LEARNING TO QUANTIFY POSITIVE FUTURES

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ABSTRACT

This paper highlights the urgent need to increase the understanding and uptake of positive messaging, metrics and analysis to facilitate learning across all areas of community and professional environmental education. It examines the failures of current environmental sustainability reporting, communication and learning frameworks to inspire and engage people. It then shows the quantification of 'unsustainability' inherent in the development of world-first automated whole-building Life Cycle Assessment and Life Cycle Impact Assessment (LCIA) software. By focussing on a negative range that stops at zero, LCIA excludes positive gains in security of supply, climate, habitat and wellness. Through case studies, the authors show how practitioners sought to improve sustainability education. They also sought to measure positive gains by developing Life Cycle Benefit Analysis (LCBA) compiled to quantify positive development gains within planetary boundaries' safe operating space. LCBA was tested in third-party-certified Environmental Product Declarations and building projects. Case studies compare benefit and damage metrics for supply, climate, habitat and wellness outcomes, carbon drawdown ratings and circularity scores. The authors report what consultants, teachers, interns and clients learnt about gaps in environmental education frameworks in other institutions. They reflect on how to expand positive sustainability messaging and learning across industry, community and education from primary to post-graduate and professional accreditation. Of vital significance is the need to address youth and student anger and apathy in response to the locked-in devastating climate change and wildlife extinctions they have inherited. The authors assert the critical need to engage people of all generations in counting benefits and gains and offer positive sustainability development strategies to this end. Among the recommendations is the need for positive climate and habitat security narratives to activate interest, empower responses and motivate teaching and learning.

Keywords: benefit, climate brake, education, positive development, security.

1. INTRODUCTION

The current extinction and climate crises reflect the extent to which sustainability imperatives have failed in their efforts to retain biodiversity and climate viability [1]. World leaders have acknowledged that transformation to regenerative supply is essential to establish sustainable markets [3], and a United Nations (UN) report states we cannot achieve a healthy planet with healthy people without urgent inclusive action [2]. Relentless disinformation undermines the Intergovernmental Panel on Climate Change (IPCC) and there are UN calls for market transformation to curb climate- and biodiversity-degenerating dependencies [4]. The world's recent climate extremes are attributed to greenhouse gas radiative forcing generated by emissions from burning fossil fuels [5].

In 2015, non-government organizations (NGOs) wrote to the International Standards Organization (ISO): 'We must act with significant emissions reductions in the next 5–10 years if we have any hope of avoiding irreversible climate change. Having a proper set of metrics installed to steer policy in the short amount of time we have to act is critical, as these metrics are essential guides for any type of informed decision making [6]'.

Understanding national educational approaches about environment, sustainability and climate change is influenced by many factors, including political history and economic systems.

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The paper contrasts four approaches in Australian, Chilean, Indian and Dutch secondary and tertiary education on individual and collective environmental responsibility. With climate tipping points looming, stringent legislation to secure climate, water and habitat security now applies in many jurisdictions. Most modern governments, carbon trusts, industry associations and leading economists also have governance for climate change and carbon accounting systems [1]. In the 20-year near term, however, critical time factors demand consistent accounting for carbon drawdown and storage [6].

This paper shows a lack of such consistency in environmental education, Life Cycle Assessment (LCA) and Life Cycle Inventory Analysis (LCIA), as well as core elements of the ISO environmental management system. Discourse analysis and building LCA case studies are used to illustrate sustainability roadblocks considering a significant >25% to 40% share of global warming potential (GWP) from building energy usage [7].

In discourse analysis of pre-COVID 19 media, Jones et al. [8], revealed negative narratives in forewarnings of unprecedented climate and habitat disasters and accusations of blame, shame and stalling. Despite the risk of demotivating audiences, media content was rife with words, images and accounts designed to stun, shock, scold or mock, which dominated the proceedings they cited. Examples include:

- world political leaders condemning Australia for cheating even on feeble targets
- news of globally unprecedented devastating fires and wildlife loss in days
- youth activists chiding elders for irresponsible fuelling of apocalyptic flames
- a leader scorning foolish, alarmist, absolute power-seeking prophets of doom and
- physicists' doomsday clock reset to 100 seconds to midnight the apocalypse hour.

The Australian Federal Government offer on the Paris Accord is widely acknowledged as feeble [8]. Australia is fossil fuel dependent, exporting 30% of the world's coal and most liquid gas [8]. Fugitive flammable methane at 6% of national GWP is omnipresent in the landscape, while unprecedented wildfires confirm its climate crisis [9] [10] [11]. The authors' work in environmental accounting could serve to enable Australia to improve its often-feeble responses.

2. METHODOLOGY

The authors asked teachers, consultants, interns and clients about variables influencing education in sustainability. The paper reports their responses on needs for benefit analysis to understand how reference frameworks differ in Australian, Chilean, Indian and Dutch education if governing frameworks ignored needs for positive assessment globally and why the LCA focus on damages excludes supply, climate, habitat and wellness benefits. It then considers benefit analysis and learning across industry, community and education in professional development and accreditation from primary to post-graduate students.

3. AIMS

The paper aims to report on the needs to facilitate learning and uptake of benefit analysis in students from primary, secondary, post-graduate to professional schooling, as well as practitioner accreditation across industry, community and educational institutions.

4. TECHNICAL BACKGROUND

The UN Environmental Economic Accounting System (UNSEEA) includes benefits from the direct use of environmental inputs but excludes indirect benefits from ecosystem services such as carbon, water and biomass storage [12]. The ISO environmental management system

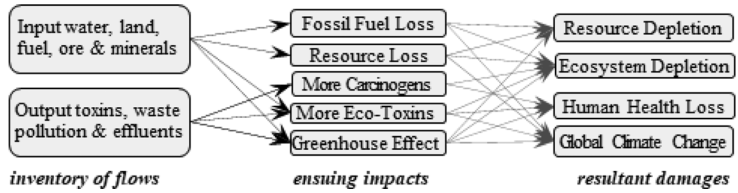

Figure 1: Inventory flows to impacts and damages [8].

for LCA, life cycle inventory (LCI), LCIA and Environmental Product Declarations (EPDs) underlie UNSEEA reference frameworks [13]. LCA and LCIA are problem-focussed with a negative bias as their original purpose was to reduce the negative burdens of pollution and resource depletion. Overarching global UNSEEA and ISO frameworks limit LCA's reach to negative outcomes, excluding positive benefits. Figure 1 illustrates LCA inventory input and outputs linked to impacts causing damage [8]. It shows a reach limited to losses and damages focussed on negative outcomes rather than positive gains.

LCIA frameworks and metrics cover borrowings of natural capital, costs to nature and damages to supply, habitat and health [13]. EPDs use methods compliant to ISO14025 or EN15804 standards to count damages, as well as benefits from reduced damages, beyond the system boundary [8]. LCIA thus lacks reach beyond zero damage to sight, assess or leverage-positive benefit or gain even if extended beyond the system.

4.1. Outdated and unbalanced metrics

ISO LCIA metrics used by 300,000 companies also ignore vital IPCC factors as they:

- use lower 100-year not 20-year horizons linked to imminent tipping points
- exclude 60% of global radiative forcing by shorter-lived natural gas emissions
- underestimate by 80% short-term benefits of avoided methane emissions
- ignore biomass sequestration across forest and paper industries and
- overlook mitigation opportunities in climate hot spots [6].

4.2. Conceptual design measures

Conceptual design tools such as the urban Frog Stick in Figure 2, however, can cover a continuum of negative outcomes and positive gains. [14]. The score of −33% reflects the failures of many typical Australian suburbs in 2019. This balanced scoreboard contrasts the negative bias of LCA that constrains the scientific assessment of sustainable outcomes.

4.3. Lessons from historical building LCA

Despite lacking federal policy in climate security, valuable lessons arise from decades of Australian industry and state governance and initiatives. For example, the Sydney Olympics bid won partly because it was based on a green games approach, addressing Agenda 21 and using LCA to audit games venues, buildings and supply contracts [15].

	Score	-100	-75	-50	-25	+25	+50	+75	+100	Score
Essentials	Township Losses	mostly	often	some	rarely	rarely	some	often	mostly	FrogStick Gains
Air	Pollutes	x								Purifies
Climate	Insecure	x								Security
Rain	Run-off	x				x				Catchment
Effluent	Pollutes	x								Purifies
Soil	Depletes	x				x				Enriches
Material	Waste		x			x				Recycles
Fire energy	Fossil	x					x			Renewables
Biomass	Decreases	x					x			Increases
Food	Consumes						x			Grown
Biodiversity	Destroys	x								Gains
Habitat	Destroys	x								Gains
Total	Negativity	-950/-1100				+ 225/+1100				Positivity
Final	Fail	-725/2200 = -33%								Win

Figure 2: Frog Stick scoreboard (%) [14].

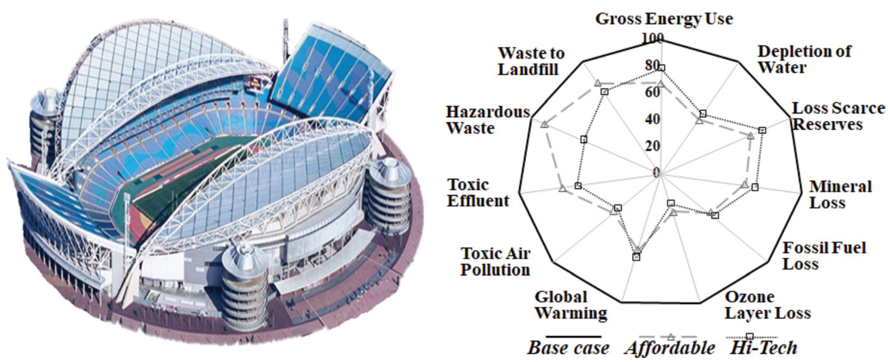

Figure 3: Olympic Stadium image and LCA results cradle-to-grave [20].

4.4. Australia's Green Games: an LCA legacy

The Green Games LCA was developed by the New South Wales (NSW) Department of Public Works (DPW) scientists, guided by founders Dr Ian Boustead (UK) and Dr Chet Chafee (USA) [16]. Figure 3 shows Australia's Olympic stadium and one of the author's charts of reduced damages – contrasting impacts from high-tech in dotted lines, the affordable as-built option in grey dashes, versus the base case in black outer lines.

To develop this LCA, seven researchers, including one of the authors, compiled, modelled and assessed the supply chain, building dimensions, product specifications and utility usage over 20 years cradle-to-grave [20]. Green Games legacies included new environmental planning law [17], the building sustainability index BASIX, LCAid™ software, the DPW LCI database and the world-first public building LCA [18, 19].

4.5. Limitations of LCA tools

Only a few nations have a comprehensive national LCI database, and supply chain Ecologically Sustainable Development is limited by the industry's lack of capacity to deliver objective information. Recognition of these deficiencies emerged during the compilation of the Sydney Olympics LCI from 1995 to 2000. The Australian Cooperative Research Centre for Construction Innovation subsequently confirmed these deficiencies during the extension of that LCI in development of automated LCDesign™ software for fast affordable building appraisal between 2000 and 2008 [21].

LCADesign™ software reads dimensions and specifications in real-time from object-oriented computer-aided design (CAD) industry foundation class (IFC) building information models (BIM) [21]. Health, ecosystem and resource damages are calculated per unit area via reasoning rules linking dimensions, specifications, inventory and impact factors. Relative site, shell, structure, element, component and operational shares are charted to enable users to compare specific and eco-preferred options and drill down on hot spots. The Evah Institute continues to develop LCADesign™ software and building supply chain LCI for Australasia, The Netherlands, Germany, the USA, the UK, Europe, China and South Africa. Evah issues third-party-certified LCA, ecolabels and EPDs plus free OzLCI databases [22] for OpenLCA software used by most Australian university students of LCA.

4.6. Testing in early education projects

From 2003 to 2008 architects and tertiary students tested LCADesign™ in Australia and around the world as part of group studies and internships. Figure 4 shows, for example, LCA over 20 years cradle-to-grave of South Brisbane College for Technical and Further Education GWP mostly from windows, inner walls and operation [20]. All students and practitioner-tester users learnt to:

- tag object groups in a CAD software package file
- save CAD BIM IFC files
- upload BIM ifc file and open them in the LCADesign™ software
- link object tags to design element material selections with reasoning rules
- calculate LCA of selected versus eco-preferred options and chart results.

In another example, one American student of the Stanford University's Centre for Facilitated Engineering in California interned with Australian scientists, including one of the authors, to develop a custom LCI database. The student compared LCADesign™ and USA software to assess Stanford University's green dorm mitigation of earthquake damage in rocking frames. Irrespective of frame type, interior walls embodied most impacts shown in Fig. 5 [23]. Despite avoiding damage, the dorm LCA could not show benefit. Later interning

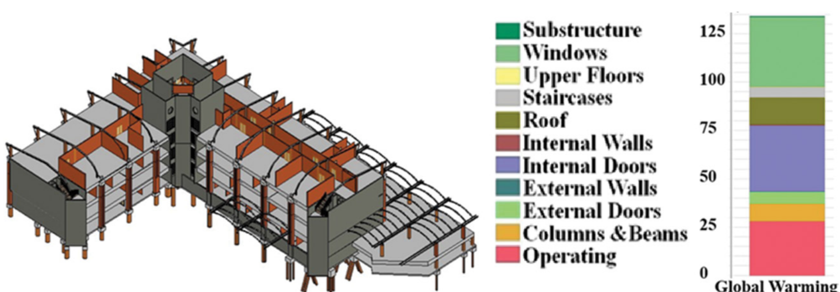

Figure 4: Technical and Further Education college GWP cradle-to-grave [20].

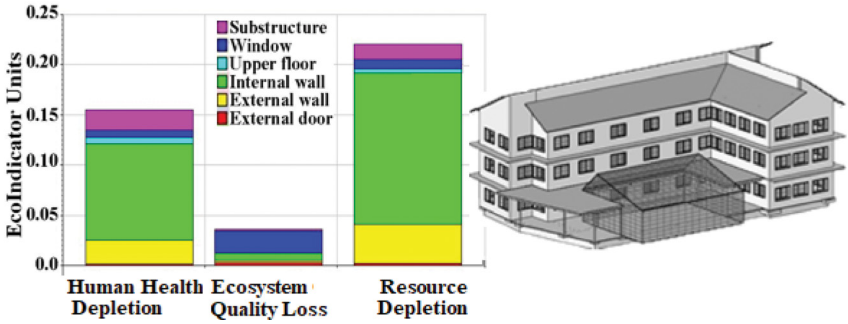

Figure 5: Green dorm LCIA results cradle-to-grave [23].

in Europe, this student used LCADesign™ to assess three Dutch and one German BIM and become more experienced in building design LCA.

After the global financial crisis 2007 to 2008 BIM uptake, building projects, green initiatives and LCA software development stalled for many years.

5. GAPS REVEALED: THE LCBA CHALLENGE

Results of several projects, including those shown in Figs. 3, 4 and 5 of damages were shown in university lectures addressing the capacity and reach of LCADesign™ software. In one lecture to post-graduates studying positive development at the Queensland University of Technology, responses to student inquiries highlighted the exclusion of positive outcomes inherent in LCA [24]. By comparison, Downton's Frog Stick in Figs. 2 and 6 each show damages and benefits. The authors' chart in Fig. 6 shows scoring across a broad range from worst to eco-secure positive outcomes.

Also, according to Birkeland, LCA had to evolve to assess positives to enable quantification of 'Positive Development' in 'eco-retrofitting of the vast urban fabric we already inhabit' [26]. So, if LCA was to assess positive ecosystem regeneration outcomes, it needed new scope and algorithms. This was vital if LCA was to consider what it had ignored at that time so that it could become useful to quantify sustainable development. Such quantification was key to avoiding sustainable development continuing to be unquantified and hence to a large extent unmanageable.

6. EARLY BENEFIT ASSESSMENT

This section shows LCBA-positive development examples by Evah authors.

6.1. Sustainable school project: positive development school report

Figure 7 shows Evah LCBA results from a sustainable school classroom fitout project for the Victorian Department of Education [25]. Headmasters requested a template for their own school teachers and students to chart campus-centred learning projects, language and metrics.

6.2. Net-positive building design

Renger et al. [29] first published GWP results from a Brisbane Exhibition Ground Interpretive Centre design in part attributed to Evah LCBA. Ray Cole later cited the whole of

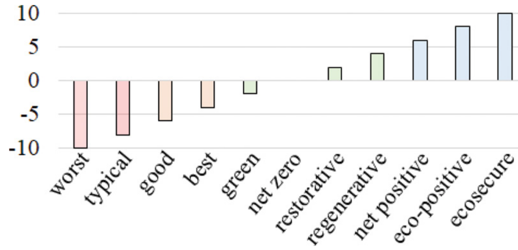

Figure 6: Scoring unsustainable to sustainable [Evah Institute original].

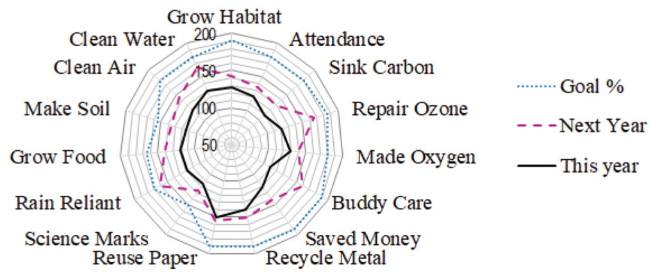

Figure 7: Positive development school report [25].

design-life net-positive carbon accounting work in this project as a world-first [30]. The full set of that Centre's LCBA results showed that – apart from one area – no net negative damage arose in climate change, smog formation, acidification, ionizing radiation, particulates, toxicity or depletion of freshwater, fossil fuel, minerals or landscape [26]. Eutrophication required a reduction in the use phase to the end of design life. Evah authors now report its LCBA annual results/m^2 gross floor area (GFA) included:

- 20 Megajoule (MJ) feedstock retained/m^2 GFA for near-term supply, and climate security
- 27 kg renewable biomass and 1.5 MJ renewable energy/m^2 GFA in supply security
- 42 kg CO_{2e} climate brake/m^2 GFA for near 20-year-term climate security and
- 30 kl water retained/m^2 GFA for supply and habitat security lower drought risk.

6.3. LCBA method for forestry

From 2014 Evah scientists learnt to assess the benefits of carbon sinks in timber. Vlieg et al. [31] show how secure forest centennial carbon uptake must compensate for losses over prior rotations in deforestation, control burns, wildfires, soil, detritus and logs plus fuel and scrap use in replanting, harvesting, debarking and milling. Product function and durability are factored as is end-of-life reuse, repair, recovery and landfill. Landfill methane generation and carbon loss are much less because of lower precipitation and higher soil oxygenation levels in Australia and the USA than the IPCC base case [32]. Jones et al. showed timber builds for 60 years and fitout over 20 years may have full to minor CO_{2e} uptake, varying with fire loss and biofuel used to debark and process logs [32].

6.4. Broad-spectrum LCBA of forest product

In 2015, Jones et al. [32] compared broad-spectrum LCBA results for six Forest Stewardship Certified (FSC) framing, cladding, panelling, paper and board products. Inherent benefits and avoided burdens for particleboard use/m^2 60 years with annual gains, included:

- 378 MJ renewable feedstock/m^2 product in near-term supply and habitat security
- 75 MJ renewable energy/m^2 product in supply and climate security
- 47 kg CO_{2e} drawdown/m^2 product in climate security in the near 20-year term
- 0.08 m^2 land area/m^2 product in retained structure, soil biome and habitat security
- 0.16 m^2 habitat/m^2 product in biodiversity and climate security gains and
- 53 minutes of added hale and able wellness/m^2 product for human health.

6.5. Broad-spectrum LCBA of diverting garbage

In 2016, the authors declared the world's first cradle-to-grave LCBA results in third-party-certified EPDs. This EPD was for a garbage diverter for high-rise residential buildings. In high-rise apartments, resident recyclables are diverted from landfill. Benefits arise from increased recycling via one 1.35-t chute displacing virgin material and extra bin rooms for every eight units over 60 years cradle-to-grave reported by Vlieg et al. [33]. Annual gains per occupant cradle-to-grave or end-of-life reuse fate include:

- 24 Gigajoule (GJ) energy recovery in near-term supply as well as for climate security
- 990 kg CO_{2e} climate brake in 20-year term delaying tipping points
- 0.03 g R11e Ozone refill and freedom from that human cancer risk
- 17 ml water retained in supply security gains and reduced drought risk
- 0.01 m^2 natural land in retained biodiversity and climate security and
- 44 days wellness in human and able lifetime.

6.6. Broad-spectrum LCBA of diverting waste oil and paper

Benefits arise from reclaimed oil in under-sink grease diverters displacing virgin oil for animal feed and surfactants reported by Vlieg et al. [34]. Gains/diverter include:

- 9.13 GJ renewable fuel retained for near-term supply and climate security
- 1.3 t CO_{2e100} retained drawdown banking for longer-term climate security
- 9.35 Gl water retained for supply security reducing drought risk and
- 129 years of added hale and able human wellness.

Evah assessed eco-benefits of typical 8 kg FSC toilet paper use per capita, cradle to end-of-life and reuse as soil conditioner [35]. Annual gains and circularity scores of resource reuse suitable for quantification of outcome of circular economies included annual/capita:

- 6296 MJ renewable energy for supply security and 87% circularity
- 221 kg CO_{2e20} drawdown braking the climate crisis and 100% circularity
- 483m^2 retained biodiversity, habitat security and 99% circularity and
- 6163 MJ retained forest habitat security and 89% circularity.

6.7. LCBA of renewables lacking benefits

In 2018, modelling by Evah confirmed that after sequestering 1.84 kg CO_{2e}/kg of renewable polylactide (PLA), the emission of 1.22 kg CO_{2e} generated from fossil fuel use in farming, harvest and polymerization resulted in gross drawdown of only 0.62 CO_{2e}kg/kg PLA. So, for example, renewability in feedstock was eroded by fossil fuel emissions in energy supply [36].

6.8. Broad-spectrum LCBA of recyclables displacing primary mineral

Using South African recycled building rubble instead of illegal river sand mining avoided contaminating water in wildlife grazing land and diverting water from downstream cities in drought [37]. Such illegal mining actually diverted significant river water upstream supply from drought-stricken Capetown facing its last day of potable water before rain came. Annual habitat security gains per kilogram dry sand include:

- 14 kg CO_{2e} 100-year drawdown in biomass for long-term climate security
- 5.2 kg of flora and forage for endangered wildlife, birds, bees, insects and frogs and
- 320 m^2 of extensive natural range retained for foraging herds grazing.

7. FRAMING POSITIVE OUTCOMES BEYOND ZERO

Until 2014, an arithmetic dictum that factoring two negatives make a positive attributed minus signs and negative names to all positive outcomes. As multiplying 'two wrongs do not make a right' double negatives add confusion. Being able to communicate and measure real benefits relied on rejecting irrelevant double negatives. This required transposing all damage names to form new benefit category names as shown in Fig. 8. It shows borrowings, risks, costs and liability in depleted supply, habitat and health versus investments, benefits, returns and asset gain in repleted supply, habitat and wellness.

7.1. The Life Cycle Benefit framework

Furthermore, Table 1 illustrates an LCBA framework for regenerating natural capital returns adapted from Jones et al. [26] and Baggs et al. [27]. It applies to reparation and growth of natural assets to finite carrying capacity in safe operating space within planetary boundaries after Rockström et al. [38]. Such repletion and regeneration measures extend to returning natural assets to approach former abundance. It is useful to identify, consider, analyse and

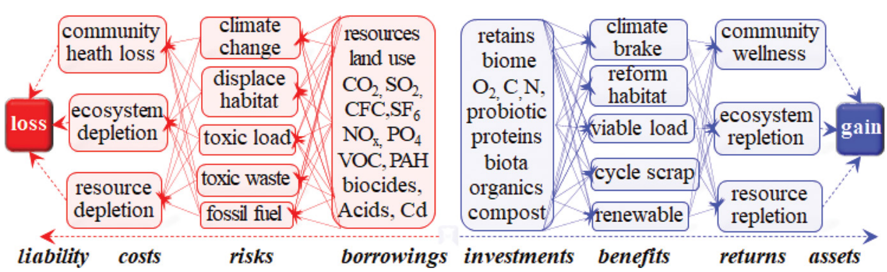

Figure 8: Evah LCBA versus typical LCIA schemas [Evah original].

Table 1: Evah LCBA framework extracts from [26 & 27].

Benefit Layer	Positive and security outcomes/m^2 per annum
Supply Energy and Resource Viability in (SERV) MJ and %	
Secure water	Reliance on accessible replenishable catchment
Secure energy	Reliance on renewable fuel and energy Supply
Secure reserves	Regenerate minerals, deposits and finite material
Hale Able Lifestyle Years per capita in (HALY) ppm @ WHO or C1750	
Air outdoors	Oxygen generation free of dust, allergens and HCFC
Air indoors	Oxygen catchment free of VOCs and carcinogens
Clean air	Free of dust, inorganic and metallic substances
Secure climate	Braking from CO_{2e} avoided and drawdown
Secure ozone	Replete stratospheric meteor and radiation shield
Positive Ecosystem Reformed to carrying capacity (PERF) @C1750 in	
Urban stock	Space converted to natural carrying capacity
Climate stock	Soil and flora sequester CO_{2e} and generate O_2
Biomass stock	Replenish terrestrial biodiversity to capacity
Aquatic stock	Flora and fauna, nutrients, biodiversity and range
Marine stock	Flora and fauna, nutrients, biodiversity and range

assess gains in soil carbon, biota, oxygen, fresh water plus ecosystem and habitat recovery. Security gains are shown in supply, climate, habitat and people.

8. EDUCATION ON ENVIRONMENT AND SUSTAINABILITY

In order to understand approaches to education about environment, climate change and sustainability, there is a need to comprehend and consider many variables in national political histories and economic systems, amongst other factors. This section contrasts four national sustainability educational situations describing some of these factors.

8.1. Australian secondary education on sustainable futures

Despite Australia's exposure to drought, wildfire and sea level rise risks, sustainability is not part of the key learning areas in the Australian Curriculum. But it is a cross-curriculum priority that provides students with the tools and language to engage with and better understand their world. And in the case of sustainability to enable them, to address the 'ongoing capacity of Earth to maintain all life' [40].

Some years ago, one of the authors teaching in Queensland was fortunate to work collaboratively with industry partners and other passionate teachers to facilitate a project with year 11 students to develop a sustainable blueprint for their school, Gladstone State High School. Over a year, the students collected and analysed a strategic data set about resource usage in water, electricity, land and waste management at the school site. Not only was their analysis a valuable life and learning experience that taught them about resource costs and management, but their efforts also resulted in the development of a sustainable blueprint for resource use at their school.

The students later formally presented this blueprint to members of Queensland parliament. Their associated parliamentary petition subsequently influenced policy development in capital works. What is important here is that the Gladstone project was an extra-curricula activity in which the students were invited and chose to participate. They did so every Wednesday night as the project was not considered part of their formal and accredited school learning and achievement.

Today, there are many examples of schools embedding sustainability education into learning experiences, for example, within a whole school approach and connecting kindergarten children to nature [41 and 42]. Despite positive examples, many schools struggle to embed sustainability education into schooling [43]. In those schools that do, it is understood that the driving force of sustainability education is passionate and concerned teachers, but in many cases, teachers lack support from educational leadership teams for implementation [43].

To add to this deficit, sustainability education in initial teacher education in Australia is still an emerging curricula activity and, as in schools, is driven by the concerns and passions of individual teacher academics [44]. In this way, passion, concern and sustainability are intertwined. Educating our future citizens to take an active role in sustainability and understand the dire implications of climate change and accelerating loss of biodiversity is not prioritized but rather at the whim of educators who care.

8.2. Chilean secondary education on sustainable futures

While environmental education in Chile, on a neoliberal system, supports scientific knowledge and individual duty on environmental matters, it does not promote collective social behaviour towards them [45, 46, 47]. Despite uncoordinated implementation of their contributions, three main stakeholder groups have influenced the current environmental education in Chile. Since the 70s and the 80s, informal education from environmental NGOs have not been documented systematically. Projects are implemented in isolation depending on funds and funding stipulations, so such work lacks profound effects [46].

Then, in the 90s, international treaties encouraged the national government to introduce environmental study areas as part of the formal education system [46]. However, research reports that the curriculum still lacks tools to develop critical thinking in students and their citizenship for sustainable development [48, 49]. As recently as 2019, Universities still exclude subjects related to environmental education in undergraduate courses [46, 47]. Professional development in this area is still also lacking [46, 48]. Therefore, teachers do not have formal knowledge and confidence for implementing project-based learning or other strategies that generate student' initiatives towards critical actions as environmental citizens.

Although Chile supports scientific knowledge and individual duty on matters related to the environment, it does discourage areas like collective participation and actions, as well as the analysis of the importance of global and local policies. Foremost, it discourages multidimensional approaches to sustainable development, including cultural, economic, political and social among other factors. In one of the author's professional teaching experience, pedagogies encourage individual actions but not collective ones.

One example is a year 6 student task where they need to design a green area to address erosion and biodiversity. Students needed to conduct research about strategies to tackle erosion in a sloped area and increase the biodiversity of that habitat. Lessons exclude how governments can encourage these types of proposal or how the community can support these types of initiatives.

8.3. Indian graduate and professional education on sustainable futures

One of the authors at an Indian university learnt ecosystem basics and processes including:

- eutrophication effects and need to protect wetland flora and fauna from urbanization
- air, water and land pollution sources from agriculture, industry and towns
- toxicology, chemistry, natural selection, carrying capacity and restoration.

Her first job was adopting Kyoto Protocol guidelines to initially understand and then reduce a pharmaceutical factory's pollution and toxins. Carbon neutrality was achieved by pelletizing nearby waste biomass to cogenerate heat and power to avoid fossil fuel, farm burn-offs and methane from decomposition. Carbon positivity was achieved via government-funded commercial regeneration of desert with pioneering gum-arabic trees. Extracts are used for treating human immunodeficiency and hepatitis C viruses, cancer, nausea and burns.

Benefits other than pharmaceutical and carbon off-sets included gains in the local:

- employment in planting, irrigating, trimming and lopping
- company-built access roads for settlers to live near forestry formerly a desert
- economy with wood supply for fuel, toothpicks, furniture, pallets and or pellets
- regenerated forest, flora and fauna stopping encroaching desertification.

Afterwards, working for an ecolabelling certifier in Australia supervising a wider project range and learning about LCA widened and deepened her perspective via LCBA. Altogether, she learnt how humanity can progress, be urban and yet protect flourishing nature; how net-positive buildings can be designed and assessed and how vital it all is for human living.

8.4. European tertiary education on positively sustainable futures

The situation in Europe in general is very advanced considering education about environment, climate change and sustainable development. Doubtless, because of its precarious exposure to risk of sea level rise from climate change, The Netherlands is most advanced. Indeed, the Universities of Delft and Leiden are long-established leaders in environmental research development and education. The Faculty of Science institute of Environmental Sciences (CML) of Leiden University has pioneered LCA development.

As industrial design contributes to many environmental damages and benefits the influence of design education is critically important for sustainability. In 2019, two Evah Institute authors facilitated research by six Master of Science students in Industrial Ecology at the Technical University Delft and University of Leiden. Students learnt mostly from literature reviews and practitioner interviews. Figure 9 shows charting of damages and benefits on a linear scale adapted from their work and Vlieg et al. [39]. Their framework for benefit assessment in LCA showed that unsustainable damages overwhelm carrying capacity, sustainable damage is within ecological carrying capacity and net-positive benefit is vital for regenerative development.

A key insight was that climate- and biodiversity-secure futures depend on gains beyond zero damage being regenerative enough to restore the natural system to C1750. This was natural system feedback control capacity before man-made global warming and biodiversity loss accelerated from industrialization.

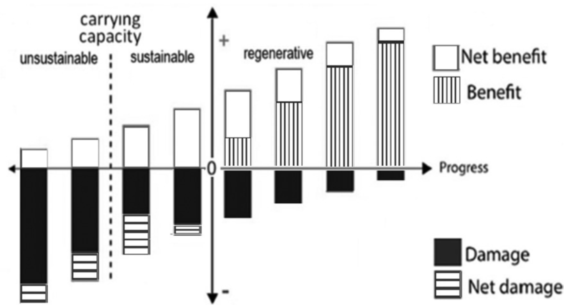

Figure 9: Unsustainable to sustainable to restorative outcomes [39].

9. POSITIVE COMMUNICATIONS: RESPONDING TO ECO-ANXIETY

Eco-anxiety is overwhelming the first generation of students knowingly inheriting unprecedented climate and habitat insecurity. Education for positive development involves developing solutions to eradicate problems. Andrews argues [50] that the focus on negative unsustainability and lack of positive change leaves people suffering from eco-fatigue and climate-depression. It is a critical time for educators to shift focus to teaching positive sustainability with pedagogic strategies for empowering students to develop solutions to avoid causing damages, consider benefits and facilitate community change.

9.1. Establishing a balanced approach

Table 2 from Jones et al. shows a communication and learning framework for balanced organizational planning considering both positive attributes and negative detriments. [8]. They propose that positive learnings and communications are vital to:

- avoid the problem-centric negativity focussed on loss, threats, blaming and barriers
- listen to engage, persuade and understand all sides and advocate win–win solutions
- gain progress in adopting solution-centric positive words, metrics and images
- use positive words, art and humour to reflect restorative solutions
- sight and acclaim restorative steps for inspiring hope in overtaking degeneration
- create, grow and drive opportunity to invest and work in sustainable markets
- hear, educate and transform endemic ignorance, isolation and complacency and
- refute disinformation to divert opponent self-interest and inspire their advocacy [8].

10. DISCUSSION OF ISSUES AND SOLUTIONS

Negative narratives have established and perpetuate a world-wide climate change and biodiversity loss and blame culture. Business unknowingly blocks recovery by ignoring highest short-term climate risks and excluding near-term IPCC factors and beneficial drawdown. Negative communications and frameworks exclude gains in security of supply, climate, habitat and wellness, and blindness to positive formation of ideas or concepts beyond zero loss creates chasms for sustainable market development.

LCBA’s distinctive competitive advantage is the systematic quantification of positive development for reporting all vital gains and losses for investment in sustainable markets.

Table 2: Narrative attributes, qualities and measures.

Framing	Positive attributes	Negative detriments
Sightlines	See opportunity beyond zero	Blind to opposing opportunity
Narratives	Good news. Half full. Praise	Bad news. Half empty. Malign
Catalysts	Praising. Carrots to assert	Scolding. Sticks to abate
Games	Win: win. Gain. Fame. Accord	No win. Lose. Blame. Oppose
Responses	Accept, affirm, honour, emulate	Ignore, deny, cheat, blame
Goals	Score on gain in capacity	Score on loss in capacity
Scope	Positive to zero. Exclude loss	Negative to zero. Exclude gain
Range	Zero origin to full gain end	Full loss origin to zero end
Reach	Approach higher full gain limit	Approach lower full loss limit
Measures	Natural asset surplus	Natural asset deficit
Capacity	Nature at former abundance	Nature at current scarcity
Purpose	To grow repletion	To slow depletion
Policy	Control benefit, gain, surplus	Control burden, loss, deficit

The same principles of communication, learning and assessment, apply to most city and organizational planning tools to leverage sustainable development. Positive networking narratives and action can synergize initiatives and invite broadest participation needed in:

- education to learn earth-system feedback-looped interactive wizardry and apps
- eco-wise science, economics, politics and law to address ecocide and eco-loss
- trending dematerialized renewal lifestyles securing climate and equity
- ethical investment in climate braking and regeneration outcomes and
- promoting wildlife corridors and care for native animals, birds, bees and worms.

National sustainability education examples of leadership and struggle were reviewed. Despite Australia's drought and wildfires, its education system does not prioritize understanding the dire implications of accelerating climate change and biodiversity loss. While sustainability is a cross-curriculum priority and despite good examples, most struggle to embed it as university and school teaching staff often lack support from educational leadership teams as initial teacher education is still emerging. Uptake is driven by individual teacher and academics concerns and passions.

In Chile, current environmental education, pedagogies support scientific knowledge and individual duty on environmental matters. But its curriculum lacks tools for students' critical thinking and teachers lack knowledge of how to generate student environmental citizenship as universities and professional development exclude related subjects. Foremost, it discourages multi-dimensional approaches and collective participation, action and analysis of vital global and local sustainable development policy.

In India, environmental education offerred ecosystem basics and processes, including eutrophication, wetland ecology, toxicology, climate, natural selection, carrying capacity and restoration. Adopting the Kyoto Protocol guidelines enabled understanding and then reduction of pollution, stepping up to carbon neutrality and then carbon positivity. Government-funded project benefits included quantifiable gains in local employment, resettlement, sequestration, investments, ecosystem vitality, species richness, regeneration and economy.

The Netherlands leads in environmental education on sustainable development and the Dutch CML pioneered LCA. As design education is critically important for sustainability development, the authors facilitated research by Delft and Leiden CML Industrial Ecology students. Students learnt that secure futures depend on regenerative gains to restore the natural system feedback control to pre-industrialization capacity. Their framework and charts showed that net-positive benefit is vital for sustainable development.

11. CONCLUSIONS

For over half a century, the entrenched negative narratives about unsustainability and climate change risks have failed to inspire the action required to avert both the current climate and extinction crises. The problem-centric unsustainability focus of core policy frameworks is blind to solution-centric sustainability measures. NGOs advised ISO that it was compelled to overturn LCIA methods, excluding IPCC factors for highest short-term climate risks, but their advice was ignored. Positive narratives and measures are vital to provide new capability to inform sustainable market investments and uphold discretion that ensures equitable gains in sustainable outcomes. Balanced frameworks and quantitative methods can address ecological remediation cover security of supply, climate, habitat and wellness. Case studies showed accounting for gains in security of supply, climate, habitat and people.

12. RECOMMENDATIONS

Talking about benefits and counting gains are critical for engaging people in climate action. Compelling climate and habitat security narratives are urgently needed around carbon drawdown. It is vital to see beyond negative perspectives on damage to zero loss and bridge barriers to positive viewpoints with sightlines to discern future benefits and gains. Beyond reducing pollution and degradation, inhabitants of a sustainable world must regenerate natural assets. Justification of investment in sustainable markets calls for the quantification of benefits and gains in natural assets as much as damages and losses do. Educating future citizens to take an active role in sustainability is at the whim of educators who care. Passion, concern and sustainability are intertwined.

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