Development_equity_and_sustainability-_Guidance_Paper

Munasinghe, M. 2001. Exploring the linkages between climate change and sustainable development: A challenge for transdisciplinary research. Conservation Ecology 5(1): 14. https://www.researchgate.net/publication/42763283_Exploring_the_Linkages_between_Climate_Change_and_Sustainable_Development_A_Challenge_for_Transdisciplinary_Research

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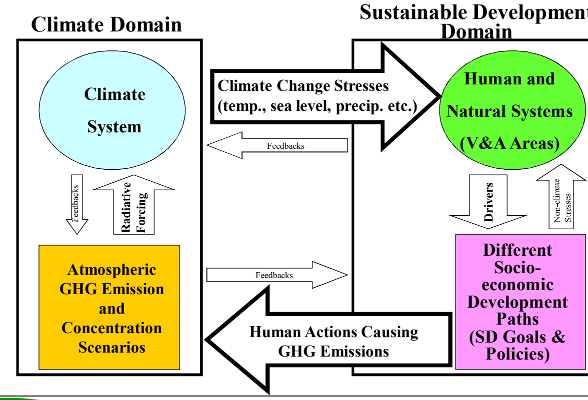
Global Two Way CC-SD Links & Human Responses: 1



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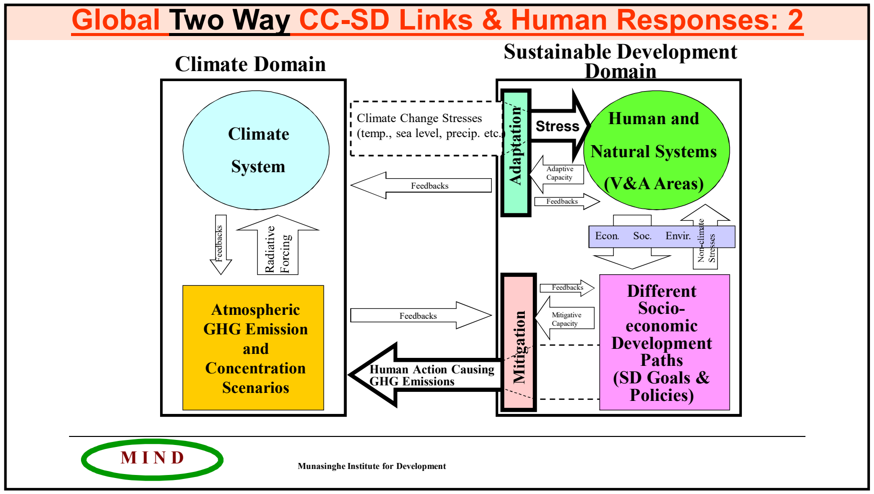
Global Two Way CC-SD Links & Human Responses: 2
Climate Domain
Sustainable Development Domain
Climate System
Feedbacks
Radiative Forcing
Atmospheric GHG Emission and Concentration Scenarios
Climate Change Stresses (temp., sea level, precip. etc.)
Feedbacks
Feedbacks
Human Action Causing GHG Emissions
Adaptation
Mitigation
Stress
Human and Natural Systems (V&A Areas)
Econ. Soc. Envir.
Different Socio-economic Development Paths (SD Goals & Policies)
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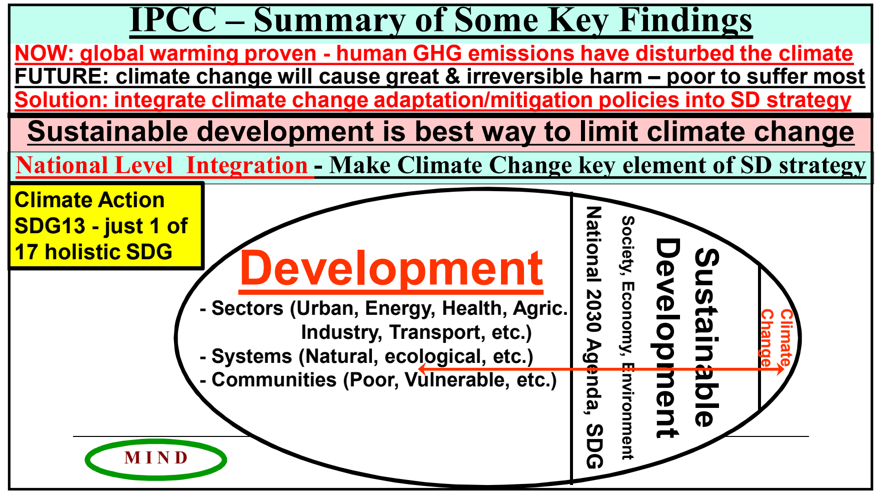
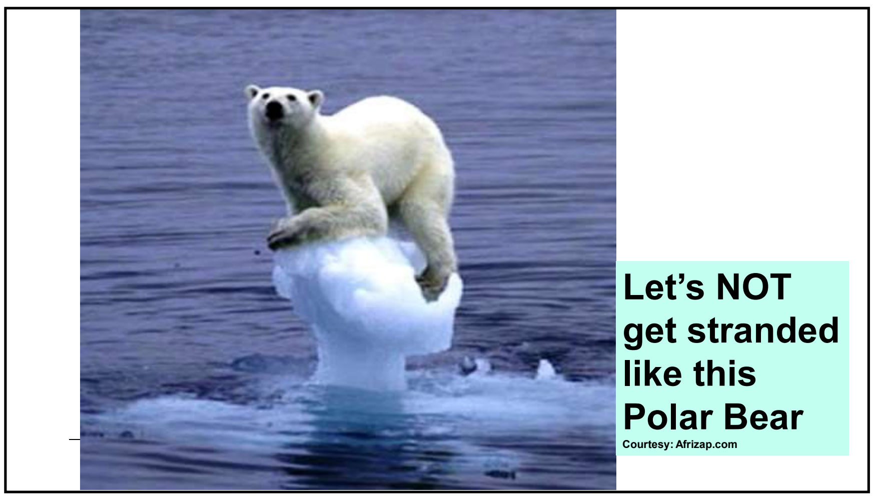
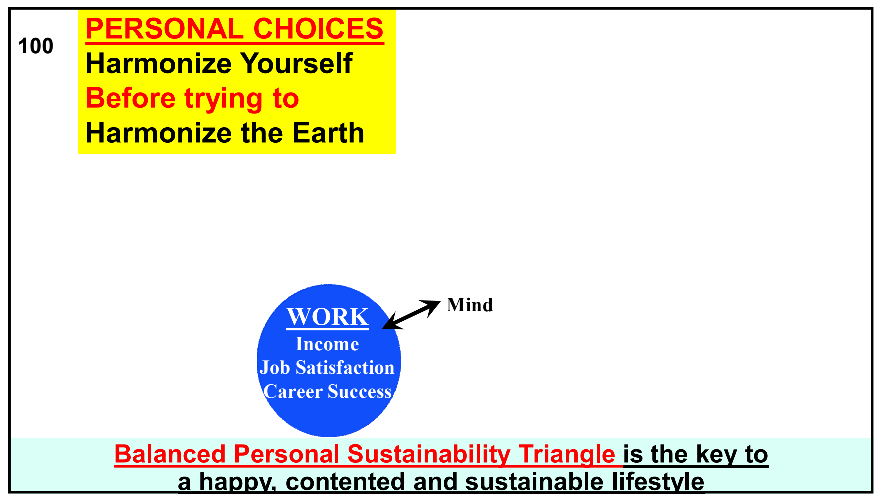
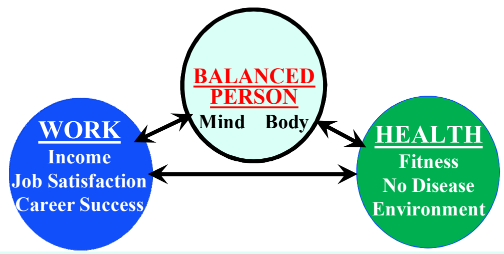

IPCC – Summary of Some Key Findings
NOW: global warming proven - human GHG emissions have disturbed the climate
FUTURE: climate change will cause great & irreversible harm – poor to suffer most
Solution: integrate climate change adaptation/mitigation policies into SD strategy
Sustainable development is best way to limit climate change
National Level Integration - Make Climate Change key element of SD strategy
Climate Action SDG13 - just 1 of 17 holistic SDG
Development
- Sectors (Urban, Energy, Health, Agric. Industry, Transport, etc.)
- Systems (Natural, ecological, etc.)
- Communities (Poor, Vulnerable, etc.)
National 2030 Agenda, SDG
Society, Economy, Environment
Sustainable Development
Climate Change
MIND


Let's NOT get stranded like this Polar Bear
Courtesy: Afrizap.com


100
PERSONAL CHOICES
Harmonize Yourself
Before trying to
Harmonize the Earth
WORK
Income
Job Satisfaction
Career Success
Mind
Balanced Personal Sustainability Triangle is the key to a happy, contented and sustainable lifestyle

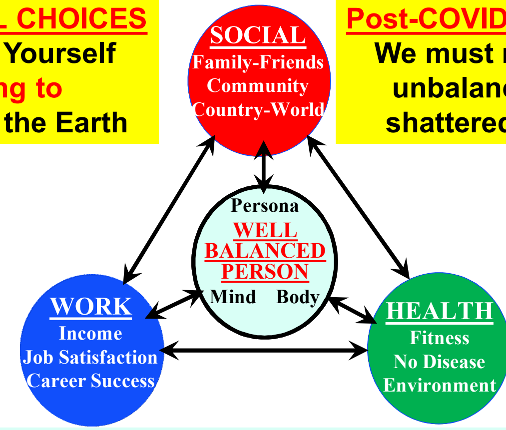
PERSONAL CHOICES
Harmonize Yourself
Before trying to
Harmonize the Earth



Balanced Personal Sustainability Triangle is the key to a happy, contented and sustainable lifestyle

PERSONAL CHOICES
Harmonize Yourself
Before trying to
Harmonize the Earth

Post-COVID19 world
We must rebuild unbalanced & shattered lives



Balanced Personal Sustainability Triangle is the key to a happy, contented and sustainable lifestyle

Watch Out for Potential Surprises!!

- Climate Change (Risk Multiplier)
- Pandemics, Environmental Crises and Resource Shortages
- Social Unrest, Terrorism and Conflicts
- Economic Crises
- Technological Disruption

Innovative thinking will build resilience against shocks and helps us survive in a dynamically changing world

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RISKS: 12 potentially economically disruptive technologies

1. **Mobile Internet** – Cheap, capable mobile computing devices & internet connectivity
2. **Artificial intelligence** - Intelligent software systems doing knowledge work with autonomy
3. **Internet of Things (IOT)** - Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization
4. **Cloud technology** - Computer hardware & software services delivered via networks or web
5. **Blockchain** – Algorithms that ensure security of data
6. **Advanced robotics** - Robots with enhanced senses, dexterity, & intelligence to automate tasks or help humans
7. **Autonomous vehicles & drones** - Vehicles navigating/operating with minimal human control
8. **3D printing** - Manufacturing techniques to create objects by printing layers of material based on digital models
9. **Advanced materials** - Materials with superior characteristics (e.g., strength, weight, conductivity) or functions
10. **Next-generation genomics**- Fast, low-cost gene sequencing, data analytics, & synthetic biology (writing DNA)
11. **Energy storage**- Devices or systems that store energy, including batteries
12. **Renewable energy and advanced fossil fuel tech** - Electricity generation from renewable sources & advanced fossil fuel technologies to limit harmful environmental & climate impacts

Optimistic final message for Japan, Sri Lanka & World

- Multiple global problems pose a serious challenge to us all – pandemics, economic crises, poverty, resource scarcities, conflict, ecosystem harm, climate change, etc. are interlinked.
- These problems can be solved together, provided we begin now, although the issues are complex and serious,
- Sustainomics shows us how to take the first steps towards making development more sustainable (MDMS), that will transform risky "business-as-usual" scenario into a safer & more secure future
- Governance systems (at all levels) must be transformed to deal with multiple crises in an integrated way.
- Manage post-Covid recovery to support SD - business and civil society can support and work with government
- Waseda University can lead in devising 21st century paths for sustainable development in Japan and the world

Remember our Past: Ancient Pali Blessing (Sri Lanka)

"DEVO VASSATU KALENA
SASSA SAMPATTI HETU CA
PHITO BHAVATU LOKO CA
RAJA BHAVATU DHAMMIKO"

Environmental: "May the rains come in time,
Economic: May the harvests be bountiful
Social: May the people be happy & contended
May the king be righteous"

Even in ancient times, a favourable environment, economic prosperity, social stability (and good governance), were well identified as key pre-requisites for making development more sustainable. Today we are rediscovering these old truths!

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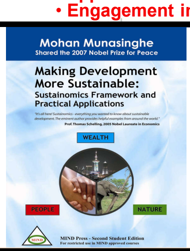
Environment
MIND
Society Economy

"making development more sustainable - MDMS"

10/1 De Fonseka Place, Colombo 5, Sri Lanka
Phone/Fax: +9411-259-0131; E-mail: MIND@mindlanka.com ;
Web: www.mindlanka.com

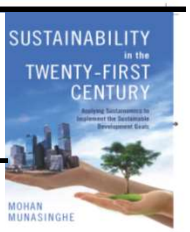
- Awards, Scholarships & Training
- Applied Research on Sustainability
- Engagement in Public Policy

MIND Press: 650 pages. Third Ed. in 2015 - Translated into Chinese Portuguese



Cambridge University Press: 660 pages. Sec. Ed: 2019 Translated into Chinese Portuguese

Post-graduate course taught in China



Further information: Visit website: <www.mindlanka.org>

ස්තූතියි Arigatogozaimasu Thank You

MIND Graduate Course on Sustainable Development and Sustainomics

MIND courses have been attended by over 2000 participants, including ministers, legislators, senior officials, policy analysts, researchers and university students in many countries (e.g., Brazil, China, India, Indonesia, South Africa, UK, USA and other nations), and UN agency staff.

Coverage, Objectives and Details

The full and compressed (15 and 30 semester hour) courses provides complete coverage of theory and many detailed case study applications covering a wide range of topic modules – including climate change, energy, agriculture-water resources, primary forests, extreme events, transport and urban development. The core course material may be tailored further to suit special student requirements -- e.g., focus on climate change or other selected sectoral applications. These courses will cover sustainable development comprehensively, paying special attention to developing a transdisciplinary framework (sustainomics), analytical methods, and decision criteria for making development more sustainable -- economically, environmentally and socially. Policy-oriented case studies will illustrate practical applications of the core theory, while classroom exercises will help build problem solving skills and provide experience in analyzing and presenting policy-relevant results to decision makers. It could include several hours of research seminar time to be provided for university lecturers, researchers, and doctoral students, who are looking for advanced research applications of sustainomics. The course material is self-contained to facilitate participation of students from a broad range disciplines, but those with prior preparation in climate change, energy, environment, or resource economics will be able to follow the lectures more easily.

Upon successful completion of the full and compressed courses, students will be able to:

1. understand the critical issues underlying all aspects of sustainable development in terms of its economic, social and environmental dimensions;
2. be familiar with the basic concepts and indicators of sustainable development so as to be able to define, frame and resolve issues;
3. assess and present alternative approaches to sustainable development, especially in critical sectors and from a decision making perspective -- in terms of the economic, social and environmental impacts;
4. apply the tools of sustainomics (including Action Impact Matrix, sustainable development analysis, multi-criteria analysis, etc.); and
5. identify and undertake graduate level research in the field.

A certificate of attendance will be provided upon successful completion.

Prerequisites: A basic course in development, climate change, industry studies, business, energy, environment, engineering or resource economics is preferred.

Course requirements:
Active participation in classroom discussions will be encouraged. The course will comprise lectures and illustrative case studies. For the 30 and 15 semester hour courses, small teams of students may be required to prepare short applications papers (on pre-agreed topics). Each team will be expected to present their paper briefly in class, and lead the ensuing discussion.

Instructors: Professor Mohan Munasinghe (biodata attached below) and other MIND staff

Course Materials:
Main text: Sustainability in the 21st Century: Applying Sustainomics to implement the Sustainable Development Goals by Mohan Munasinghe (Cambridge University Press, 2019) available on request to all participants. Other materials include readings from two additional text books ("Climate Change and Sustainable Development" and "Aftermath of the Asian Tsunami"), modularized slides, DVDs, and other handouts.

FULL POST-GRADUATE COURSE OUTLINE (30 hours = 10 modules x 3 hour per module)

Module 1: Introduction to SD
Module 2: Sustainomics Framework and Balanced Inclusive Green Growth (BIGG)
Module 3: Analytical Tools and Methods
Module 4: Climate Change Applications
Module 5: Sustainable Energy Development Applications
Module 6: Agriculture and Water Resource Applications
Module 7: Extreme Event Applications
Module 8: Transport and Urban Development Applications
Modules 9 & 10: Preparation of Applications Papers and Presentation of Results in Class
Additional modules available: Business & SD, Science and Technology for SD, Industry and Trade, etc.

Brief Biodata of Prof. Mohan Munasinghe – Course Instructor

<http://www.mohanmunasinghe.com/default.cfm>

Prof. Mohan Munasinghe is the 2021 Blue Planet prize Laureate and shared the 2007 Nobel Prize for Peace, as Vice Chair of the UN Intergovernmental Panel on Climate Change (IPCC-AR4). Currently, he is Founder Chairman of the Munasinghe Inst. of Development (MIND), Colombo; and Distinguished Guest Professor, Peking University, Beijing, China. He has earned post-graduate degrees in engineering, physics and development economics from Cambridge University (UK), Massachusetts Institute of Technology (USA), and McGill University and Concordia University (Canada). Prof. Munasinghe has also received several honorary doctorates (honoris causa). Highlights from 40 years of distinguished public service include working as Senior Energy Advisor to the President of Sri Lanka, Advisor to the United States Presidents Council on Environmental Quality, and Senior Advisor/Manager, World Bank. He has taught as Visiting Professor at leading universities worldwide, and won many international prizes and medals for his research and its applications. He has authored 120 books and over 350 technical papers on economics-business, sustainable development, climate change, power, energy, water resources, transport, environment, disasters, and information technology. He is a Fellow of several internationally recognized Academies of Science, and serves on editorial boards of a dozen scientific journals.

MIND CC-SD Training Course, CMA, Beijing, July-Aug, 2006
270 Senior Chinese Officials

MIND Munasinghe Institute for Development

MIND SD Course, Delhi, Feb. 2007
25 Senior Indian Civil Service Officers

MIND-ERC CC-SD Training Course, University of Cape Town, October 2007,
for 30 Senior Decision Makers from Government, Business and Civil Society

SD Full Course, FES, Yale University, New Haven, 2004-5
24 Graduate Students

SD-CC Graduate Course, April 2009, SCI, Univ. of Manchester

SD-Business-Industry Graduate Course, Sept. 2013, Darmstadt Univ., Germany. 60 students

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