

FRAMEWORK OF THE RESEARCH

January 31, 2021

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INTRODUCTION

The present document provides an overview of the proposed framework for the 2020-21 research direction of the Zofnass Program, as described in the Research proposal shared with the Sustainability Industry Advisory Board (SIAB) on November 14th, 2020. The Research proposal was a follow-up action to the discussion of November 10, 2020 with the SIAB members¹, where input was requested on a potential research direction.

Since its original launch in 2012, Envision® has demonstrated an ability to be reactive and receptive to the various external trends that drive industry changes, concretized into two updated versions of Envision so far. The industry understanding of resilience in 2015 motivated an expansion of the Envision to incorporate a more advanced appreciation and understanding of resilience, by updating and reviewing resilience credits. Moreover, there is a growing demand for ESG investing, motivating Envision to incorporate an evaluation of the economics of sustainable infrastructure projects. Presently, the SDGs gain global momentum due to the urgency of climate action and the on-going COVID-19 pandemic crisis, the recovery from which can speed up the transition to a better paradigm.

A shared view among the SIAB members during the November discussion is the expected availability of funds to support restart of the global economy in a post-COVID era -therefore investment in infrastructure projects- constitutes an opportunity and at the same makes more urgent the need for the prioritization of the “right projects”. Envision can be strategic, which is not possible at the level of individual firms.

Two areas of focus emerged to be studied as part of the Envision® framework:

- rate projects explicitly on climate change mitigation and adaptation, and
- evaluate sustainable projects for their return on investment adjusted for risk, which can easier attract financing

Moreover, a discussion on what approach should be adopted in terms of climate change action, mitigation vs. adaptation was initiated that should be further explored.

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1. RESEARCH STATEMENT

The 2020-21 ZHP Research focus aims to assist the Envision framework in adapting and contributing to the ongoing global discourse and research on (a) climate change and (b) investments in sustainable projects.

The Envision® framework, as a set of criteria for the sustainable performance of infrastructure projects, can serve as the basis for the research on the prioritization of projects to be funded a tool to be used by investors. This may lead to prioritizing selected criteria over other criteria. Such a task complements the importance of all criteria that collectively ensure an infrastructure project's sustainable performance. Envision® is a triple bottom line sustainability certification system essential for ensuring a sustainable project regarding social, environmental, and economic performance. None of the three dimensions should be ignored or underrated. However, the use of any tool may lead to 'we are doing the project right in terms of being sustainable,' rather than address the selection of 'the right project.'

1.1. SCOPE OF RESEARCH

The proposed research focus for the Zofnass Program for 2020-2021 consists of research that can support investors for funding projects that address climate change through mitigation and adaptation projects. A dual approach to address the importance of climate change mitigation and adaptation while supporting investors on decision-making or selecting projects to invest in.

The research will build upon the Envision V3 framework and study how Envision can respond to the current urgency and investors demand for climate-friendly projects. To bring out these high-priority criteria, a specific 'filtering' of Envision is required. Therefore, it is essential to research and define what the specific right filtering should be. We propose to follow a recent research methodology that has led to the development of the Lifecycle Sustainability tool by Prof. Pollalis as part of research in collaboration with the National Research Council of Canada (NRCC), to be used during the early decision-making process.

It is worth highlighting that the research's focus on climate change and investors does not suggest a mono-criteria or two-or-three criteria analysis of projects. Priority credits and strategies will be considered across the full extent of their related impacts to provide a stronger case of why investors should choose to fund these projects and the multiple benefits and trade-offs of such decisions.

1.2. RESEARCH QUESTIONS

A series of research questions emerge to support the research's scope and define the research objectives.

- Why is prioritization of projects that mitigate and/or adapt to climate change critical?
- What projects can be considered as climate-related? What baseline requirements do they have to meet?
- Climate change mitigation VS. climate change adaptation
- What are the risks and opportunities of investing on climate projects?

- Is support to climate change action a priority for investors?
- Recovery from COVID-19 as an opportunity to speed up climate action.
- How can Envision contribute to the prioritization of the right projects?
- How can Envision provide evidence to investors of the climate-risks addressed by the project and evidence of the opportunities it presents based on investment imperatives?

2. RESEARCH METHODOLOGY

STEP 1. Literature Review

The literature review is to explore, identify and analyze the topics emerging from the two areas of focus of this research:

- prioritization of projects with significant impact on climate change mitigation, zero-carbon projects, etc., and
- identification of the projects with a high return on investment, risk-adjusted

STEP 2. Envision Review

1. Evolution of Envision from V2 to V3
2. Envision analysis in terms of climate mitigation vs. adaptation
3. Envision analysis in terms of economics

STEP 3. Life Cycle Sustainability Tool Review and reduction to a Generic Form of the Tool

1. Life Cycle Sustainability tool overview
 - A. Add-ons to the Envision Manual
 - B. Usefulness of the tool
 - C. Value for the purposes of the present research
2. Generic Application of the Life Cycle Sustainability tool
 - A. A generic form of the tool (non-transportation specific) to be used in the proposed research
 - B. Review of the generic tool's list of 'IMPACTS' and identification of gaps related to the research main questions
 - C. Update of the list of 'IMPACTS' to create a **final list of 'IMPACTS'** appropriate for the purposes of the research

STEP 4. Input from Companies/Agencies and Investors

Input from SIAB-ZPH members on the basic research questions:

- analysis of the priorities of investors based on interviews

- input from companies and agencies on climate mitigation and adaptation input from investors to identify the main 'IMPACTS' related to climate change and investors
- input from SIAB-ZPH members on potential weighting enhancement to reflect high-priority of climate change and investment criteria.
- members on a case study to (a) provide insight on how climate change & investors risks and opportunities are addressed on a project level and (b) to calibrate/ test the research outcome,
- Selection criteria for project to be used as a representative case study
- use of specific project example(s) to explore multiple benefits or project trade-offs in the social and economic categories of impact

The above input is suggested to be collected through the development of questionnaires. The questionnaires will include questions to help set the selection criteria for the case study to be used. The questionnaires will be adjusted based on progress plus on the literature review.

Issues regarding the questionnaire(s) to be further examined: Is it going to be more beneficial to include two questionnaires? One questionnaire for projects that incorporate climate change mitigation strategies and another one for investors' priorities?

Additionally, information and input from SIAB-ZPH members will be requested regarding:

- the selection criteria for project to be used as a representative case study
- the use of specific project example(s) to explore multiple benefits or project trade-offs in the social and economic categories of impact

STEP 5. Additions to the Generic (Life Cycle Sustainability) Tool based the research findings and reviews

The input from interviews is important to guide the finalization of the list of 'IMPACTS' and develop the final filtering tool for climate change & investor priorities.

STEP 6. Envision Analysis through Final Filtering Tool

1. Analysis of Envision credits regarding the two Research priorities (filtering based on climate change and investor-related criteria) to determine to what extent Envision covers explicitly or implicitly the specific IMPACTS.
2. The Envision filtering will provide the input/material towards an Envision-based prioritization model for investment on 'the right projects'.

STEP 7. Application of the Envision-based Prioritization Model based on a Selected Case Study

STEP 8. Review and Update of the Research Outcome based on Final Comments

3. SCHEDULE: TASKS & DELIVERABLES

3.1 List of Research Tasks

- Task 1:** Literature review (STEP 1)
- Task 2:** Comparisons of mitigation vs adaptation in Envision rating system (STEP 2)
- Task 3:** LC Sustainability tool review (STEP 3)
- Task 4:** Reduction to a generic form of LC Sustainability tool (STEP 3)
- Task 5:** Review of the generic tool's existing list of IMPACTS, identification of gaps related to the research main questions and update of the list of 'IMPACTS' (STEP 3)
- Task 6:** Development of generic questionnaire(s) for input request by the SIAB members (STEP 4)
- Task 7:** Conduction of Interviews / Collection of material shared by companies/agencies and investors and compilation of data input (STEP 4)
- Task 8:** Selection of project case study (STEP 4)
- Task 9:** Development of the final list of 'IMPACTS' and transform the generic tool into the final filtering tool adapted for climate change & investors (STEP 5)
- Task 10:** Envision Analysis through the final filtering tool (STEP 6)
- Task 11:** Application of the Envision-based prioritization model on the selected case study (STEP 7)
- Task 12:** Final Review and research submission (STEP 8)

3.2 Schedule & Deliverables

Tasks	RESEARCH SCHEDULE																							
	DECEMBER				JANUARY				FEBRUARY				MARCH				APRIL				MAY			
	D1	D2	D3	D4	J1	J2	J3	J4	F1	F2	F3	F4	Mar1	Mar2	Mar3	Mar4	A1	A2	A3	A4	May1	May2	May3	May4
Research document																								
Literature review (Task 1)																								
Comparisons of mitigation vs adaptation in Envision rating system (Task 2)																								
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Envision Analysis through final filtering tool (Task 10)																								
Application of the Envision-based prioritization model on the selected case study (Task 11)																								
Final Review and research submission (Task 12)																								

| Milestones and Deliverables
 | Presentations to & input request from SIAB members

List of deliverables

J4 - end of January:

Research framework (document) _ First submission including:

- Literature review (preliminary) related to climate change, mitigation, adaptation, impacts, current trends and to investors priorities, risks, current trends etc.
- Comparisons of mitigation vs. adaptation in Envision rating system (1st draft)
- Life Cycle Sustainability tool presentation (1st draft)
- Reduction to a generic form of Life Cycle Sustainability tool (1st draft)
- Review of the generic (Life Cycle Sustainability) tool's existing list of 'IMPACTS' & identifying gaps related to the research main questions (1st draft)

F1- 1st week of February:

- Development of generic questionnaire(s) (for companies, agencies and investors) to request input from the SIAB members

F2- mid February:

- Research framework presentation (ppt) to SIAB members based on the end of January Research framework submission

- Present the generic questionnaire to get input from SIAB members
- Suggest the use of a project case study and request input from SIAB members regarding the project selection

F3- 3rd week of February:

- Update the generic questionnaire(s) based on SIAB members review and input

F4- end of February:

- Starting with interviews and with the compilation of data reviewed from companies/agencies and investors
- Completion of the updated existing list of 'IMPACTS' & transformation of the generic tool into the final filtering tool adapted for climate change & investors

Mar1- 1st week of March:

- Starting with the development of the final list of 'IMPACTS' for filtering

Mar2- mid of March:

- Review input regarding Interviews and compilation of data input
- Review input from SIAB members in relation to the selected project case study and the received material
- Discussion with SIAB members regarding the completion of the final list of 'IMPACTS' for filtering

Mar4 - end of March:

Research document _ INTERIM REPORT including:

- Literature review interim submission
- Progress related to the interviews and compilation of data input
- Final material regarding the selected project case study
- Progress on the final list of 'IMPACTS' for filtering
- Complete review of the material received regarding the selected project case study
- Starting with the Envision Analysis through the final filtering tool

A2- mid of April :

Research progress presentation (ppt) to SIAB members including:

- Literature review (semi-final submission)
- The final list of 'IMPACTS' for filtering progress
- The progress on Envision Analysis through the final filtering tool
- The 1st draft application of the new Envision-based prioritization model on the selected case study

A4- end of April :

Research document semi-final update including:

- Literature review (final)
- The final input received from the SIAB members, companies/agencies and investors
- The completion of the final list of 'IMPACTS' for filtering
- The Envision Analysis through the new tool and final conclusions
- The application of the new Envision-based prioritization model on the selected case study and conclusions

May4- end of May :

Research document: FINAL Submission

PART1: BACKGROUND RESEARCH

1. LITERATURE REVIEW (in progress)

Literature Review methodology

Considering the broad field and multiple concepts, key words and scientific researches related to : climate change mitigation, adaptation, resilience, impacts, urgent actions, investors risks, priorities, hidden costs, initiative etc. the literature review methodology will be based on:

- Briefly documenting a timeline of milestones when main topics of the research were introduced. For example the 2030 Agenda for Sustainable Development refers to the Global indicator framework for the Sustainable Development Goals (SDGs) and targets. When did the global discussion on SDGs become more intense and urgent? Obviously these milestones, events, discussions and concepts are related to International organizations, Programmes, Funds, Agencies, Conventions, Panels, Reports, Projects and documents and it is part of this literature review to go through and examine those that serve the research purpose.
- Determining in which period, this study will mainly focus. It is important to define what are considered current main shifts and milestones today, after which the research's questions will be explored. For example what are the current risks and opportunities of investing on climate projects? Which are the current trends that drive industry changes?
- developing a list/matrix of keywords, trends and topics that will highlight the connections among climate change mitigation, adaptation and investor-related criteria. As mentioned earlier, an analysis of Envision in terms of climate change has already been performed as part of the Life Cycle Sustainability research. It has linked Envision credits (and their related strategies) with a positive or negative impact. For example, impact related to direct contributors to climate change, such as 'energy', emissions and embodied carbon (mitigation) and secondly 'resilience value', 'ecological resilience', 'social resilience' (adaptation). However how these impacts are related to investors' risks and opportunities and which new impacts should be added will be further explored.

1.1. LITERATURE REVIEW ON CLIMATE CHANGE

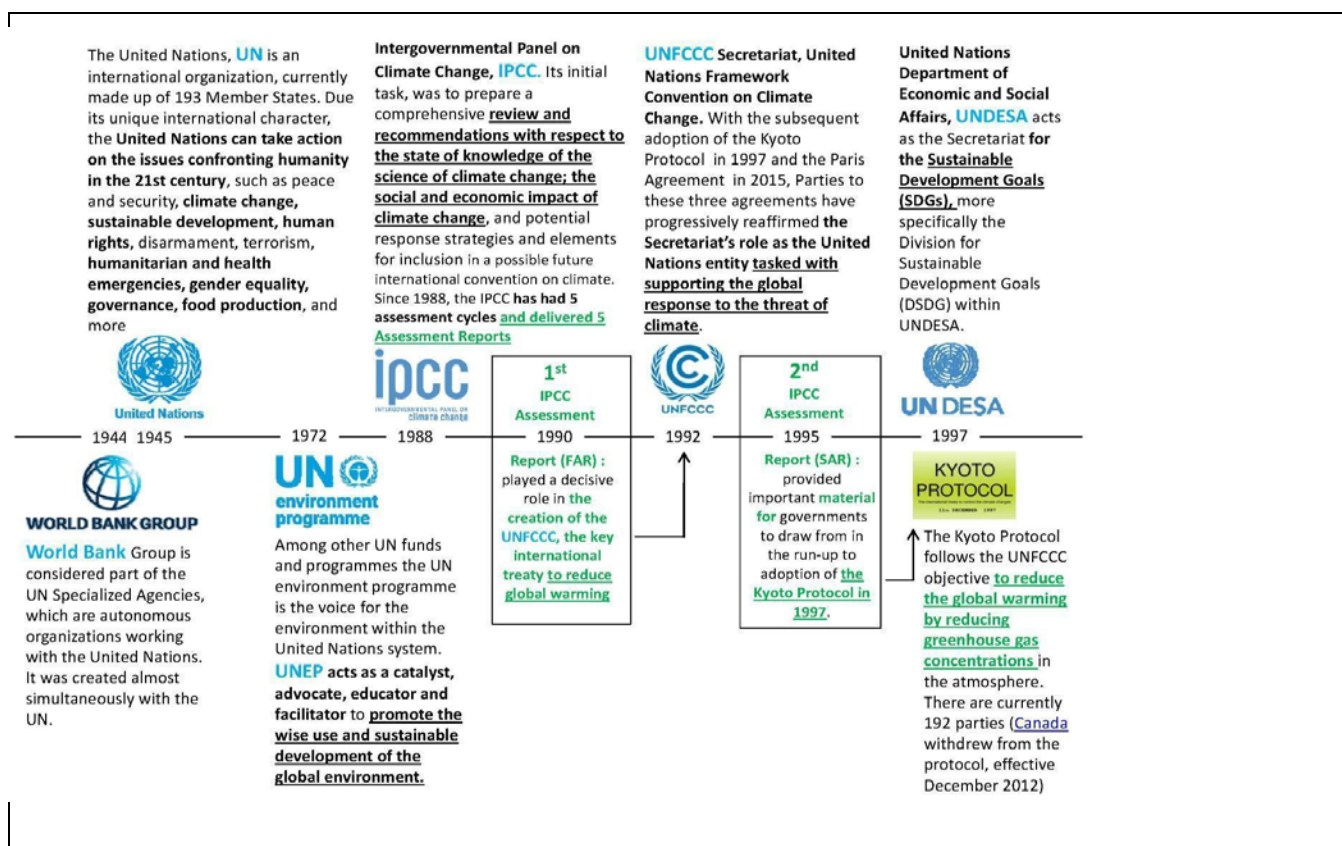
One of the two areas of focus to be studied in the proposed research and as part of the Envision® framework is to rate projects explicitly on climate change mitigation and adaptation.

As part of the literature review we try to identify milestones in the on-going global discourse on Climate change and the gradual evolution of the science of climate change through Institutions, organizations and agencies which analyzed, explore and highlighted the need and lately the urgency for a sustainable development of the world environment.

In the timeline presented below it is evident that for almost 5 decades since its establishment United Nations' Environment Programme is the voice for the environment, its protection and wise use at a global scale.

At the same time milestones such as *the creation of the Intergovernmental Panel on Climate Change (IPCC) a body of the United Nations for assessing the science related to climate change, provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options.*² Since 1990 the IPCC has published 5 Assessment Reports, each one of which has paved the way for significant steps towards global warming reduction, the oldest and widely acknowledged being the Kyoto Protocol signed in 1997 and the most recent milestone being the Paris Agreement signed in 2015 with 187 countries being party to it. Main points of both Kyoto Protocol and Paris Agreement will be explored and presented. The multiple Institutions, Funds, Initiatives and Programs that were founded the last decades with the aim to support the global response to climate change cannot be extensively explored within the research’s limited boundaries.

However a background on the Sustainable Development Goals (SDGs) evolution, which focused attention on the impacts of climate change and the need for adaptation, will provide a strong base to understand the current the uncertainty in investment decision making and the strategies needed to be adopted.



² <https://www.ipcc.ch/>

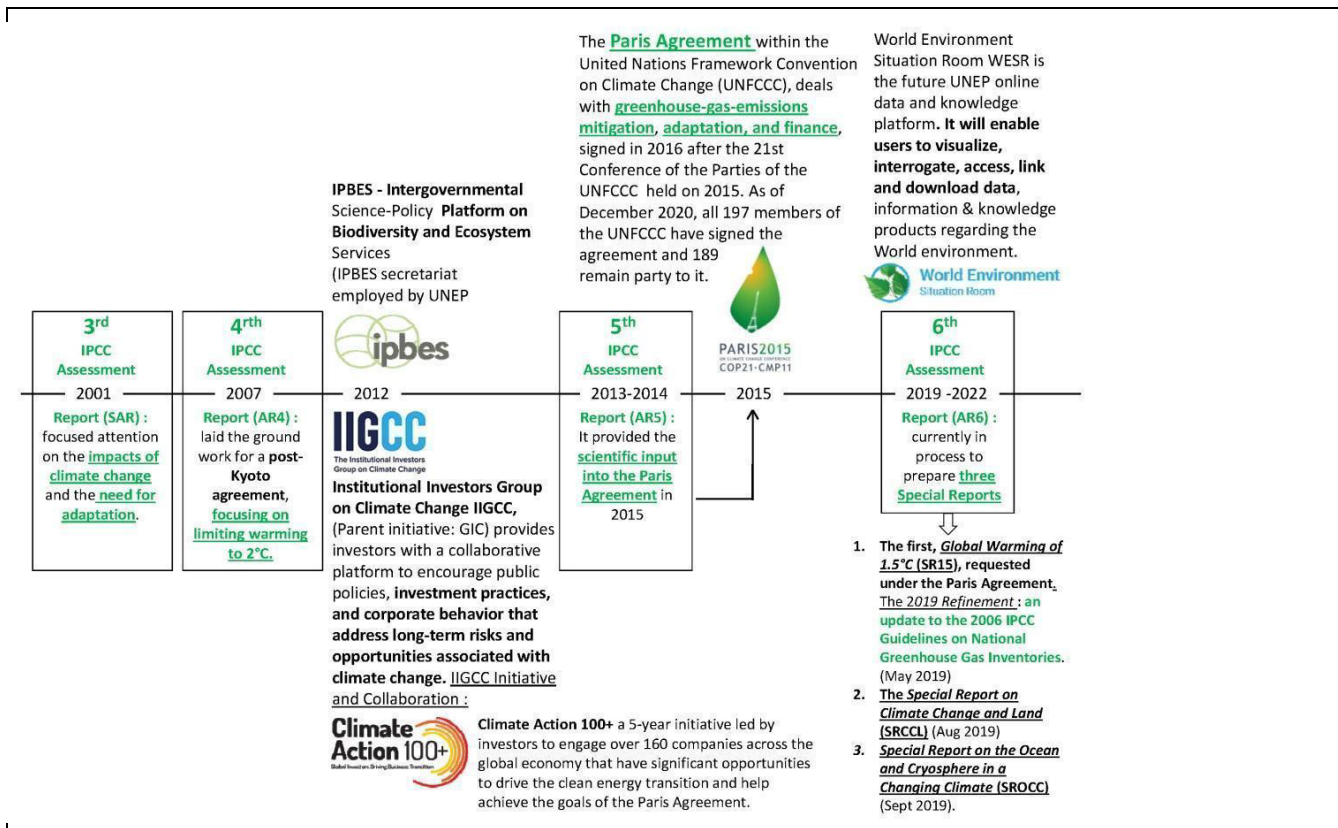


Fig. 1: A draft timeline documenting main milestones and some of the international institutions, panels, reports and more involved in the development of Kyoto Protocol (1997) and Paris Agreement (2015).

1.1.1. Main objectives and goals until 2015

The Kyoto Protocol - GHG emission limits, market mechanisms for trading of emissions permits and the Adaptation Fund

The Kyoto Protocol is an international agreement, adopted on 1997 (which entered into force as an international law on 2005) where 192 Parties/Nations committed to reducing their CO₂ emissions by an average of 5.2% over the five year period 2008–2012³, which would represent about 29% of the world's total emissions.⁴

The Kyoto protocol, defined also as an extension or product of the *United Nations Framework Convention on Climate Change (UNFCCC)*⁵, set binding emission reduction targets for 37 industrialized countries and economies in transition and the European Union⁶, to **limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets**.⁶ It was a first time a treaty asks developed countries to **adopt policies and measures on mitigation and to report periodically**, underlying this way the *historical responsibility*

³ 2008-2012 was the first commitment period addressed in Kyoto agreement, https://unfccc.int/kyoto_protocol

⁴ Countries that ratified the Kyoto Protocol were assigned maximum carbon emission levels for specific periods and participated in carbon credit trading. If a country emitted more than its assigned limit, then it would receive a lower emissions limit in the following period, <https://earth.org/the-kyoto-protocol/>

⁵ The UNFCCC is also the parent treaty of the 1997 Kyoto Protocol, <https://unfccc.int/about-us/about-the-secretariat>

⁶ https://unfccc.int/kyoto_protocol

*of rich countries for emitting greenhouse gases. The Kyoto Protocol made concrete how big emitters should take the lead in slowing climate change.*⁷

An important consideration in the Kyoto Protocol was the separation of developed (the 37 industrialized nations plus the EU) and developing nations. The emission limits were applied to the first group, while the developing countries were asked to voluntarily comply. *However, more than 100 developing countries, including China and India, were exempted from the treaty.*⁸

By recognizing these two groups of countries, the Kyoto Protocol introduced ***flexible market mechanisms based on the trade of emissions permits***, which offered to the countries – which their priority is to *meet their targets primarily through national measures - an additional means to meet their targets by way of three market-based mechanisms (a) International Emissions Trading (IET), (b) Clean Development Mechanism (CDM) and (c) Joint implementation (JI).*⁹ By investing in projects to lower emissions a country earns credits that could be exchanged, traded or sold to a country with high carbon emissions. This meant countries that did not meet reduction targets could "buy" the right to extra emissions from the budgets of less-polluting countries. Trading carbon at the end allows (developed) countries to continue emitting GHGs and *CO₂ had been given a price for the first time.*¹⁰

The “trade of emissions mechanism” couldn’t be implemented if there wasn’t for a *monitoring emission targets system that would ensure transparency and hold Parties to account. Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out.*¹¹

Another element addressed by the Kyoto Protocol is related to increasing resilience through the establishment of the Adaptation Fund *which finances projects and programmes that help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views and priorities. Since 2010 has committed US\$ 720 million to climate adaptation and resilience activities, including supporting 100 concrete adaptation projects.*¹²

Despite the Doha Amendment¹³ to the Kyoto Protocol, where a second commitment period 2013 until 2020 was adopted, mostly focusing on new commitments for the parties/nations to follow during that new period and on revising the list of GHG emissions, the results and targets were not reached. Key factors to missing the targets and commitments were the withdrawal of the U.S. formally in 2001¹⁴ and of Canada in 2011. *Without*

⁷ <https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473>

⁸ <https://earth.org/the-kyoto-protocol/>

⁹ These mechanisms ideally encourage GHG abatement to start where it is most costeffective, for example, in the developing world, https://unfccc.int/kyoto_protocol

¹⁰ <https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473>

¹¹ https://unfccc.int/kyoto_protocol

¹² <https://www.adaptation-fund.org/about/>

¹³ Doha Amendment was held in 2012, <https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment>

¹⁴ “When the US — responsible for a large part of historic CO₂ emissions — withdrew from the agreement in 2001, and Canada in 2011, many observers thought the Kyoto Protocol had failed. But by 2012, the emissions of the industrialized countries had dropped 20% from 1990 levels — five times the Kyoto targets of the remaining nations. The EU cut emissions by 19%, and Germany by 23%. Over the same period, however, global emissions rose by around 38%”, <https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473>

the two largest carbon dioxide emitters — the U.S. and China — in the treaty, any progress made by the remaining countries was less significant on a global scale.¹⁵

Millennium Development Goals (2000-2015)

An almost parallel to the Kyoto Protocol on Climate change action, was the *historic United Nations Millennium Declaration signed in September 2000 by world leaders of 189 countries and United Nations, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals (MDGs). The 8 MDGs were revolutionary in providing a common language to reach global agreement among all the world's countries and the entire world's leading development institutions*¹⁶.



Fig. 2: The 8 Millennium Development Goals – MDGs that originated from the UN Millennium Declaration

Regarding the “new global partnership” part of the commitment and the respective responsibilities shared by both developed and developing countries, within the MDGs framework *for the first time rich countries acknowledged and agreed that:*

- *Poor countries cannot achieve the goal unless rich countries increase and improve the effectiveness of their aid and change the rules of trade to foster development.*
- *Donors are part of the problem and, as such, are willing to become part of the solution, allowing recipient countries to take on their responsibilities. **This is what the MDGs are about: an agreement between rich and poor countries, each of which must be held accountable by their own respective citizens.***¹⁷

¹⁵ Andrew Wong, “Even without the US, the Paris climate agreement can succeed where its predecessor failed”, Published in 2018, <https://www.cnbc.com/2018/02/11/unlike-the-kyoto-protocol-the-paris-agreement-can-still-succeed.html>

¹⁶ The MDGs were realistic and easy to communicate and were structured with a clear measurement / monitoring mechanism, <https://www.un.org/millenniumgoals/bkgd.shtml>

¹⁷ <https://www.un.org/en/chronicle/article/millennium-campaign-successes-and-challenges-mobilizing-support-mdgs>

As for the ultimate goal of the MDGs to reduce of extreme poverty, with the aim to increase living standards and improve the well-being in the developing world, the MDGs emphasized three intertwined areas: **the human capital, the infrastructure and human rights** (social, economic and political).

*The Goals for hunger and disease are part of human capital. The Goals for water and sanitation and slum dwellers are part of infrastructure. The Goal for environmental sustainability is part of natural capital. The first Goal for income poverty is part of economic growth. And because meeting the Goals for hunger, education, gender equality, environment, and health is vital for overall economic growth and development, it is a mistake to talk simply about the rate of economic growth needed to achieve the Goals in a country. It is more helpful, particularly for the poorest countries caught in economic stag-nation, to describe the range and levels of investments needed to achieve the Goals and thus to support overall economic growth.*¹⁸ This means that although the goals are global, they need to be adapted into the local conditions, priorities and needs which have to be locally determined. **The most important aid reform is realizing that donors do not develop; developing countries must develop themselves.**¹⁹

Although ambitious and with a global involvement, a decade after the MDGs adoption, the achievements seemed to have been uneven. The main lessons learned from the 8 goals²⁰ formed the base for the next steps and new goals that succeeded the MDGs. Indicative points to be taken into consideration are the following :

- *MDGs acceleration depends on the timeliness and effectiveness of policy instruments*
- *Strong government involvement ensures the greatest impact of MDG-related interventions*
- *Lack of quality data and analysis poses a serious constraint to timely monitoring, policy development and the ability to target interventions where most needed.*
- *Communities mobilization are central to achieving development results*
- *Achieving long-term development requires bridging the humanitarian and development agendas*
- *Operating under a normative framework, the UN system needs to push for the inclusion of issues that may have been deprioritized at the country level.*

*At the same time a discussion of a post-2015 agenda had started and was focusing on building a sustainable world where environmental sustainability, social inclusion, and economic development are equally valued.*²¹ Hence the MDGs have been superseded by the Sustainable Development Goals, the SDGs.

1.1.2. Main objectives and goals after 2015[†]

*Climate change presents the single biggest threat to sustainable development everywhere and its widespread, unprecedented impacts disproportionately burden the poorest and most vulnerable.*²²

¹⁸ UN Millenium project, "Investing in Development-A practical Plan to achieve the MDGs", 2005, Overview p.5
<https://www.who.int/hdp/publications/4b.pdf>

¹⁹ <https://www.un.org/en/chronicle/article/millennium-campaign-successes-and-challenges-mobilizing-support-mdgs>

²⁰ The ten key points from the lessons learned during the MDGs adoption are presented in the 'Transitioning from the MDGs to the SDGs' report, by the UN System Chief Executives Board for Coordination (CEB) 2015,
<https://reliefweb.int/sites/reliefweb.int/files/resources/Transitioning%20from%20the%20MDGs%20to%20the%20SDGs.pdf>

²¹ 'From MDGs to SDGs' , The SDG Fund, <https://www.sdgfund.org/mdgs-sdgs>

The year 2015 was a landmark year for multilateralism and international policy shaping, with the adoption of several major agreements.²³ Collectively, four post-2015 agendas for action that coincided are:

1. The 2030 Agenda for Sustainable Development calling for an urgent action to halt climate change and deal with its impacts and **setting new goals (building on the MDGs), the Sustainable Development Goals (SDGs)** was signed in September 2015
2. The Paris Agreement, a historic agreement reached in December 2015 at the COP21 Paris Climate Conference
3. The Sendai Framework for Disaster Risk Reduction, *signed in March 2015*, was the foundation for sustainable, **low-carbon and resilient development under a changing climate, a transition towards zero emissions**
4. The Addis Ababa Action Agenda on Financing for Development which was adopted in July 2015²⁴

*These agreements provided a set of common standards and achievable targets to reduce carbon emissions, manage the risks of climate change and natural disasters, and to build back better after a crisis.*²⁵

The 2030 Agenda and the Sustainable Development Goals – SDGs (2015-2030)

At the "Rio+20" Conference on Sustainable Development, governments decided to develop global Sustainable Development Goals, including issues such as natural resources management, sustainable consumption and production, effective institutions, good governance, the rule of law and peaceful societies. Some of the most important characteristics of the 2030 Agenda are:²⁶

- a. **The set of the 17 Sustainable Development Goals and 169 targets**
- b. **Its scale, ambition and approach.** *For example the SDGs are global in nature and applicability, taking into account national realities, capacities, levels of development and specific challenges. All countries have a shared responsibility to achieve the SDGs and a meaningful role to play locally, nationally and on the global scale*
- c. **The integration of the 3 dimensions of sustainable development – economic, social and environmental.** *It must be implemented in an integrated manner, as the various goals and targets are closely interlinked.*
- d. **The concept of global partnership,** *supported by a comprehensive approach to the mobilization of all means of implementation*²⁷. *In order to ensure progress and long-term accountability, the 2030 Agenda includes a strong follow-up and review mechanism which will allow all partners to assess the impact of their actions.*

In contrast to the MDGs, the SDGs seek to complete what the first set of goals did not achieve, applying thus to all countries from the Global South to the Global North and recognizing that local needs and priorities are different and variable. Moreover adding to economic and social goals, the SDGs explicitly address ecological sustainability challenges.

²² <https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs>

²³ <https://sdgs.un.org/goals>

²⁴ <https://sdgs.un.org/goals>

²⁵ <http://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html>

²⁶ https://ec.europa.eu/environment/sustainable-development/SDGs/index_en.htm

²⁷ The implementation of the 2030 Agenda is complemented by the Addis Ababa Action Agenda, which is an integral part.



Fig. 3: The 17 Sustainable Development Goals SDGs

As presented in the graph in the next figure some of the MDGs were developed into two SDGs, like in the case of MDG 1, as for the MDG 4, MDG 5, MDG 6 they were combined to form a new goal SDG 3 related to “Good health and well being”.



Fig. 4: The evolution from MDGs to SDGs²⁸

However the most interesting elaboration is the case of MDG 7 “Ensure Environmental Sustainability”. Taking into consideration that the new goals set from 2015 onwards, *are an urgent call to shift the world onto a more sustainable path*²⁹, MDG 7 resulted into 6 new SDGs :



Fig. 5: The MDG no.7 “Ensure Environmental Sustainability”, resulted in 6 new SDGs³⁰

SDG 6 “Clean water and sanitation”

SDG 7 “Affordable and clean energy”

SDG 12 “Responsible Consumption and production”

SDG 13 “Climate action”

SDG 14 “Life below water”

SDG 15 “Life and land”

²⁸ Image taken from the paper by Stefan Zagelmeyer and Rudolf R Sinkovics, “MNEs, Human Rights and the SDGs – The Moderating Role of Business and Human Rights Governance”, 2019, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3624076

²⁹ <http://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html>

³⁰ <http://muslimpoliticians.blogspot.com/2018/02/dari-mdgs-ke-sdgs-transformasinya-dan.html>

Paris Agreement – Long-term temperature goal – Towards Zero carbon solutions

In Paris, on 2015, Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and **intensify the actions and investments needed for a sustainable low carbon future.**³¹

It is considered a milestone *in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.* **The central aim** of the Paris Agreement is to cut GHG emissions so as to **keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels, while taking steps to limit this to 1.5 degrees.**³²

The mechanism for implementing the Agreement is **Nationally determined contributions (NDCs)**, requesting from each signatory country to submit their own plan for climate action, in line with the overall targets and dates. *In their NDCs, countries communicate*

- *Actions they will take to **reduce their Greenhouse Gas emissions** in order to reach the goals of the Agreement. Climate finance is needed **for mitigation**, because large-scale investments are required to significantly reduce emissions³³ and it is equally important to *direct finance flows to projects which align with lower GHG emissions*³⁴ It is worth noting that the definition of climate change mitigation, used by the European Union, has been adapted to the goals set by the Paris Agreement.”³⁵*
- *Actions they will take to **build resilience to adapt** to the impacts of rising temperatures. Climate finance is equally important **for adaptation**, as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate.*

Additional supportive tools³⁶ referred in the Paris Agreement, for countries to reach these ambitious goals are:

- A new technology framework and enhanced capacity-building. This means that since not all developing countries have sufficient capacities to deal with many of the challenges brought by climate change, it is requested from all developed countries to enhance support for capacity-building actions in developing and the most vulnerable countries, *in line with their own national objectives.*
- A new tracking progress through *a transparency, implementation and compliance*³⁷ framework. In this context the Agreement requires, in addition to reporting information on mitigation, adaptation and support, that the information submitted by each Party undergoes international technical expert review.

³¹ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement>

³² <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

³³ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

³⁴ <https://earth.org/what-is-the-paris-agreement/>

³⁵ E.U. Environmental Social Governance (ESG) Regulations Guide, 2020

³⁶ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

³⁷ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement>

Developed with a loose-fitting framework, the accord allows individual countries to independently evolve and adjust their climatic strategies. But, unlike the Kyoto Protocol, there are no legally binding terms in the Paris agreement. The difference is the willingness of the countries to participate in the Paris accord — which is a wholly voluntary agreement. “The signatories in the agreement are there voluntarily, and this shows that they are committed in fighting climate change, as opposed to the Kyoto Protocol,”³⁸

The COVID-19 pandemic has delayed this year’s Conference of the Parties (COP26) talks until 2021, where updated NDCs would have been announced and the Paris Agreement would officially come into effect. However the aims for COP26 focuses on more ambitious NDCs submitted by all countries, committing to further cuts in carbon emissions by 2030 and placed high emphasis on all countries to commit **to reach net zero emissions as soon as possible.**³⁹

Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 was the first major agreement of the post-2015 development agenda and provides Member States with concrete actions to protect development gains from the risk of disaster. *It works hand in hand with the 2030 Agenda agreement, the Paris Agreement on Climate Change, the Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda and ultimately the Sustainable Development Goals and it advocates for:*

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

It recognizes that the State has the primary role to reduce disaster risk, but that responsibility should be shared with other stakeholders including local government, the private sector and other stakeholders.⁴⁰

To support the assessment of global progress in achieving the *Expected outcome and goal*⁴¹, **7 global targets have been agreed:**

- (a) *Substantially reduce global disaster mortality by 2030*
- (b) *Substantially reduce the number of affected people globally by 2030*
- (c) *Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030*
- (d) *Substantially reduce disaster damage to critical infrastructure and disruption of basic services, by 2030*

³⁸ As Chris Field, the director of Stanford Woods Institute for the Environment explained to CNBC author Andrew Wong, “Even without the US, the Paris climate agreement can succeed where its predecessor failed”, Published in 2018, <https://www.cnbc.com/2018/02/11/unlike-the-kyoto-protocol-the-paris-agreement-can-still-succeed.html>

³⁹ <https://earth.org/what-is-the-paris-agreement/>

⁴⁰ <https://www.undrr.org/implementing-sendai-framework/what-sendai-framework>

⁴¹ According to the “Sendai Framework for Disaster Risk Reduction 2015-2030 report the Expected outcome and goal” to achieve and realize the goal the Framework advocates for, over the next 15 years, a strong commitment and involvement of political leadership in every country at all levels in the implementation, a follow-up of the present Framework and the creation of the necessary conducive and enabling environment are required.

https://www.preventionweb.net/files/43291_sendaiframeworkfordren.pdf

- (e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
- (f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementing the Framework by 2030
- (g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.⁴²

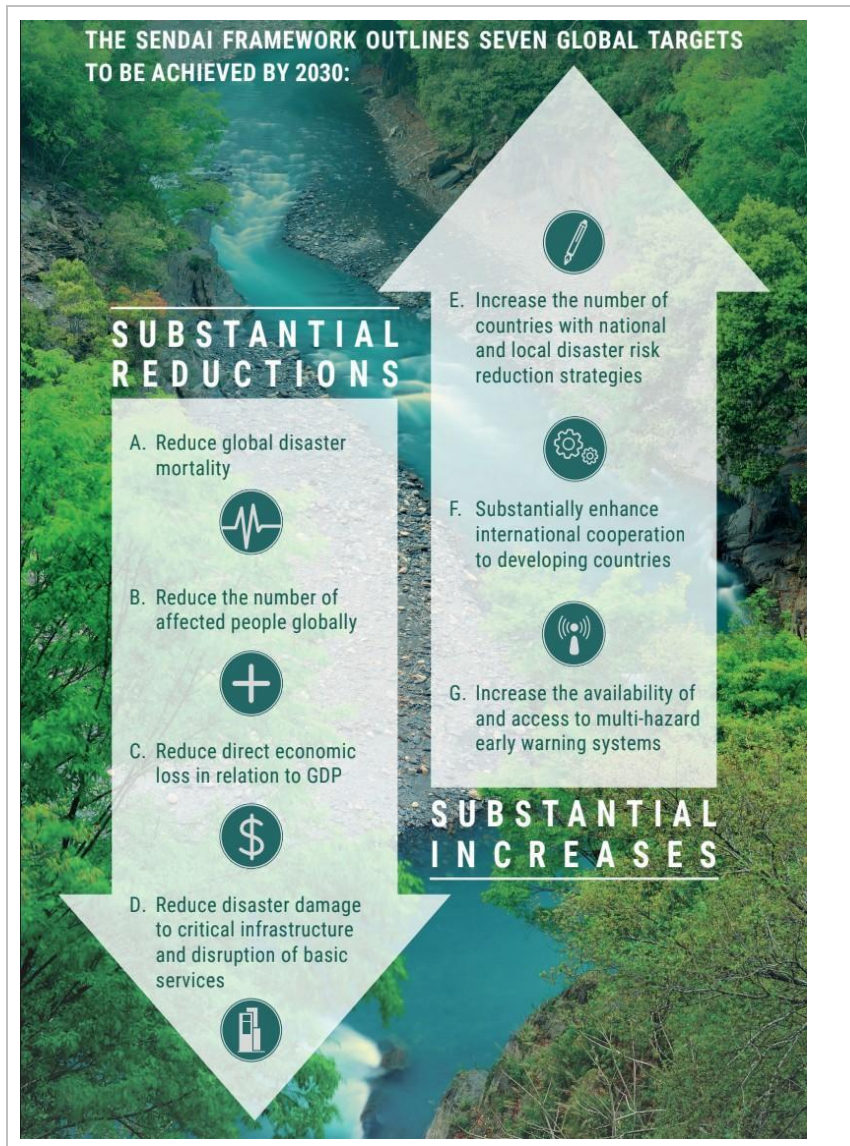


Fig. 6: The 7 targets of Sendai Framework

Risk is increasingly systemic. If we want to reduce risk then we also must be increasingly joined up in our approaches: working cross-sectors, between and within institutions, and ensuring harmony from policy through to activity. Both the Sendai Framework and the Sustainable Development Goals (SDGs) outcomes is a product of interconnected social and economic processes. As such, there is a lot of synergy between the two policy

⁴² https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

*instruments.*⁴³ There is recognition in the proposals for both the SDGs and the Sendai Framework that their desired outcomes are a product of complex and interconnected social and economic processes with overlap across the two agendas.

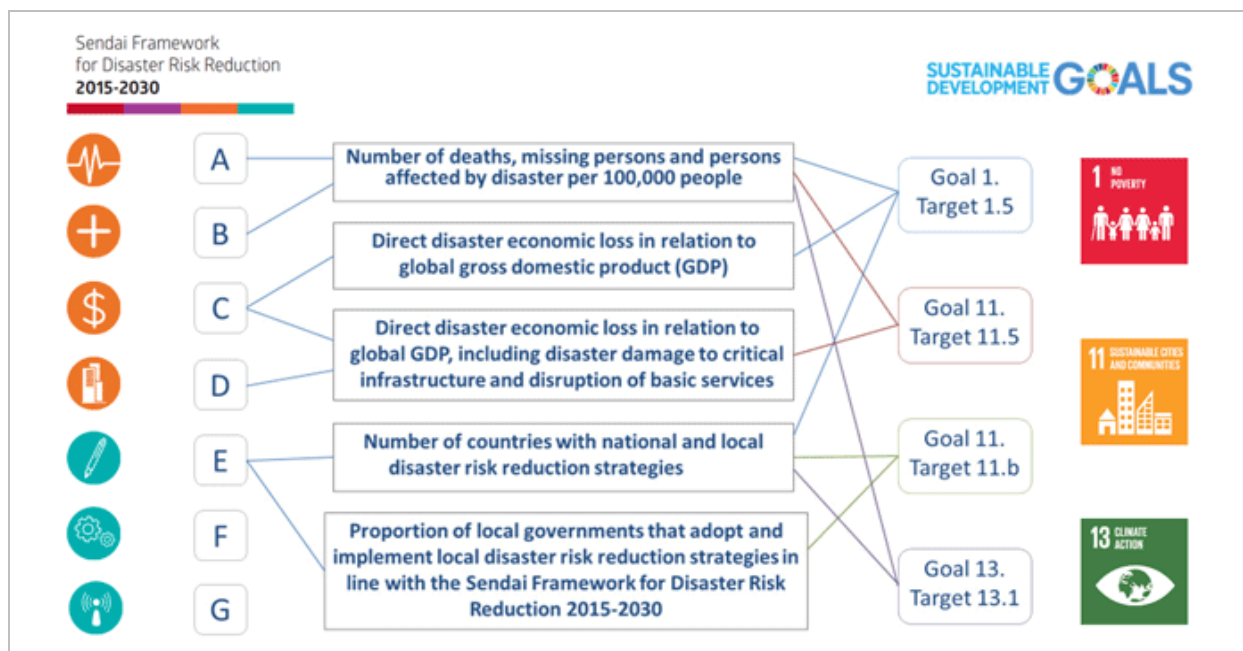


Fig. 7: Integrated monitoring of the global targets of the Sendai Framework and the Sustainable Development Goals⁴⁴

1.1.3. On Urgency, “Climate Action” goal beyond 2020

“Despite clear emission reduction objectives agreed in the 2015 Paris Agreement on Climate Change, global greenhouse emissions have continued to climb until 2019 where they flatlined. There is now scientific consensus⁴⁵ that global emissions must drop by 50% over the next decade for the world to have a chance of staying at 1.5 degrees of global warming and thus avoid the most catastrophic consequences of climate change. This has clear and immediate implications for businesses.”⁴⁶

The impacts of climate change are now inevitable and apparent with signs that several alarming tipping points will be reached, particularly in excessive air pollution, water stress and biodiversity loss that undermines ecosystems.

“The message on the urgency of environmental and climate risks is getting through. In its 15th Global Risks Report published in January 2020, the World Economic Forum (WEF) found that, for the first time in the

⁴³ <https://www.undrr.org/implementing-sendai-framework/sf-and-sdgs>

⁴⁴ <https://www.preventionweb.net/sendai-framework/sendai-framework-monitor/common-indicators>

⁴⁵ Point C1 of the Summary for Policy Makers of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C, <https://www.ipcc.ch/sr15/> (Source: EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020)

⁴⁶ EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020

report's history, **all of the “top long-term risks by likelihood” are environmental, and climate change is rated the biggest global threat.**⁴⁷

One of the main questions that the proposed research seeks to explore is if supporting climate change action is a priority for investors?

*Governments and businesses should use the lessons learned and opportunities arising from this crisis to accelerate the transitions needed to achieve the Paris Agreement and the Sendai Framework for Disaster Risk Reduction 2015–2030, **redefine our relationship with the environment, and make systemic shifts and transformational changes to become low-greenhouse-gas emission and climate-resilient economies and societies.***⁴⁸

In this context, many existing ESG regimes, as for example the EU ESG regime, are being redeveloped to align with the 17 SDGs, as part of their commitment to the UN 2030 Agenda.

“Of the SDGs, the goal of combating climate change (SDG 13) has been identified by the EU political institutions as the most pressing, after adopting the UN Paris Climate Change Agreement.”⁴⁹

Sustainable Development Goal 13 “Climate action” targets

5 Targets linked to the climate action:⁵⁰

- Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- Target 13.2: Integrate climate change measures into national policies, strategies and planning
- Target 13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
- Target 13.a: Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly \$100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
- Target 13.b: Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

⁴⁷ WEF Global Risks Report 2020, <https://www.weforum.org/reports/the-global-risks-report-2020> (Source: EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020)

⁴⁸ SDG 13 “Climate Action”, <https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf>

⁴⁹ E.U. Environmental Social Governance (ESG) Regulations Guide, 2020

⁵⁰ <https://www.unenvironment.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-13>

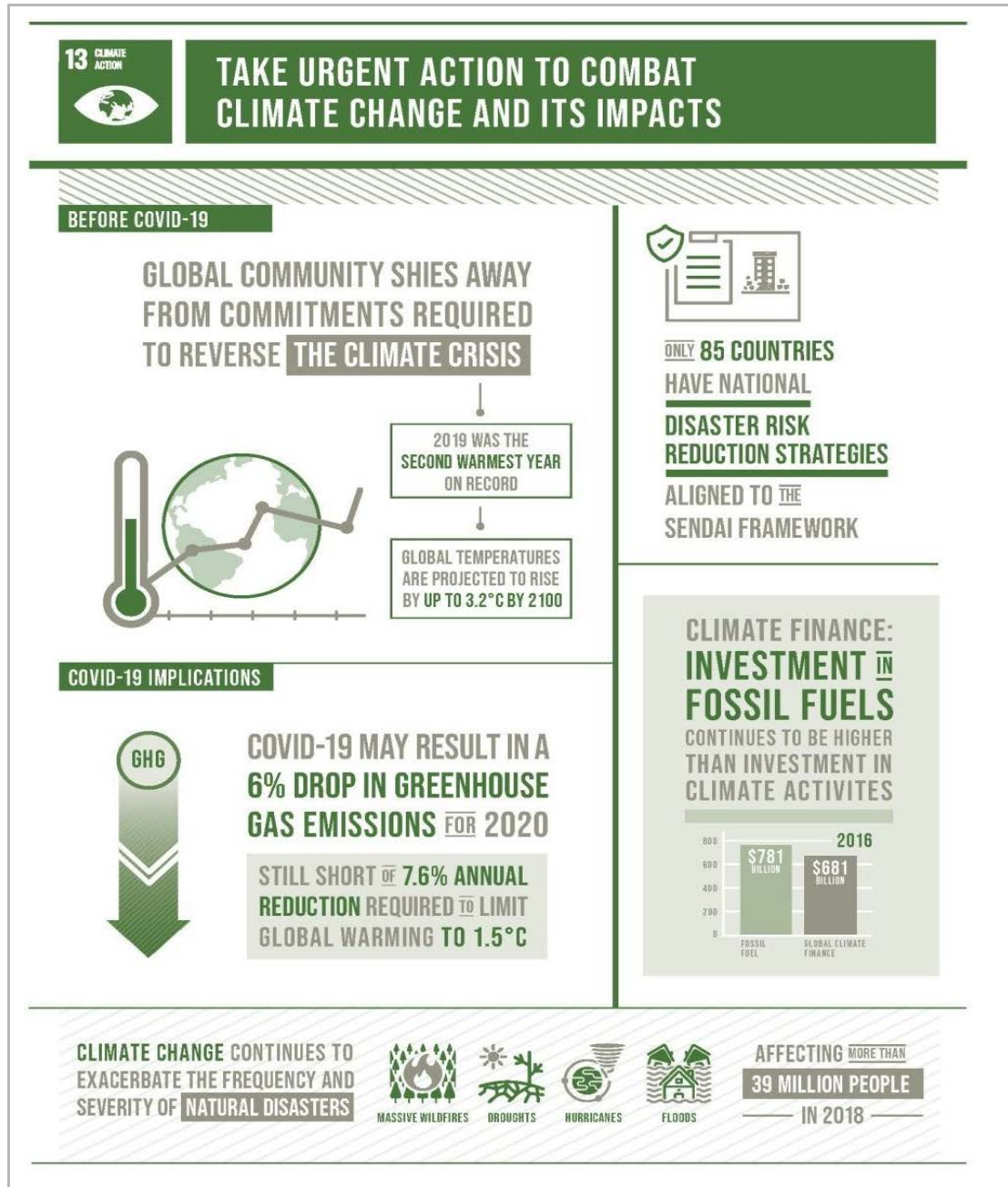


Fig.8: SDG No.13."Climate Action" in relation to Covid-19 Implications, as presented in Sustainable Development Goals Report 2020⁵¹

In the Sustainable Development Goals Report 2020 regarding Climate Action SDG 13⁵² some indicators highlight existing trends to the prioritization of projects:

- **Financing for climate action has increased substantially, but it continues to be surpassed by investments in fossil fuels.** Global climate-related financial flows saw a 17 per cent rise from 2013–

⁵¹ <https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf>

⁵² Climate Action, <https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf>

2014 to 2015–2016, from \$584 billion to \$681 billion. The spurt in growth was largely due to high levels of new private investment in renewable energy, which represents the largest segment in total climate-related flows. However, investments in climate activities across sectors continued to be surpassed by those related to fossil fuels in the energy sector, which totaled \$781 billion in 2016. To achieve a low-carbon, climate-resilient transition, a much greater scale of annual investment is required. Climate-related financing provided by developed countries to developing countries increased by 14 per cent in 2016, reaching nearly \$38 billion. **Climate change mitigation remained the predominant focus, at \$24.3 billion, followed by climate change adaptation (\$5.6 billion) and cross-cutting issues (\$5.1 billion).**

- **Most developing countries have begun to formulate plans to strengthen resilience and adapt to climate change** National adaptation plans (NAPs) help countries achieve the global goal on adaptation under the Paris Agreement – namely, to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change. In 2019, at least 120 of the 153 developing countries had undertaken activities to formulate and implement NAPs, an increase of 29 countries over the previous year. Eighteen countries, including five Least Developed Countries LDCs and four small island developing States, have completed and submitted their NAPs to the United Nations Framework Convention on Climate Change Secretariat, while many others are at various stages in the process.
- **Despite its glaring relevance, progress in meeting the 2020 disaster risk reduction target has been slow.** The Sendai Framework for Disaster Risk Reduction 2015–2030 aims to reduce existing – and prevent new – disaster risk through clear targets and priorities for action, in accordance with the 2030 Agenda for Sustainable Development. Target (e) of the Sendai Framework, which focuses on the establishment of national and local disaster risk reduction strategies, has a 2020 deadline. As of April 2020, 85 countries – slightly over 40 per cent – reported that they have national disaster risk reduction strategies aligned, to some extent, to the Sendai Framework, with six of the countries reporting fully aligned national strategies.

Moreover the current Emissions Gap Report 2020⁵³ and the Adaptation Gap Report 2020⁵⁴ address the importance of commitments from countries to the mitigation goals, the urgency of financing projects with respect to adaptation planning, and to the ***New tools needed, such as sustainability investment criteria, climate-related disclosure principles and mainstreaming of climate risks into investment decisions can stimulate investments in climate resilience.*** More specifically regarding:

Mitigation it is stated that *“in order to achieve the temperature goals of the Paris Agreement, countries need to strengthen the ambition of their Nationally Determined Contributions and increase the effectiveness of domestic policy. To bridge the 2030 emissions gap and ensure long-term decarbonization, countries must also*

⁵³ For over a decade, the UNEP Emissions Gap Report has provided a yearly review of the difference between where greenhouse emissions are predicted to be in 2030 and where they should be to avoid the worst impacts of climate change, UNEP, UNEP DTU Partnership, Emissions Gap Report 2020, 9 December 2020, <https://www.unenvironment.org/emissions-gap-report-2020>

⁵⁴ The fifth edition of the UNEP Adaptation Gap Report looks at progress in planning for, financing and implementing adaptation – with a focus on nature-based solutions, UNEP, UNEP DTU Partnership, Adaptation Gap Report 2020, 14 January 2021, https://www.unenvironment.org/resources/adaptation-gap-report-2020?_ga=2.25128506.1422488007.1611823088-1674895308.1609656262

enhance their mitigation ambitions. By scaling up the ambition in their NDCs, nations send an important signal regarding mitigation commitments, both internationally and domestically. However, to translate mitigation ambition into action, it is the domestic policies that are crucial.”⁵⁵

Adaptation funded by “Public and private finance must be stepped up urgently, along with faster implementation. Nature-based solutions – locally appropriate actions that address societal challenges, such as climate change, and provide human well-being and biodiversity benefits by protecting, sustainably managing and restoring natural or modified ecosystems – must also become a priority. Adaptation planning is growing, but funding and follow-up lagging. The most encouraging finding of the report is that 72 percent of countries have adopted at least one national-level adaptation planning instrument. Most developing countries are preparing NAPs. However, the finance needed to implement these plans is not growing fast enough. All nations must pursue the efforts outlined in UNEP’s Emissions Gap Report 2020, which called for a green pandemic recovery and updated NDCs that include new net-zero commitments. However, the world must also plan for, finance and implement climate change adaptation to support those nations least responsible for climate change but most at risk.”⁵⁶

1.2. LITERATURE REVIEW ON CLIMATE CHANGE & INVESTORS

This chapter of literature review explores methodologies related to investments more specifically on projects that embrace climate change, with the aim to explore ways to evaluate sustainable projects for their return on investment adjusted for risk, which can easier attract financing.

1.2.1. Evolution of investors demand for sustainability

Sustainability is high on many investors’ agendas. Gradually it has been proven not only that investments returns and sustainability are not mutually exclusive, but also that sustainable companies perform better financially in the long term.

ESG investing

Across the asset-management world, interest in environmental, social and governance (ESG) has raised since the launch of the Principles for Responsible Investments (PRI) in 2006. ESG is about risk-based investing which evaluates, in equal measure, all potential risks and drivers of long-term return, and assesses whether those risks are priced in. In other words, ESG represents the recognition that non-financial information was necessary for investors to have a clear picture of the issues that are likely to impact a company’s financial condition of assets directly.

⁵⁵ Emissions Gap Report 2018 – key messages, https://wedocs.unep.org/bitstream/handle/20.500.11822/26896/EGR-KEYMESSAGES_2018.pdf?sequence=1&isAllowed=y

⁵⁶ <https://www.unep.org/news-and-stories/press-release/step-climate-change-adaptation-or-face-serious-human-and-economic>

Investment managers need to be able to measure and understand risk in order to manage it. This led to an increasing demand for transparency on sustainable performance through the ESG standards, ratings and reporting.

ESG investing is an approach that seeks to incorporate environmental, social, and governance factors into asset allocation and risk decisions to generate sustainable, long-term financial returns. Recent industry and academic studies suggest that ESG investing can help improve risk management and lead to returns that are not inferior to returns from traditional financial investments, demonstrating the superiority of sustainable infrastructure, including better risk-adjusted returns, improved revenue stability, and decreased insurance premiums.

The recognition of ESG risks and opportunities had, as a result, the significant growth of the number of investment portfolios that had integrated key elements of ESG. Moreover, the products and services related to ESG ratings, indices, and standards have multiplied, leading to market fragmentation and often confusing investors concerning which approach to follow.

Currently, numerous ESG actors shape the ESG ecosystem:

- ESG Disclosure Framework developers and providers (such as the Sustainability Accounting Standards Board (SASB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), the Taskforce on Climate-related Financial Disclosures (TCFD), etc.),
- Standard-setters (including the United Nations (UN), the Organization for Economic Co-operation and Development (OECD), the International Organization for Standardization (ISO) among other organizations), the International Financial Reporting Standards (IFRS),
- Policy drivers (such as the EU) that published ESG regulations and various oversight authorities assess ESG taxonomies and disclosure.
- Private agencies that provide ESG ratings, issuing ESG Risk Rating Licenses for companies who want to assure their investors that they finance green or social projects

ESG standards are still considered a field under development. There is no agreed-upon approach for what metrics related to ESG approaches are sufficient to enhance shareholders' value. ESG investing has been motivated by shifts in demand, driven by the search for better long-term financial value and pursuit of better alignment with finances.

SDG investing

Since 2015, when the 2030 Agenda for Sustainable Development was adopted, establishing the Sustainable Development Goals (SDGs) as a globally accepted set of overarching goals, the 'alignment with values' to guide investors to redirect capital has acquired an additional new global definition.

Therefore, it is the transition to an ESG-aligned world that shapes investors' perception of risks and opportunities and the transition to an SDG-aligned world, resulting in an urgent investors' demand for ESG sustainable and SDG- aligned projects/ companies. The shift from ESG to SDG investing showcases a trend of moving from a company agenda to a global agenda.

Soon after the SDGs were launched, the first initiatives for a responsible and SDG aligned investment funds started. The UN embraced these initiatives, as large investments are needed to achieve the SDGs, not only by governments, but also by private parties.

Increasingly more companies are reporting on their SDGs performance, creating an opportunity for investors to invest based on SDG. The UN SDG framework can potentially be guidance for companies and responsible investors to aim their effort to. However, SDG investing by private parties is still relatively smaller than ESG investing. ESG is not excluding SDG. On the contrary, the alignment with SDGs is a common approach for most ESG frameworks and a focus of the current work-in-progress on ESG standards.

The work-in-progress on ESG standards is gaining global momentum, due to the increasing popularity of SDGs and the on-going COVID-19 pandemic crisis, the recovery from which becomes an opportunity to speed up action transition to a better environmental, climate, and social paradigm. There are several initiatives under development or recently published consultation papers on ESG standards.

2. RESEARCH TOOLS

2.1. ENVISION

2.1.1. Evolution of Envision from V2 to V3

The Envision framework evolution from version 2 to version 3 was triggered by industry advances in the understanding of resilience due to the growing evidence of climate change adverse effects that made the need for climate change mitigation and adaptation actions even more urgent. The Envision V2 Climate & Risk Category was renamed to Climate & Resilience and resilience credits were reviewed and updated. Moreover, credits were expanded to integrate construction activities (activities with short-term but also recurrent impacts along the life of the project, given that major rehabilitations or replacement of assets involve construction works). Finally, as a response to a growing interest in linking non-financial sustainability performance with financial performance to strengthen the business case of sustainable projects, ISI identified the need to place greater emphasis on evaluating the economics of infrastructure projects.⁵⁷

As presented in the following tables, the new credits added, the new sub-categories: Mobility in the Quality of life, Economy in Leadership, Conservation and Ecology in Natural World and the enhancement of Climate & Resilience category and the emphasis placed in Leadership regarding the Economics of infrastructure, developed in Envision V3, illustrate the importance and urgency of the topics explored in the proposed research.

⁵⁷ As part of the release of the 3rd version of the Envision in 2018: *“The industry understanding of resilience has grown tremendously, especially in the wake of major natural disasters in recent years (e.g., hurricane Sandy); therefore, ISI identified the need to expand the framework to incorporate a more advanced appreciation and understanding of resilience. Also, ISI identified the need to place greater emphasis on evaluating the economics of infrastructure projects, as well as the need to extend the framework to more specifically include construction related sustainability aspects.”*

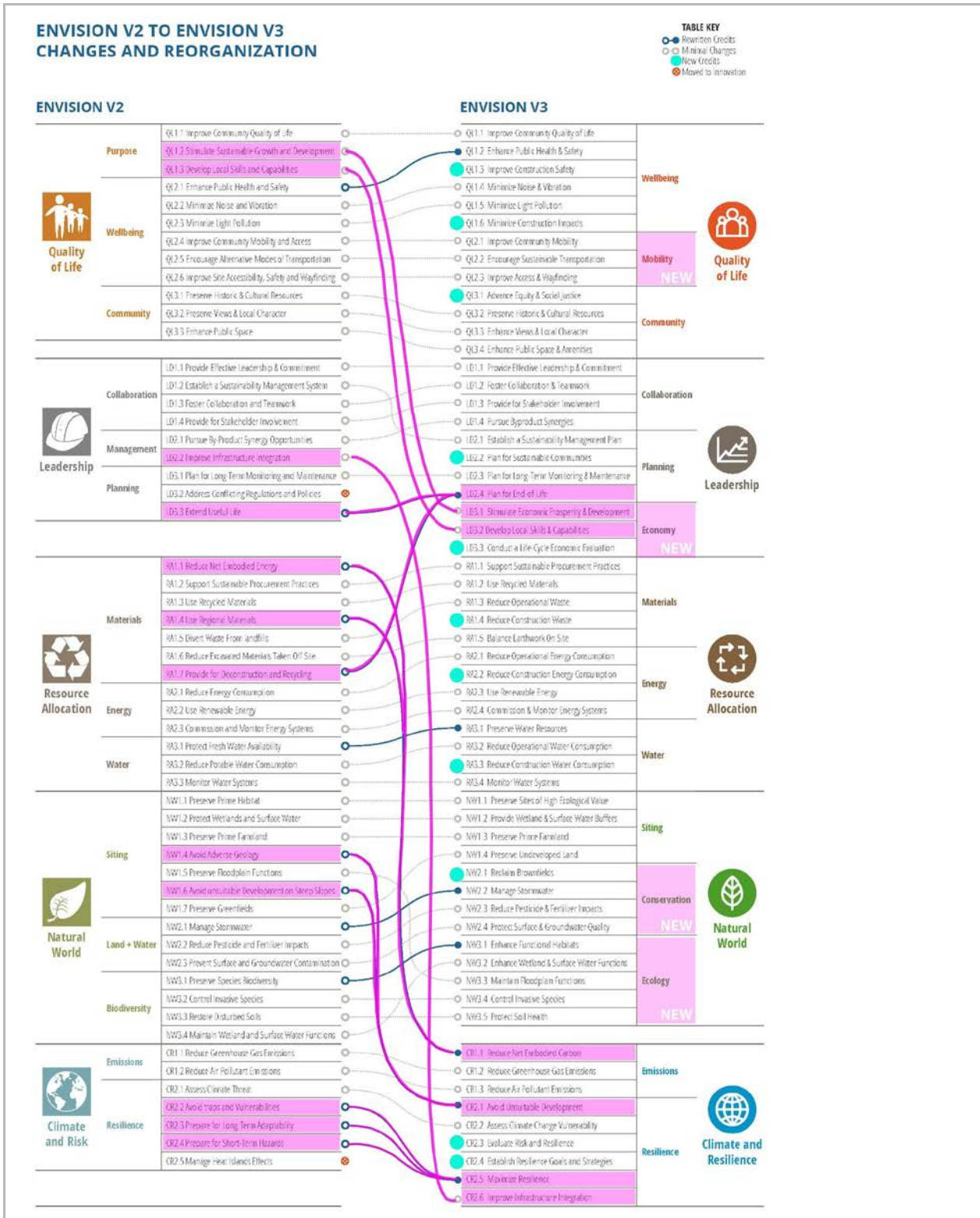


Fig. 9: Overview of changes between Envision V2 and V3, highlighting (i) the New sub-categories, (ii) the main credit changes related to Climate & Resilience and Leadership (iii) and the new credits.

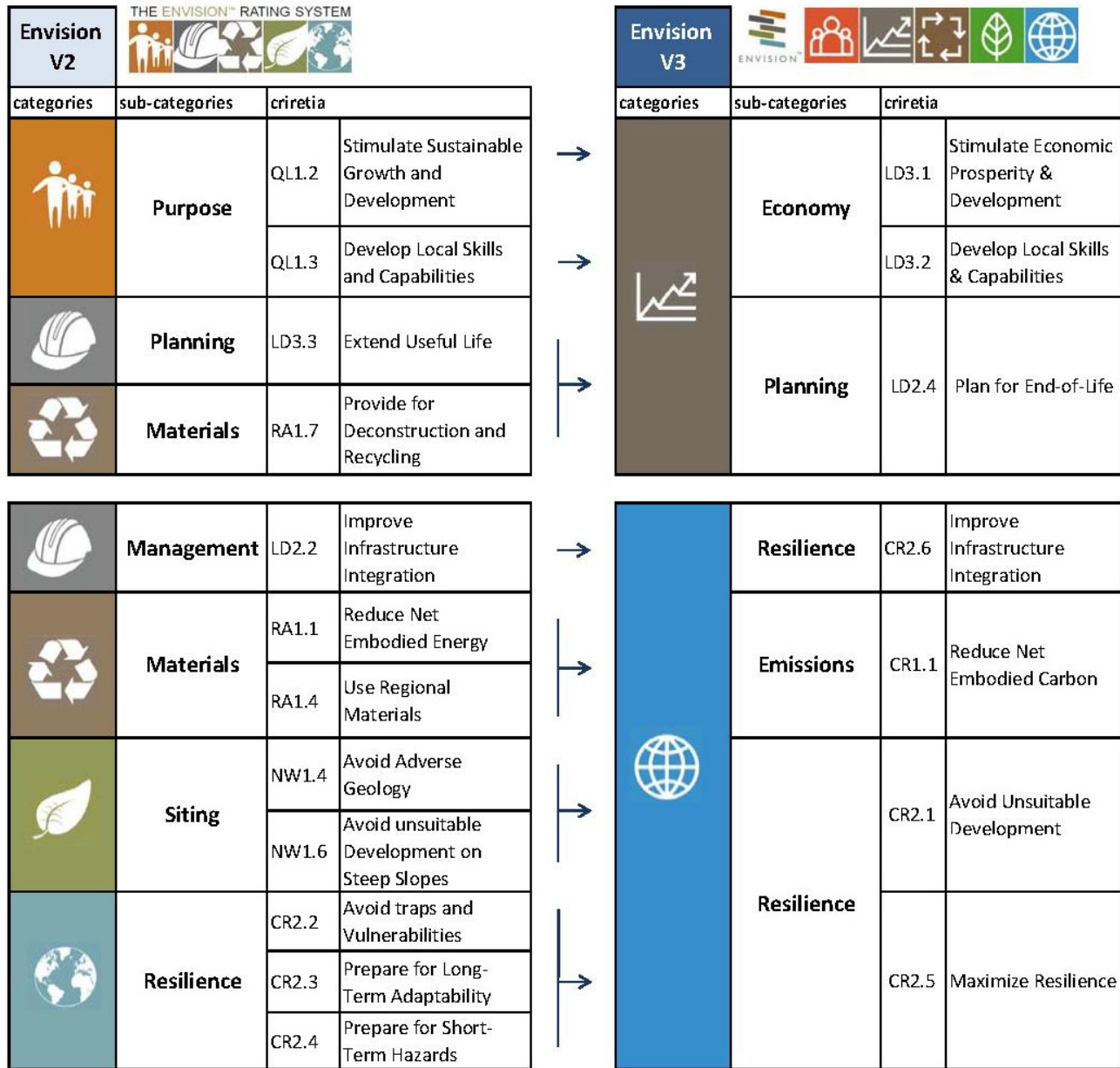


Fig. 10: The enhancement of Climate & Resilience category and the emphasis on evaluating the economics of infrastructure projects through the new subcategory “economy” in Leadership category.

2.1.2. Envision analysis in terms of climate mitigation vs. adaptation

Key question to explore:

Are Climate change mitigation and Climate change adaptation equally weighted in the Envision rating system?⁵⁸

A first step for this analysis will be based on credits that explicitly refer to climate mitigation or adaptation.

Table 1: Envision credits that assess climate change mitigation strategies are:

Credit		Points per level of achievement				
		Improved	Enhanced	Superior	Conserving	Restorative
RA2.1	Reduce Operational Energy Consumption	6	12	18	26	-
RA2.2	Reduce Construction Energy Consumption	1	4	8	12	-
RA2.3	Use Renewable Energy	5	10	15	20	24
RA2.4	Commission & Monitor Energy Systems	3	6	12	14	-
CR1.1	Reduce Net Embodied Carbon	5	10	15	20	-
CR1.2	Reduce Greenhouse Emissions	8	13	18	22	26
total		28	55	86	114	50

Table 2: Envision credits that assess climate change adaptation strategies are:

Credit		Points per level of achievement				
		Improved	Enhanced	Superior	Conserving	Restorative
CR2.1	Avoid Unsuitable Development	3	6	8	12	16
CR2.2	Assess Climate Change Vulnerability	8	14	18	20	-
CR2.3	Evaluate Risk and Resilience	11	18	24	26	-
CR2.4	Establish Resilience Goals and Strategies	-	8	14	20	-
CR2.5	Maximize Resilience	11	15	20	26	-
CR2.6	Improve Infrastructure Integration	2	5	9	13	18
total		35	66	93	107	34

(Number of credits per topic and weighting (Score point system))

What percentage of the overall scoring does mitigation and adaptation assessment constitute?

⁵⁸ Climate change adaptation is the process of adjusting to current and/or expected climate change and its impact. Climate change mitigation refers to any actions or efforts taken to reduce or prevent the long-term risks of climate change on human life and property by reducing the sources or enhancing the sinks of greenhouse gases emissions.

2.1.3. Envision analysis in terms of economics

An initial step for this analysis will be based on credits that explicitly refer to / assess economically sustainable performance. Through the Leadership's subcategory 'Economy' Envision assesses the economic sustainability of project through three credits:

Table 3: Economy Credits

LD3.1	Stimulate Economic Prosperity & Development
LD3.2	Develop Local Skills & Capabilities
LD3.3	Conduct a Lifecycle Economic Evaluation

Credits LD3.1 and LD3.2 encourage project teams to extend their assessment to account for socio-economic sustainability. Credit LD3.3 encourages conducting a Lifecycle Economic Evaluation. Moreover, as part of its evaluation for higher levels of performance Credit LD3.3 requires:

- mapping and quantification of the social and environmental impacts of the project, and
- quantification and measurement of the broader financial, social, and environmental benefits of the project, using triple bottom line cost-benefit analysis (TBL-CBA) or sustainable return on investment (SROI).

To further guide users in mapping the social and environmental impacts, the credit's evaluation criteria provide a list of potential impacts.

Only those credits that explicitly refer to/ assess climate change mitigation or adaptation and economic sustainability were mentioned in the preceding tables. However, there are inherent relations/ synergies between credits as highlighted within the Envision manual, the 'Related Envision Credits' included in each credit's description. Therefore, key questions that emerge are:

- Which **credits indirectly** contribute to mitigation or adaptation to climate change?
- Which **credits indirectly** contribute to the economic costs/benefits?

2.2. Life Cycle SUSTAINABILITY TOOL

2.2.1. Life Cycle Sustainability Tool Overview

As mentioned, it is proposed to use a recent research methodology that led to the development of the Sustainability Lifecycle tool by Prof. Pollalis in collaboration with the National Research Council of Canada (NRCC). The research and developed tool are presented in the report entitled "Integrating Sustainability and LCA, Pilot application on transportation infrastructure projects" of September 2020, already shared confidentially with the SIAB.

In the Sustainability Lifecycle tool, the research objective was to develop a tool that integrates sustainability assessment and lifecycle assessment to be used in transportation projects. The analysis for the development of the Tool was based on:

- A. A review of ISO Lifecycle Assessment (LCA) of infrastructure in the triple bottom line (TBL).
- B. A review of three widely used Sustainability Assessment systems for the lifecycle of a project, Envision®, CEEQUAL®, and ISCA®.
- C. The analysis of a transportation infrastructure project, of a typical bridge replacement project by the Ontario's Ministry of Transportation West Region Bridge Office.

A sustainability assessment system was chosen to be the basis of the proposed tool instead of the ISO LCA methodology since:

- A sustainability assessment framework, by definition, considers the environmental, social, and economic aspects of a project. In contrast, as explained in the analysis, ISO LCA accounts only for either environmental or economic impacts.
- A sustainability assessment considers the entire Lifecycle of a project.
- ISO LCA follows a highly technical and labor- and data-intensive process. Capacity building is necessary for agencies to perform LCAs in-house, which has been a constraint in its use.

Among the three analyzed systems, the Envision® framework was selected to be used as the basis of the proposed model to address life cycle sustainability and further link it with the ISO LCA. The result is a self-assessment tool, that assesses project performance:

- per lifecycle stage (design and material production, construction, operation, maintenance, and end-of-life)
- concerning specific triple bottom line impacts (environmental, social, and economic).

The Sustainability Lifecycle tool uses the Envision methodology, approach, and structure. It is an interpretation of the Envision Manual, extracting and highlighting selective information within the Envision credits. The tool is based on an extensive background table (in XLS format), structured according to Envision's five impact categories and credits, which contains multiple levels of information for each Envision credit:

- performance indicators & associated metrics
- lifecycle stage
- TBL impacts

The '**performance indicators**' are consistent with the Envision evaluation criteria requiring evidence and documentation. Same with Envision evaluation criteria, the indicators include both qualitative and quantitative requirements (metrics). However, while the evaluation criteria are framed as questions, the performance indicators are more focused and straightforwardly formulated, aiming to assist in high-level evaluations of sustainability features and strategies for decision making.

The list of performance indicators functions as a set of guidelines or strategies and, therefore, will be referred to as strategies in the tool's presentation.

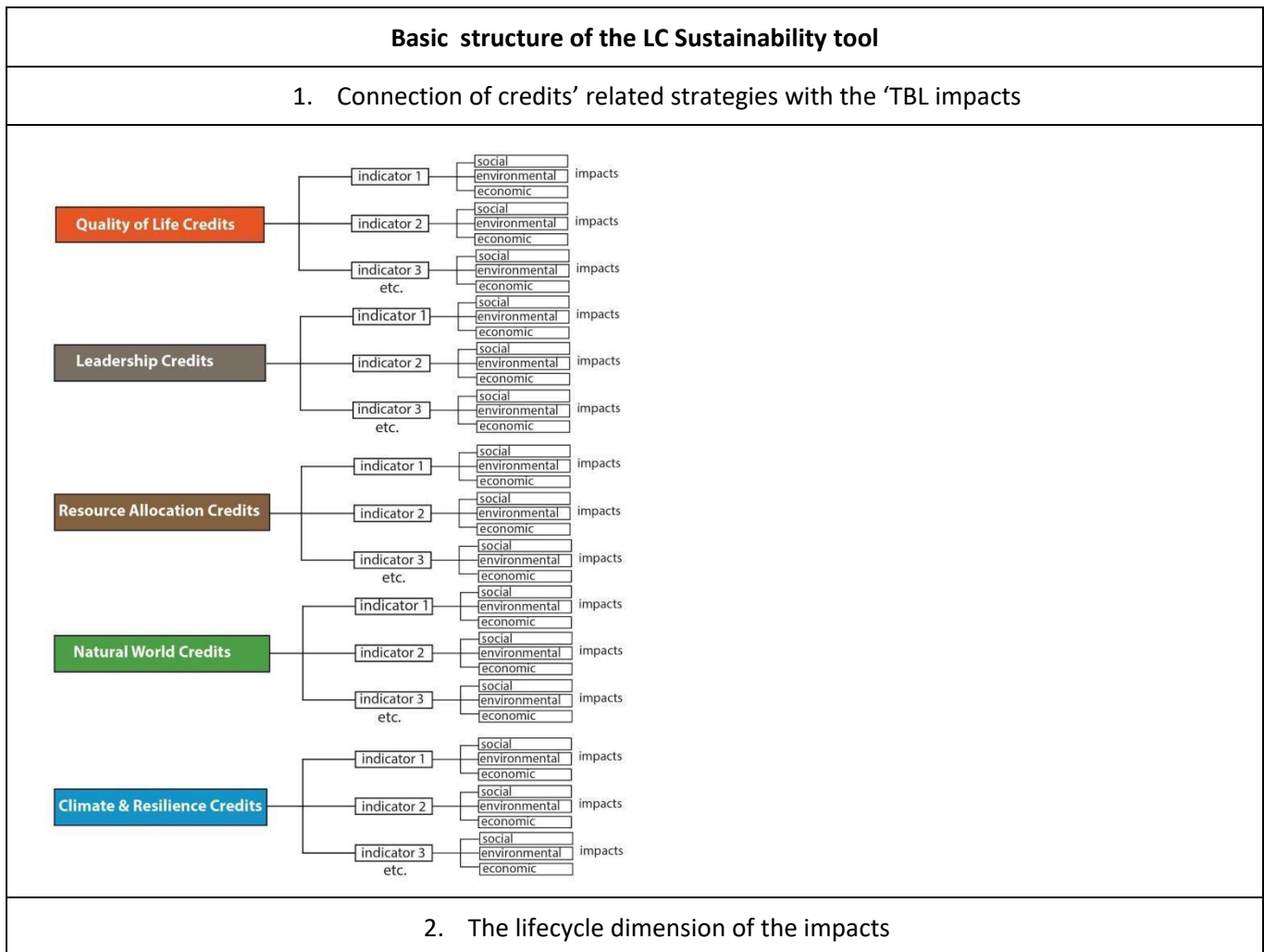
The 'lifecycle stage' indicates the stage of the project that the credits and their related strategies refer to (as a boundary of the credit's assessment):

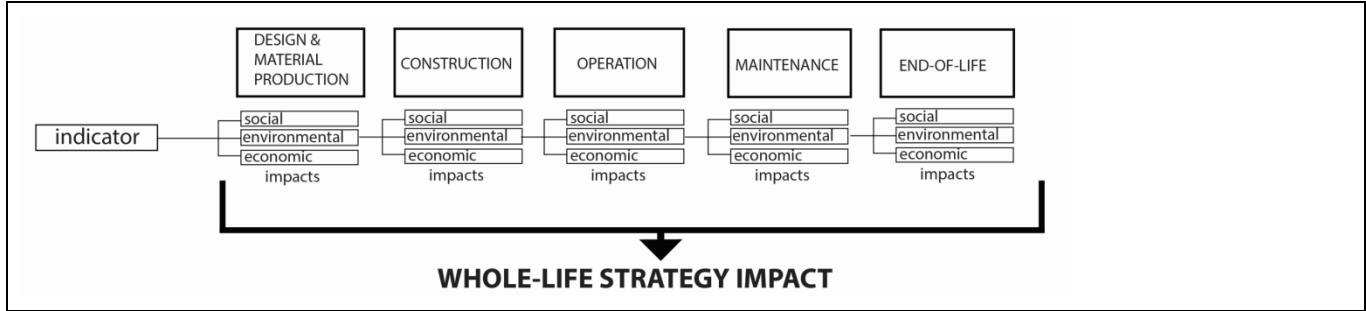
The 'TBL impact' links credits with the type of impact they assess. Moreover, the various strategies within a credit are connected with their specific impacts. An impact can be negative or positive, direct or indirect (indirect benefit, trade-off and incremental impact).

B. Add-ons to the Envision Manual

The Add-ons to the Envision Manual can be summarized as:

1. Direct connection of related strategies to credits (as described within the Envision Manual) with the 'TBL impacts', the type of impacts they mitigate (positive impact) or contribute to (negative)
2. Connection of indirect impacts to strategies
3. The lifecycle dimension of the impacts
4. The key credits





Linking Envision credits and their related strategies with impacts across the life cycle stages allows a decision-maker to have a holistic understanding of a sustainable strategy and prioritize accordingly.

The role of Key credits

The tool demarcates a set of Envision credits as ‘key credits.’ The six key credits within the Sustainability Lifecycle Tool are the following:

- LD1.3 Provide For Stakeholder Engagement
- LD3.1 Stimulate Economic Prosperity
- LD3.3 Conduct A Lifecycle Economic Evaluation
- CR1.1 reduce net embodied carbon
- CR2.2 Reduce GHG Emissions
- CR2.5 Maximize Resilience

The key credits include indicators that request input from other Envision credits. The credits which provide input are identified through search/filtering based on specific impacts.

Overall, the key credits explicitly refer to core impacts, which are at the center of the research and aim to provide a basis for their quantification: impact on the community, cost, climate change and resilience against future uncertainty.

Table 4: Overview of impacts captured by the six key credits

KEY CREDITS	TBL CATEGORY	TYPE OF IMPACT FOR FILTERING	IMPACT FOR FILTERING
LD1.3 Provide For Stakeholder Engagement	SOCIAL	‘DIRECT SOCIAL IMPACT’	COMMUNITY SATISFACTION
LD3.1 Stimulate Economic Prosperity	ECONOMIC	INDIRECT ECONOMIC IMPACT’	ECONOMIC PROSPERITY
	ECONOMIC	INDIRECT ECONOMIC IMPACT for USER	TRAVEL TIME VALUE
LD3.3 Conduct A Lifecycle Economic Evaluation	ECONOMIC	‘DIRECT ECONOMIC IMPACT for ‘AGENCY’	ALL

	ECONOMIC	DIRECT ECONOMIC IMPACT' for 'AGENCY' & 'DIRECT ECONOMIC IMPACT' for 'USER'	ALL
	ECONOMIC	DIRECT' & 'INDIRECT' 'ECONOMIC IMPACT' for 'AGENCY' and 'USER'	ALL
CR1.1 Reduce net embodied carbon	ENVIRONMENTAL	INDIRECT ENVIRONMENTAL IMPACT	EMBODIED CARBON
CR2.2 Reduce GHG Emissions	ENVIRONMENTAL	INDIRECT ENVIRONMENTAL IMPACT'	EMISSIONS
CR2.5 Maximize Resilience	ECONOMIC	INDIRECT ECONOMIC IMPACT'	RESILIENCE VALUE

The key credits aim to familiarize the user with the LC Sustainability tool's core capability, the capability to perform filtering of the various impacts linked to credits and related strategies. Thus, the user decision-maker has the option to include his additional indicators, customized based on his needs: e.g. 'Identify all indicators/strategies with a positive impact on 'CLIMATE CHANGE.' Therefore, the user can focus on certain areas of interest.

B. Usefulness of the tool

The LC Sustainability tool is an Envision-based tool customized for transportation projects that aim to achieve sustainable performance across their lifecycle. Project teams of transportation infrastructure need to make core decisions, for which, by definition, the impacts related to the lifecycle stages have to be addressed. Typical examples of such decisions are:

- choose between the option to rehabilitate or the option to replace an existing infrastructure project (for existing deteriorating structures),
- materials selection
- selection of construction methods that will be applied
- provision to accommodate the future potential increase in demand or not

Thus, decision-makers need to have a tool based on which they can form and adapt the project's core decisions towards an enhanced sustainable performance throughout its lifecycle.

The lifecycle sustainability tool highlights sustainable performance indicators already included in Envision, which can be used as guidelines for decision-makers and project teams, ideally in the early stages of inception and initial planning. They can also be used during design development and construction planning. Apart from the triple-bottom-line sustainability dimensions, the guidelines also consider impacts throughout all life cycle stages of the project, including the operations, maintenance, and end-of-life, allowing its users to optimize project resilience for both short-term and long-term impacts. Therefore, it provides a holistic framework that considers environmental, social, and economic impacts for the whole lifecycle of projects to enable informed decisions on sustainable transportation infrastructure.

Being an extension of the Envision framework, the tool invites owners, communities, designers, contractors, and other stakeholders to collaborate for higher sustainable transportation infrastructure development. It is suggested that project teams using the Sustainability Life cycle tool should be familiar with the Envision rating system and framework to make the most of the process towards more informed sustainable choices in infrastructure development.

The lifecycle sustainability tool's framework has several uses, combined with the Envision rating system methodology:

- as a Lifecycle self- assessment tool
- multiple criteria, decision-making tool
- guidelines to enhance sustainable performance
- as an educational manual for lifecycle sustainability
- as evidence-based documentation of project decisions

C. Value for the purposes of the present research

As part of the lifecycle research, the Envision® manual was entered in a computer model (in Excel format), maintaining the five categories and credits structure. All the related strategies as described within the Envision manual's ('credit intent', 'description', 'documentation and evaluation criteria') were organized as a set of performance indicators for each credit. Moreover, a new coding was applied to each performance indicator focused on Lifecycle stages and Triple Bottom Line (TBL) impacts based on the Envision manual's information.

Thus, the manual was transformed into a searchable and filterable format, enabling and facilitating targeted analyses. The capability of the LC Sustainability tool that is more useful for the purposes of the research is the ability to **filter** all Envision credits based on a selected impact or impacts. **It will be used as a filtering tool** to highlight how Envision already addresses or not the research questions.

Central in this process of filtering is the list of 'IMPACTS', as it determines which impacts can be accounted for.

Table 5: The list of the Triple bottom line impacts accounted in the LC Sustainability tool

SOCIAL	ENVIRONMENTAL	ECONOMIC	
		AGENCY	USER
Access Safety Health Noise Light pollution Community satisfaction Inclusivity Equity Sense of place Wellbeing Livability Integration Capacity building Social resilience	Materials Energy Embodied energy Water Water quality Embodied water Air quality Waste Soil quality Emissions Embodied carbon Ecosystem quality Resource depletion Land occupation Climate change Ecological Resilience	Capital (initial)cost O&M cost Rehabilitation cost Replacement cost Residual value Revenues Delay cost Liability claim/Penalty cost Noise cost Restoration cost Resilience value Ecosystem services value	Travel time value Vehicle cost Fuel cost Fare cost Accident cost Health cost Job creation Economic prosperity Resilience value Ecosystem services value

(The exact definitions of the above impacts are presented as part of the Appendix)

For example, climate change is already included in the list of impacts of the LC Sustainability tool. It represents an indirect impact of various strategies across various ENV Categories of credits and not only of the credits of the Climate & Resilience category or the Resource Allocation’s Energy subcategory. This provides the additional advantage of awareness of every single strategy across all Envision categories that contributes to climate change, or mitigates or adapts to its adverse effects.

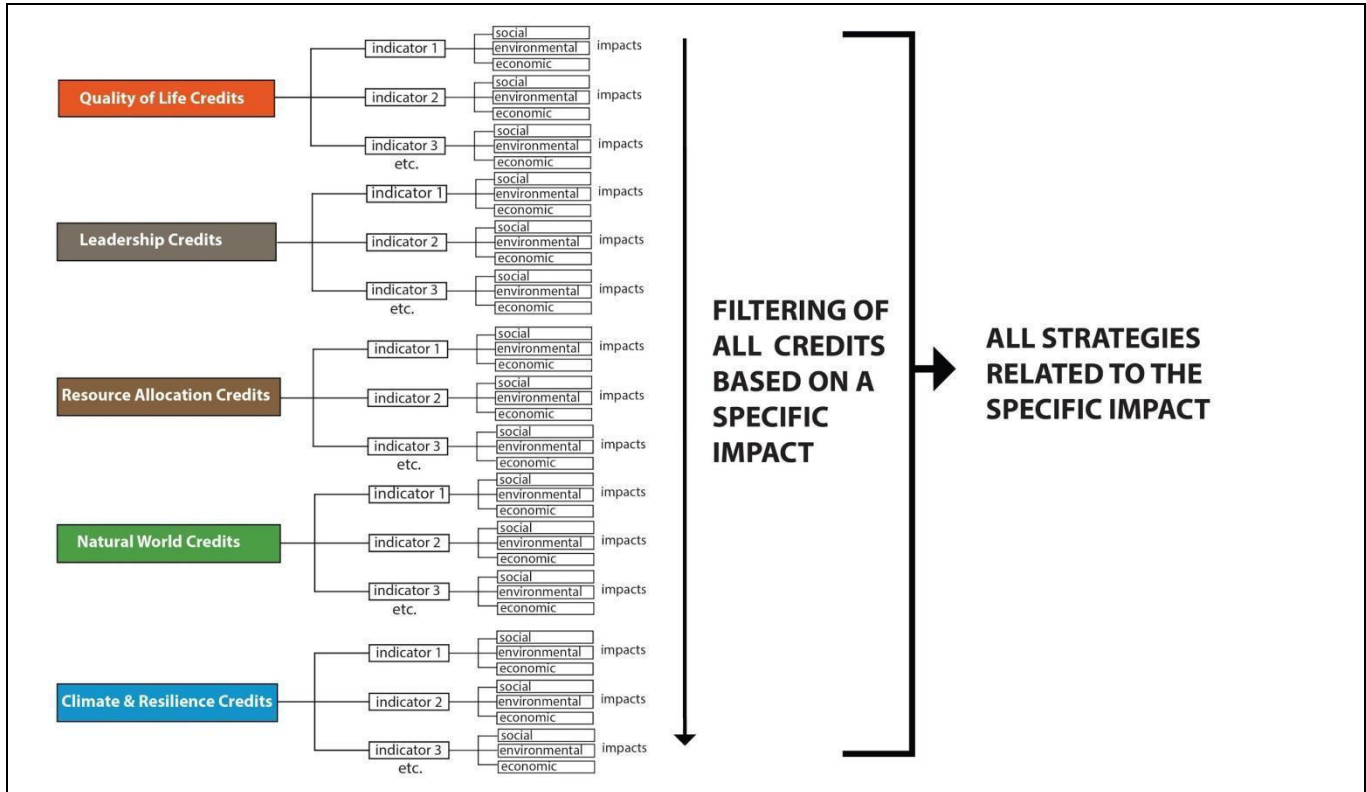


Fig. 11: Filtering across all credit categories per impact

2.2.2. Generic Application of Life Cycle Sustainability Tool

A. A generic form of the tool (non-transportation specific) to be used in the proposed research

The LC Sustainability tool was requested by NRCC and developed as an early decision-making tool, to be used in transportation infrastructure projects. Therefore the tool includes an additional level of customization as compared to Envision, result of input from literature review, transportation agency and project input.

In the proposed research, the transportation-specific features will be removed to deliver a generic of the tool that applies to every infrastructure type, as Envision does. What makes the tool more specific for transportation projects are the performance indicators and their associated metrics included in each credit. Therefore, a review of the XLS that forms the LC Sustainability tool's basis will focus on identifying and removing all types of information that refers exclusively to transportation projects.

B. Review of the generic tool's list of 'IMPACTS' and identification of gaps related to the research main questions

After the generic LC Sustainability tool is derived, the list of 'IMPACTS,' which are included within the tool, will be reviewed regarding the main research questions of the proposed research: climate change mitigation and adaptation & investor-related.

Interconnections of impacts

A first task in the process of the review of the list of indicators is highlighting the existing inherent connections between the listed impacts; in other words, highlighting the underlying assumptions and rules that govern the assignment of impacts to each strategy to ensure a consistent use across strategies. A strategy designed to address a specific direct (primary) environmental impact has been examined across the other TBL categories and lifecycle stages, to identify its parallel social or economic impacts, as well as its indirect impacts across all categories, initial or future. There are some recurring connections, ‘packages of impacts’ that are being formed and used based on the direct impact a strategy addresses.

Providing the overview of the interconnected impacts is a starting point for identifying the spectrum of strategies an investment has to take into account for either minimizing or avoiding some or all of the primary and associated impacts of an infrastructure development project.

The relationships between impacts are shown in the work-in-progress table below:

Table 6: Connection between impacts (as included in the Lifecycle Sustainability tool)

Impact of a strategy of the project on:		DIRECT				INDIRECT			
		SOC	ENV	ECON		SOC	ENV	ECON	
				agency	user			agency	user
ENVIRONMENTAL IMPACTS	energy use -->		energy (use)	O&M cost		emissions climate change			
	emissions -->		emissions	capital cost	health	climate change	penalty cost		
	embodied carbon -->		embodied carbon	O&M cost Revenues	health	climate change	penalty cost		
	materials use -->	access	materials (use)	capital cost rehabilitation cost replacement cost	travel time value vehicle cost fuel cost accident cost	noise	energy (fuel from private vehicles) embodied energy embodied water embodied carbon climate change resource depletion	economic prosperity	
	water use -->		water (use)	capital cost OR O&M cost			resource depletion ecosystem quality ecological resilience	resilience value ecosystem services value	
	water quality -->		water quality			health	ecosystem quality ecological resilience	penalty cost restoration cost resilience value ecosystem services value	health cost ecosystem services value
	waste (generation) -->	access	waste land occupation	capital cost OR O&M cost	travel time value vehicle cost fuel cost accident cost	noise	energy (fuel from private vehicles) emissions embodied energy embodied water embodied carbon climate change water quality ecosystem quality ecological resilience	ecosystem services value	ecosystem services value
	ecosystem quality -->		ecosystem quality				ecological resilience	ecosystem services value	ecosystem services value

SOCIAL IMPACTS	access (disruption or enhancement)	access		rehabilitation cost residual value	travel time value vehicle cost fuel cost accident cost	wellbeing noise	energy (fuel from private vehicles) emissions climate change		economic prosperity
	safety	safety			accident cost	health		liability claim cost	health cost
	health	health						liability claim cost	health cost
	noise	noise				health	ecosystem quality	noise cost	
	community satisfaction	community satisfaction						delay cost	
	inclusivity	inclusivity						delay cost	
	integration	integration	materials	capital cost rehabilitation cost replacement cost	travel time value vehicle cost fuel cost accident cost	noise	embodied energy embodied water embodied carbon climate change resource depletion	resilience value	resilience value

Another recurrent ‘package of impacts’ is the so-called “construction works’ impacts”. In order to capture a strategy’s implications across the life of a project, the Life Cycle Sustainability tool accounts for the impacts of additional or avoided initial or future construction works, resulting from a specific strategy. This feature goes beyond Envision credits that refer to construction activities (credits QL1.3, QL1.6, RA1.4, RA2.2 and RA3.3) and incorporate construction works’ impacts to all credits.

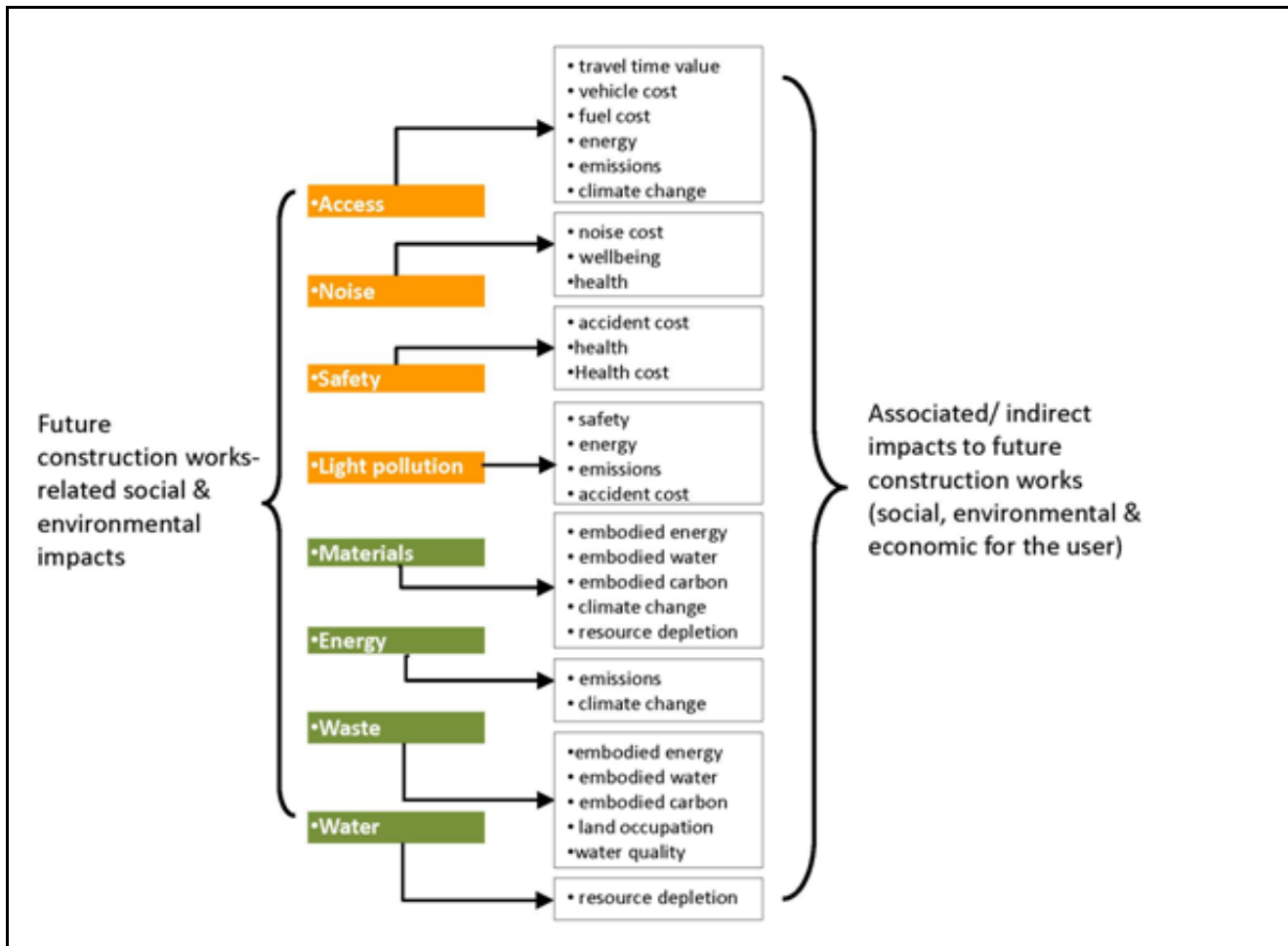


Fig. 12: Construction works-related impacts

The benefits gained having a list of the impacts related to construction activities and their interconnection are showcased in the example of transportation projects; given that construction works in transportation projects (whether new construction, rehabilitation, or replacement) include features and processes with significant impacts, initial and future construction works impacts are being accounted for if relevant to a specific strategy. Such function provides the capability to efficiently address the gap identified during the bridge replacement project analysis. A representative example of the importance of such capability is the case of lifecycle impacts of strategies that extend a project’s service life and thus minimize future rehabilitation and replacements works, such as:

- use of premium materials for a redundant corrosion protection system
- design for structure durability (e.g., use of integral abutments)
- improved durability through construction quality
- extension of the project’s service life through repurposing, adaptability for increased capacity, etc.

In the following table, a detailed list of all impacts related to the use of premium materials (e.g., stainless steel) for corrosion protection is presented to highlight the importance of whole-life impacts accounting for adopting a strategy:

Table 7: Example of lifecycle impacts of strategies that contribute to minimization/ avoidance of future maint

SOCIAL IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	IMMEDIATE/ INITIAL	FUTURE
(+ access	(+ travel time value (+ vehicle cost (+ fuel cost (+ energy (+ emissions (+ climate change	Avoided disruptions of access/ closure due to reduced maintenance needs; avoided construction traffic		Recurring for period of works
		Avoided fuel consumption by private vehicles due construction traffic or detouring and associated emissions		
		Avoided cost of lost productivity, vehicle operating costs and fuel cost due to avoided disruption of access and construction traffic		
(+ safety	(+ health (+ health cost	Increased safety due to durable structures		Long-term
	(+ accident cost	Increased safety due to avoided construction works and related traffic Avoided cost of accidents for public (vehicle repair or medical cost)		Recurring short-term
(+ noise	(+ noise cost (+ wellbeing (+ health (+ ecosystem quality	Avoided construction worksite noise for future maintenance; construction traffic noise		Recurring for period of works
		Avoided operational noise/ vibration due to state of good repair	Long-term	Long-term
		Avoided cost for passive noise mitigation (e.g.) Sound Insulation schemes for affected residences	Long-term	Long-term
		Avoided potential health impact from increased noise levels		Long-term

		Positive impact on habitats as increased noise levels disturb their equilibrium		
(+) light pollution	(+) safety (+) energy (+) emissions (+) accident cost (+) ecosystem quality	Avoided energy consumption due to light wastage during nighttime works and associated emissions Positive impact on habitats as light pollution disturbs their equilibrium Avoided nighttime works and exposure of drivers to accidents due to intrusive light		Recurring for period of works
ENVIRONMENTAL IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	INITIAL/ IMMEDIATE	FUTURE
(+) materials	(+) embodied energy (+) embodied water (+) embodied carbon (+) climate change (+) resource depletion	Reduced material use due to optimizing size of structures due to the redundant corrosion system/ premium materials	Short-term	
		Reduced use of materials (permanent) due to avoided replacement works through design, longer-lived materials		Recurring short-term
		Reduced use of temporary material for replacement works (equipment, safety barriers/ temporary signage, noise barriers etc.)		Recurring short-term
		Reduced embodied energy, water and carbon of materials due to avoided maintenance needs; avoided hauling routes		Recurring short-term
(+) energy	(+) emissions (+) climate change	Avoided construction worksite energy consumption and associated emissions		Recurring short-term
(+) waste	(+) embodied energy (+) embodied water (+) embodied carbon (+) land occupation (+) water quality	Reduced construction waste due to avoided rehabilitation or replacement works		Recurring short-term
		Reduced embodied energy, water and carbon of construction waste Reduced land occupation for landfilling Improved water quality		
(+) water	(+) resource depletion	Avoided construction water consumption Reduced contribution to depletion of resources		Recurring short-term
ECONOMIC IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	IMMEDIATE/ INITIAL	FUTURE
(-) capital cost		Added capital cost for more durable materials (premium) and structures	Short-term	
		Reduced capital cost for labor or transport of heavier components (for downsized structures)	Short-term	
(+) rehabilitation cost		Avoided future rehabilitation cost due to longer-lived structures and materials		Recurring short-term
(+) replacement cost		Avoided future replacement cost due to longer-lived structures and materials		Recurring short-term

(+)	residual value	Increased residual value		future
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The capability of connecting indirect impacts to strategies

One of the capabilities of the Life Cycle Sustainability tool, as already mentioned, is that of connecting strategies to their indirect impacts. This enables to answer two key questions of the present research:

- Which **Envision credits indirectly** contribute to mitigation or adaptation to climate change?
- Which **Envision credits indirectly** contribute to the economic costs/benefits?

As seen in the table below, an ‘impact filtering’ can easily identify all strategies (indicators) across various credits that address or contribute to the specific impact.

This feature enables to account for all strategies with mitigation and adaptation performance, improving the overall project contribution.

However, the extent to which the research topics/questions are addressed in the current list of ‘IMPACTS’, is to be further examined to identify potential gaps and the need for potential further additions. This process entails the performance of relevant filtering and a review of the result.

- Filtering of Envision credits through ‘climate change mitigation’ related IMPACTS.
- Filtering of Envision credits through ‘climate change adaptation’ related IMPACTS.

An analysis of Envision in terms of climate change has already been performed as part of the LC Sustainability research. It has linked Envision credits (and their related strategies) with a positive or negative impact on:

- direct contributors to climate change, such as ‘energy’, emissions, and embodied carbon (**mitigation**) and
- ‘resilience value’, ‘ecological resilience’, ‘social resilience’. (**adaptation**)

The relation of Envision credits to ‘investor-related’ IMPACTS (risks or opportunities) will be entirely explored in proposed research as it was not addressed through the LC Sustainability tool. To what extent some of the existing ‘IMPACTS’ are related to investors and which new ‘IMPACTS’ should be added.

Guidance on this direction will be provided through literature review and input from investors on criteria for selecting a project to invest, e.g. reputational risk, license to operate, etc.

Table 8: Examples of no. of indicators and related credits per filtered impact

		FILTERING RESULT																		
FILTERINGS PER IMPACT		NO. of performance indicators	CREDITS within which the resulting performance indicators																	
impact filtered																				
KEY CREDIT FILTERINGS	LD1.3	Community satisfaction	12 indicators	QL1.1	QL1.4	QL1.6	QL2.1	QL3.1	QL3.2	QL3.3	QL3.4	LD1.4	LD3.1	LD3.2	LD3.3					
	LD3.1	Economic prosperity	92 indicators	RA1.1	RA2.3	NW1.3	NW1.4	NW2.1	NW3.2	NW3.3	CR2.5	CR2.6								
		Travel time value	56 indicators	QL1.3	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD3.1	LD3.3	RA1.2	RA1.3	RA1.4	RA1.5	RA2.2	RA3.3	NW2.4		
	agency costs	Capital cost	142 indicators	RA1.1	RA1.2	RA1.4	RA1.5	RA2.1	RA2.2	RA2.3	RA2.4	RA3.2	RA3.3	RA3.4						
		O&M cost	86 indicators	NW1.1	NW1.3	NW2.1	NW2.2	NW2.3	NW3.1	NW3.2	NW3.4	NW3.5	CR1.2	CR1.3	CR2.5	CR2.6				
		Major rehabilitation cost	58 indicators	QL1.4	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD3.3	RA1.3	RA2.1	RA2.3	RA2.4	RA3.2	RA3.4		
		Replacement cost	64 indicators	QL1.4	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD2.3	LD2.4	LD3.3	RA1.2	RA2.4	NW3.1	NW3.2	NW3.3	CR2.5	CR2.6	
		End-of-life cost	3 indicators	LD2.4																
		Residual value	48 indicators	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD2.3	LD2.4	LD3.3	RA1.2	NW3.1	NW3.3	CR2.5					
		Revenues	27 indicators	QL2.1	QL2.2	QL3.1	LD3.3	CR1.1	CR2.6											
		Delay cost	28 indicators	QL1.1	QL1.4	QL1.6	QL2.1	QL3.2	QL3.3	LD1.3	LD3.3	NW2.4	NW3.5	NW3.1	NW3.5	CR2.5				
		Liability claim cost	12 indicators	QL1.2	QL1.6	QL3.3	LD3.3													
		user costs	Penalty cost	31 indicators	QL1.6	LD3.3	RA3.1	RA3.4	NW1.2	NW2.1	NW2.2	CR1.1	CR1.2	CR1.3						
	Noise cost		19 indicators	QL1.4	QL1.6	LD1.4	LD2.3	LD3.3												
	Restoration cost		31 indicators	QL1.3	QL1.6	QL3.3	LD3.3	RA3.1	RA3.4	NW1.3	NW2.4	NW3.1	NW3.2	NW3.5						
	Travel time value		56 indicators	QL1.3	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD3.1	LD3.3	RA1.2	RA1.3	RA1.4	RA1.5	RA2.2	RA3.3	NW2.4		
	Vehicle cost		49 indicators	QL1.3	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD2.4	LD2.3	RA1.2	RA1.3	RA1.4	RA1.5	RA2.2	RA3.3	NW2.4	NW3.1	
	Fuel cost		48 indicators	QL1.3	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD2.4	LD3.3	RA1.2	RA1.3	RA1.4	RA1.5	RA2.2	RA3.3	NW2.4		
	Fare cost		4 indicators	QL2.1	QL2.2	QL3.1														
	Accident cost		65 indicators	QL1.2	QL1.3	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD3.3	RA1.4	RA2.1	RA2.2	NW1.4	NW2.2	NW3.1		
	Health cost		104 indicators	QL1.2	QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	LD1.4	LD2.3	LD3.3	RA2.1	RA3.3	RA3.4			
	Job creation		22 indicators	QL2.1	QL2.2	LD3.2	LD3.3	NW1.4	NW2.1											
	Economic prosperity	92 indicators	QL1.1	QL2.1	QL2.2	QL2.3	QL3.1	QL3.4	LD1.1	LD1.3	LD1.4	LD3.1	LD3.2	LD3.3						
		RA1.1	RA2.3	NW1.3	NW1.4	NW2.1	NW3.2	NW3.3	CR2.5	CR2.6										
	CR1.1	Embodied carbon	85 indicators	QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD2.4	RA1.1	RA1.2	RA1.3	RA1.4	
	CR1.2	Emissions	94 indicators	RA1.5	RA2.2	RA2.3	RA2.4	RA3.3	NW1.4	NW2.3	NW3.1	NW3.3	NW3.4	NW3.5	CR2.5	CR2.6				
		QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	LD1.2	LD1.4	LD2.3	LD2.4								
	CR2.5	Resilience value (agency)	108 indicators	RA1.4	RA1.5	RA2.1	RA2.2	RA2.3	RA2.4	RA3.3	NW2.4	NW3.3	CR2.6							
QL2.1		QL2.2	QL2.3	LD1.2	LD1.4	LD2.3	LD2.4	LD3.1	LD3.2	LD3.3										
RA2.3	RA3.1	RA3.2	NW2.2	NW2.3	NW3.2	NW3.4	CR1.1	CR1.2	CR2.5	CR2.6										
Resilience value (user)	88 indicators	QL2.1	QL2.2	QL2.3	LD1.2	LD2.3	LD2.4	LD3.1	LD3.2	LD3.3										
energy (by the project)	61 indicators	QL1.2	QL1.5	QL1.6	QL2.1	QL2.2	QL3.4	LD1.2	LD2.3	RA2.1	RA2.2	RA2.3	RA2.4	NW2.4	NW3.3	CR2.6				
energy (fuel by private vehicles)	41 indicators	QL1.3	QL1.6	QL2.1	QL2.2	QL2.3	LD2.3	LD2.4	RA1.4	RA1.5	RA2.2	RA3.3	NW2.4							
embodied energy	87	RA1.5	RA2.2	RA2.3	RA2.4	RA3.3	NW1.4	NW2.3	NW3.1	NW3.3	NW3.4	NW3.5	CR2.5	CR2.6						
materials	59 indicators	QL1.5	QL1.6	QL2.1	QL2.2	QL3.4	LD1.2	LD1.4	LD2.3	RA1.2	RA1.3	RA1.4	RA1.5	RA2.3	RA3.4					
water	31 indicators	NW1.4	NW2.3	NW3.1	NW3.3	CR2.5	CR2.6													
embodied water	84	LD1.2	LD2.3	RA3.1	RA3.2	RA3.3	RA3.4	NW2.2												
	QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD2.4	RA1.1	RA1.2	RA1.3	RA1.4				
water quality	55 indicators	RA1.5	RA2.2	RA2.3	RA2.4	NW1.4	NW2.3	NW3.1	NW3.3	NW3.4	NW3.5	CR2.5	CR2.6							
waste	21 indicators	QL1.5	QL1.6	RA1.1	RA1.2	RA1.3	RA1.4	RA1.5												
integration	8 indicators	QL1.5	LD1.2	LD1.4	LD2.3	RA1.2	RA1.3	RA1.4	RA1.5	RA3.3										
access	56 indicators	QL2.1	QL2.2	LD1.2	CR2.6															
equity	12 indicators	QL1.6	QL2.1	QL2.2	QL2.3	QL3.1	LD2.3	RA2.2	CR2.5											
inclusivity	21 indicators	QL1.2	QL2.1	QL2.2	QL3.1	LD1.3	RA1.1	NW1.4												
		QL1.1	QL1.2	QL1.6	QL2.1	QL3.1	LD1.2	LD1.3	LD2.4	LD3.1										

C. Update of the list of 'IMPACTS'

The final list of 'IMPACTS' appropriate for the purposes of the research will:

1. be defined based on literature review, input from SIAB members, companies, agencies and investors and input from a real world project (case study).
2. transform the generic tool to the final filtering tool adapted for climate change & investors

To sum up, in methodological step 3, the aim is to first review the LC Sustainability tool's performance indicators and metrics to develop a more generic form of the (LC Sustainability) tool, which will apply to all infrastructures. Secondly, review the generic tool's existing list of 'IMPACTS' and identify gaps in climate change mitigation and adaptation & investor-criteria. This will highlight the required changes in the existing list of 'IMPACTS' and the additional impacts of climate change adaptation, climate change mitigation, and investors. In the end, the updated, final list of 'IMPACTS' will lead to the transformation of the generic tool into a final filtering tool. As explained in the following step 6 of methodology, this process intends to provide recommendations towards an Envision-based prioritization model for investment on 'the right projects.'

APPENDIX

LIST OF KEY ORGANIZATIONS AND INSTITUTIONS WORKING ON CLIMATE CHANGE

The **United Nations, UN** is an international organization, currently made up of 193 Member States. Due its unique international character, the United Nations can take action on the issues confronting humanity in the 21st century, such as peace and security, climate change, sustainable development, human rights, disarmament, terrorism, humanitarian and health emergencies, gender equality, governance, food production, and more. The main organs of the UN are the General Assembly, the Security Council, the Economic and Social Council, the Trusteeship Council, the International Court of Justice, and the UN Secretariat. All were established in 1945 when the UN was founded. The UN system, also known unofficially as the 'UN family', is made up of the UN itself and many programs, funds, and specialized agencies, all with their own leadership and budget. The programs and funds are financed through voluntary rather than assessed contributions. The Specialized Agencies are independent international organizations funded by both voluntary and assessed contributions.⁵⁹

The UNEP - United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system . UNEP acts as a catalyst , advocate, educator and facilitator to promote the wise use and sustainable development of the global environment.⁶⁰

The UNDP - United Nations Development Programme works in nearly 170 countries and territories, helping to eradicate poverty, reduce inequalities and build resilience so countries can sustain progress. As the UN's development agency, UNDP plays a critical role in helping countries achieve the Sustainable Development Goals.⁶¹

The UNFCCC - United Nations Framework Convention on Climate Change Secretariat - UN Climate Change - was established in 1992 when countries adopted the United Nations Framework Convention on Climate Change (UNFCCC). With the subsequent adoption of the Kyoto Protocol in 1997 and the Paris Agreement in

⁵⁹ <https://www.un.org/en/sections/about-un/main-organs/index.html>

⁶⁰ <https://www.un.org/en/sections/about-un/funds-programmes-specialized-agencies-and-others/index.html>

⁶¹ Background on the goals : <https://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html>

2015, Parties to these three agreements have progressively reaffirmed the Secretariat's role as the United Nations entity tasked with supporting the global response to the threat of climate change.⁶²

COP - Conference of the Parties under the UNFCCC - Under the 1992 United Nations Framework Convention on Climate Change, every country on earth is treaty-bound to “avoid dangerous climate change”, and find ways to reduce greenhouse gas emissions globally in an equitable way. COP stands for conference of the parties under the UNFCCC, and the annual meetings have swung between fractious and soporific, interspersed with moments of high drama and the occasional triumph (the Paris agreement in 2015) and disaster (Copenhagen in 2009).⁶³ A key task for the COP is to review the national communications and emission inventories submitted by Parties. Based on this information, the COP assesses the effects of the measures taken by Parties and the progress made in achieving the ultimate objective of the Convention.⁶⁴

UNDRR (formerly UNISDR)-United Nations Office for Disaster Risk oversees the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030, supporting countries in its implementation, monitoring & sharing what works in reducing existing risk and preventing the creation of new risk.⁶⁵

The UNSD -United Nations Statistics Division is committed to the advancement of the global statistical system. Its aim is to compile and disseminate global statistical information, develop standards and norms for statistical activities, and support countries' efforts to strengthen their national statistical systems. Moreover it facilitates the coordination of international statistical activities and supports the functioning of the United Nations Statistical Commission as the apex entity of the global statistical system.⁶⁶

The Sustainable Development Goals Fund (SDG Fund) is an international multi-donor and multi-agency development mechanism created in 2014 by the United Nations to support sustainable development activities through integrated and multidimensional joint programs. Its main objective is to bring together UN agencies, national governments, academia, civil society and business to address the challenges of poverty, promote the 2030 Agenda for Sustainable Development and achieve SDGs. Convening public-private partnerships for SDGs is in the SDG Fund's DNA.⁶⁷

IPCC - Intergovernmental Panel on Climate Change was established in 1988 to provide policymakers with regular scientific assessments on the current state of knowledge about climate change. Its initial task, was to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; the social and economic impact of climate change, and potential response strategies and elements for inclusion in a possible future international convention on climate. Since 1988, the IPCC has had five assessment cycles and delivered five Assessment Reports. It has also produced a range of Methodology Reports, Special Reports and Technical Papers, in response to requests for information on specific scientific and

⁶² <https://unfccc.int/about-us/about-the-secretariat>

⁶³ <https://www.theguardian.com/news/2019/dec/02/climate-crisis-what-is-cop-and-can-it-save-the-world>

⁶⁴ <https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop>

⁶⁵ <https://www.undrr.org/about-undrr>

⁶⁶ <https://unstats.un.org/home/about/>

⁶⁷ <https://www.sdgfund.org/who-we-are>

technical matters from the United Nations Framework Convention on Climate Change (UNFCCC), governments and international organizations.⁶⁸

IMPACTS DEFINITION

Social Impacts:

Access=access to key community activities (job, education, healthcare, etc.)

Safety = exposure to the risk of accident (during operations or construction works) for public/ safety for workers; the level of stress for users; premature mortality due to accidents

Health = project's impact on human health (air-, water-, noise- prone diseases and premature mortality)

Noise= community disturbance caused by project-generated noise (operational or during construction and maintenance works)

Light pollution= impact of excessive, misdirected, or obtrusive artificial outdoor light (during operations or during construction and maintenance works)

Community satisfaction= Project approval by the affected by the project community as reflected in positive feedback

Inclusivity=inclusion of people who might otherwise be excluded or marginalized (minority groups) and inclusion of all related stakeholders in the decision-making process

Equity=equal and without prejudice treatment of all individuals affected by the project (communities) and involved in the project delivery (project team, workforce), as well as fair distribution of benefits and burdens and funding

Sense of place= heritage & cultural identity

Wellbeing= Given that human wellbeing is a broad concept with numerous interpretations that lacks a universally acceptable definition, as part of this research entails living standards, needs fulfillment, human comfort, freedom of choice, ride quality, visual comfort (removal of eyesores); and workers comfort. Though not a quantifiable impact, it is used to highlight the project's contribution to relevant themes.

Livability=contribution to the creation of livable communities

Integration= operational relationships and functional integration of the project into connected, efficient, and diverse infrastructure systems beyond its boundary

Capacity building= Skill and knowledge expansion (for the workforce, community), awareness building and behavioral change

Social Resilience= avoided loss of life, loss of health, loss of assets due to acute shocks and chronic stresses and avoided impact on the community due to loss of service; as well as adaptation to demographic shifts

Environmental Impacts:

Materials= use of primary materials

Energy= fuel & electricity use; depending on the credit could refer to fuel use of equipment/ vehicles;

Embodied energy= embodied energy of materials, equipment and fleet vehicles (from cradle to gate)

⁶⁸ <https://www.ipcc.ch/reports/>

Water = quantity of freshwater used during construction works and O&M, as well as embodied water of materials

Water quality= contamination of wetlands, surface water bodies, and groundwater, acidification, eutrophication of water bodies

Embodied water= embodied water of materials, equipment, and fleet vehicles (use of water from cradle to gate)

Air quality= emission of air pollutants: particulate matter (including dust), volatile organic compounds (VOC), etc.

Waste= waste generation during construction or replacement works and project operations

Soil quality= disturbance of soil health and functionality (e.g., water holding capacity, nutrient retention capability, and erosion prevention capability)

Emissions= GHG emissions; depending on the credit could refer to emissions from waste & waste hauling; from materials hauling; emissions refer directly to 'Climate change.'

Embodied carbon= embodied carbon of materials, equipment, and fleet vehicles (from cradle to gate, therefore including emissions during material extraction and production; equipment/vehicle manufacture; fuel production; supply chain.

Ecosystem quality= ecosystem degradation, biodiversity loss, loss of habitat connectivity (and in some cases wildlife-vehicle collisions)

Resource depletion =intensification of raw materials extraction, freshwater (surface and groundwater) as a result of materials, water used by the project

Land occupation= area of land (undeveloped) permanently or temporarily occupied and converted to accommodate the project, or temporary construction works, as well as land to accommodate waste produced (landfill)

Climate change= project's contribution (exacerbation or mitigation) to climate change

Ecological resilience= Project's contribution to the potential degradation of ecosystems

Economic impacts:

Economic impacts are added or reduced costs for/by incorporating a sustainable feature and implementing a sustainable strategy. In line with Lifecycle Costing and Cost-Benefit Analysis, methodologies costs are distinguished in agency and user costs.

For the agency:

Capital cost= initial capital/ investment cost (including preliminary engineering, contract administration, initial construction, construction supervision & administrative costs)

O&M cost= recurring operational & routine maintenance cost

Rehabilitation cost= cost or avoided costs of major rehabilitation

Replacement cost = cost or avoided costs of replacement of the project/ end-of-life cost

Residual value = (also known as salvage value) is the estimated value of an asset at the end of its lease term or useful life.

Revenues= streams of income due to service provision, pricing schemes in-place, by-product synergies with external groups, carbon credits trade.

Delay cost= avoided cost due to delays in project delivery due to public opposition, or extended approval processes

Liability claim/Penalty cost= avoided potential cost of liability claims (e.g., in the case of an accident) and cost of potential penalties for exceedance of regulation limits (e.g., noise, air quality, water quality, etc.)

Noise cost= avoided cost for passive noise mitigation (e.g.) Sound Insulation schemes for affected residences.

Restoration cost= cost of restoration or clean-up of a natural system in the case of an environmental incident during construction and operation.

Resiliency value= value of protection from the effects of future/repeat disasters; such as avoided future cost of repair, of displacement, or cost of loss of service that may create a financial downturn or slowdown for the organization

Ecosystem services value= impact on natural capital and avoided costs for substituting natural control processes (availability of clean air, fresh water, reduced risk of flooding or drought) with engineered controls

Moreover, a further breakdown of capital, O&M, rehabilitation, and replacement costs is provided for additional and more specific data on the source of cost:

- Land acquisition cost (for temporary staging area)
- Materials cost (for acquisition)
- Labor cost
- Schedule efficiency cost (avoided cost through optimized work completion)
- Hauling & fuel cost
- Waste cost

This additional information, in the form of notes, can provide a better account for trade-offs for the consideration of alternatives (Lifecycle Costing).

For the user:

Travel time value= avoided cost of time spent on transport. It includes costs to businesses of the time their employees and vehicles spend on travel and costs to consumers of personal (unpaid) time spent on travel. Therefore, it translates time loss, e.g., due to congestion into productivity for individuals and businesses. A person's time value is determined by the average income level and working hours)

Vehicle cost= avoided vehicle operating cost due to increased miles traveled (affected by vehicle type, age, and condition of road surface condition)

Fuel cost= avoided cost of excess fuel consumption due to stop-and-go traffic flow during congestion & due to surface roughness and deflection of the road surface (which is a function of design and maintenance)

Fare cost= the impact of the project on the affordability of service

Accident cost= avoided cost of accidents (vehicle repair or medical cost)

Health cost= avoided medical cost of illness

Job creation= direct or indirect jobs created as a result of the project (construction, O&M, supply chain)

Economic prosperity=project's contribution to socioeconomic conditions of the affected community through attractiveness to businesses, workforce, etc., and user's productivity through increased capacity, improved level of service, etc.

Resiliency value= value of protection from the effects of future/repeat disasters, such as avoided loss of life, loss of health, damage or loss of property; and loss of productivity due to disruption of service

Ecosystem services value=impact on natural capital, a community asset, given that the preservation of ecological functions is necessary for human needs fulfillment (availability of clean air, fresh water, reduced risk of flooding or drought, stabilization of local and regional climates, control on the range and transmission of certain diseases; provisioning of food; visual comfort, recreation, etc.)

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