GreenDelta

sustainability consulting + software

Social Life Cycle Impact Assessment & S-LCA of the Nicaragua Canal Project

Dr. Andreas Ciroth, Franziska Eisfeldt
GreenDelta
sLCA 2016, Cambridge MA, June 14, 2016

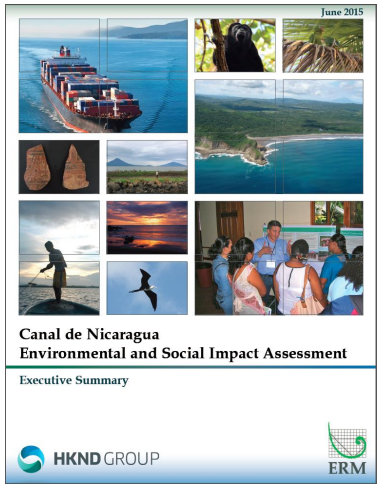
Points for today

1. The case: Canal de Nicaragua
2. Environmental and Social Impact Assessment
3. A hybrid case: extending SIA with Social LCA
    1. Scope
    2. Inventory
    3. Results
    4. Interpretation

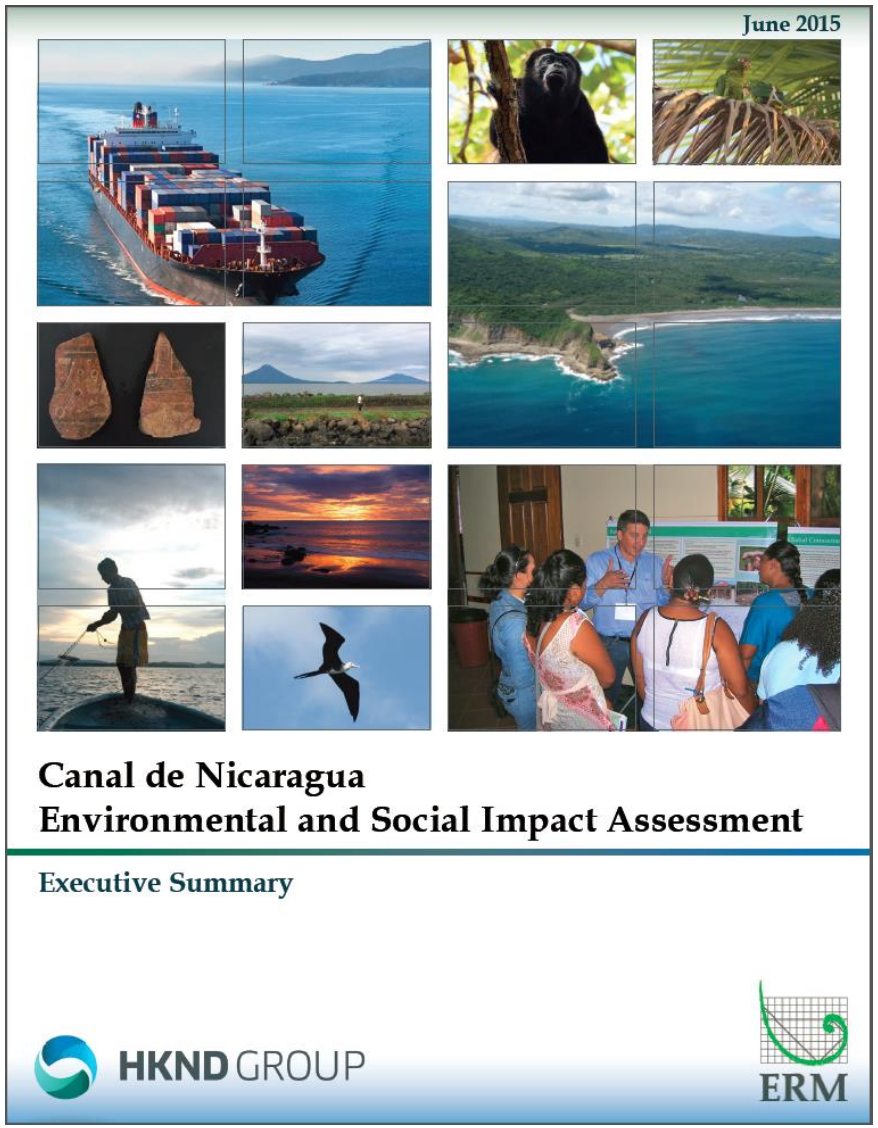
The case: Canal de Nicaragua

The case, Canal de Nicaragua

- „Canal de Nicaragua. Environmental and Social Impact Assessment“ (ESIA), study June 2015 by Environmental Resources Management (ERM)
- Comprehensive 11,000 pages study
- Commissioned by the main sponsor and planner HKND Group (Hong Kong Nicaragua Canal Development Investment Co., Limited)



The case, Canal de Nicaragua

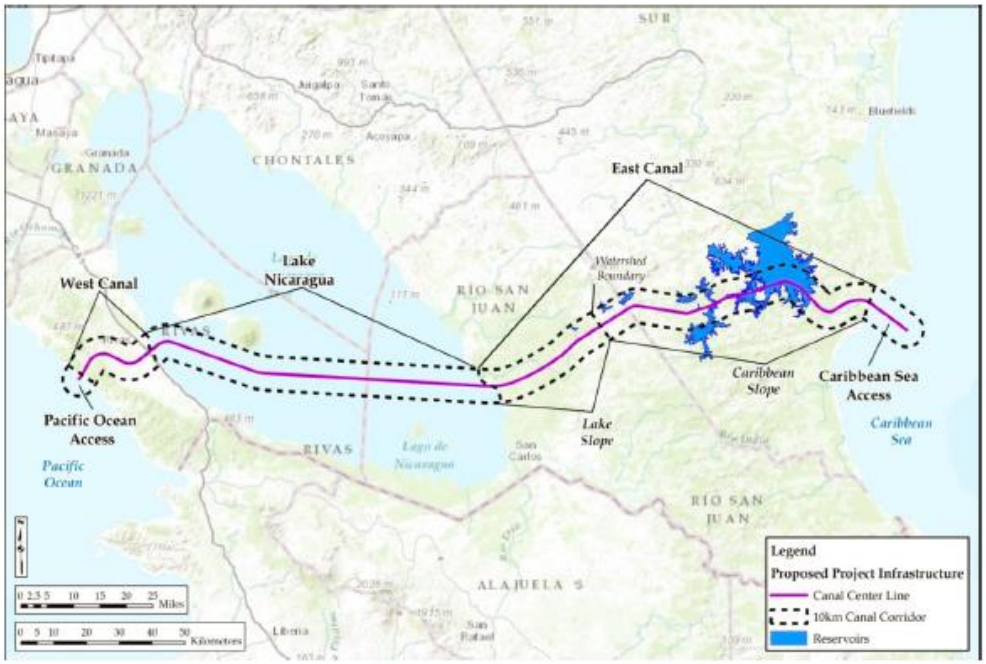


The case: General facts

- Purpose and need: significant benefit for Nicaraguan economy expected (increase of GDP per capita by almost 200% compared to projections without canal)
- Length: 275.5 km
- Projected construction time: from 2014 – end of 2019 (5 years)
- HKND, a privately-held infrastructure development firm, obtained a renewable **50-year concession** to finance, construct, and operate the Canal
- Estimated costs: between 40 and 50 billion USD (however, experts expect much higher costs)
- Number of workers: 50,000 during construction, raises from 3700 in 2020 to 12,700 in 2050

The case: General facts

- Nicaragua Grand Canal project consists of **6 sub-projects**:
  - Canal (including 2 locks)
  - 2 Ports
  - a Free Trade Zone
  - Holiday Resorts
  - International Airport
  - several roads
  - power station
  - cement factory
  - other related facilities



ERM Executive summary (2015), p. 11

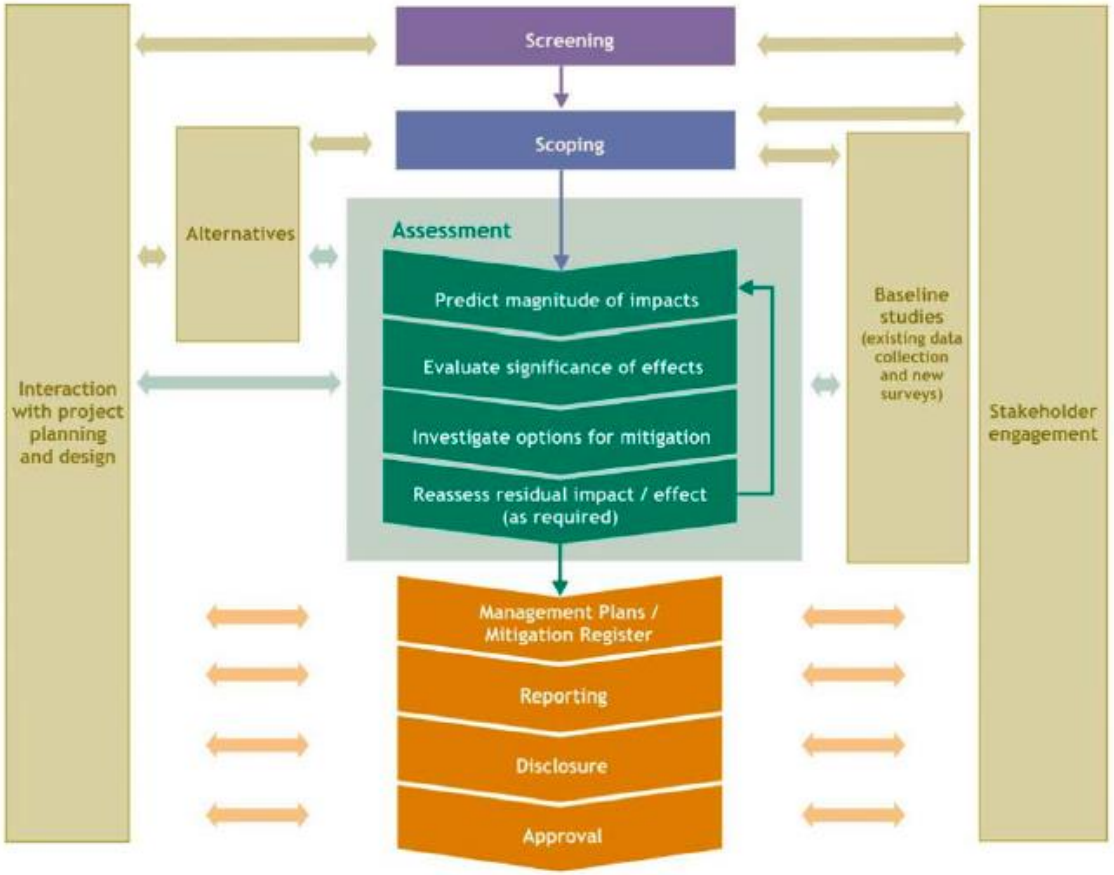
- considerable ecological and social impacts – both positive and negative – are expected

Environmental and Social Impact Assessment study: approach

ESIA study: Introduction

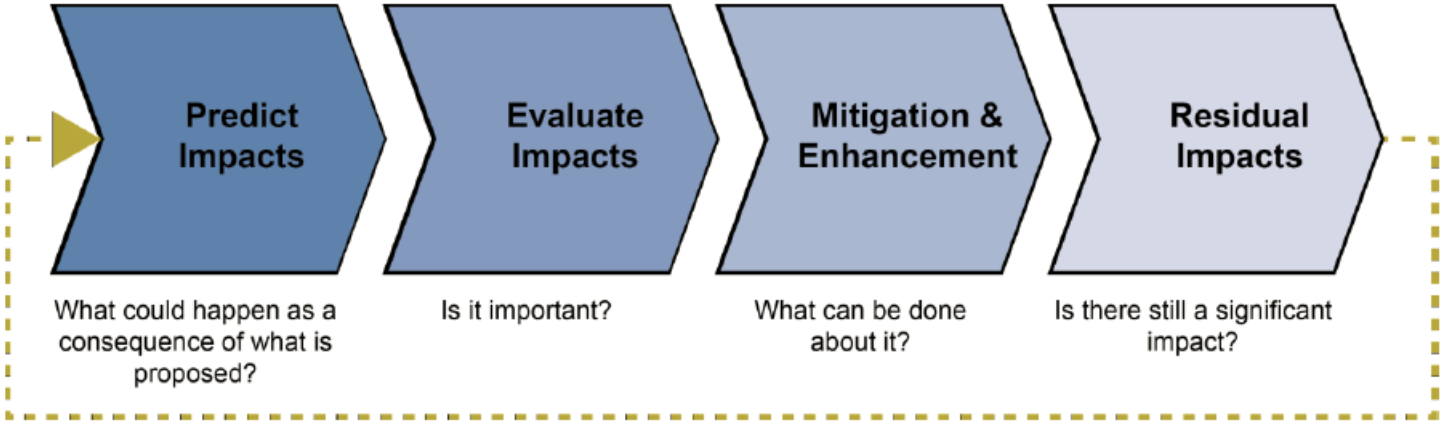
- Project must comply with international good practice, external doubts about social and env. impacts
- HKND´s objective: to achieve a Net Positive Impact
- Impacts are **potential** (i.e. assumed, depending on strategy of the project and on **mitigation** procedures)
- Subcategories and impacts assessed for local communities, workers, government and national economy
- Assessment based on field studies
- Assessment only for construction and operation of the three canal segments (not for sub-projects)

ESIA: ESIA process



ERM Executive summary (2015), p. 25

ESIA: Impact Assessment



ERM Executive summary (2015), p. 26

- ESIA evaluates Project against Equator Principles, i.e. compliance with relevant host country regulations, and permits: International Finance Corporation´s Performance Standards (PSs), World Bank Group´s Environmental, Health, and Safety Guidelines (WB EHS Guidelines)

ESIA: Determination of impact significance

- ..as result of impact magnitude and receptor vulnerability

Negative Impacts					
			Vulnerability of Receptors		
			Low Minimal areas of vulnerabilities; consequently with a high ability to adapt to changes brought by the Project	**Medium** Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to changes brought by the Project	**High** Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project
Magnitude of Impact	Minimal	Change remains within the range commonly experienced within the household or community.	Negligible	Negligible	Negligible
	Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare, and affects a small proportion of receptors and is of short duration.	Negligible	Minor	Moderate
	Medium	Clearly evident difference from baseline conditions. Tendency for impact to affect a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.	Minor	Moderate	Major
	Large	Change dominates over baseline conditions. Affects the majority of the area or population in the Area of Influence and/or persists over many years. The impact may be experienced over a regional or national area.	Moderate	Major	Major
Positive Impacts					
Magnitude of Impact	Positive	In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless ample data supports a more robust characterization. It is usually sufficient to indicate that the Project will result in a positive impact, without characterizing the exact degree of positive change likely to occur.	Positive	Positive	Positive

ERM Volume 4 (2015), p. 8.1-11

ESIA: Magnitude

- Magnitude reflects the size or degree of change caused by social and community health impacts
- Magnitude = function of four elements:
  - Scale (minimal – large): degree of change to household level livelihood, individual or household level health status and quality of life
  - Duration (temporary – permanent): timeframe over which an impact would be experienced
  - Geographic extent (local - national): geographic reach of impact
  - Frequency (remote – constant): constancy or periodicity of an impact

ESIA: Vulnerability

- Vulnerability or sensitivity is a pre-existing status independent of project
- Related to population´s resilience, i.e. capacity to cope with changes
- 3 levels of vulnerability

Level	Characterization
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.
Medium	Some, but few areas of vulnerability; still retaining an ability to at least in part adapt to change brought by the Project and opportunities associated with it.
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project and opportunities associated with it.

ERM Volume 4 (2015), p. 8.1-4

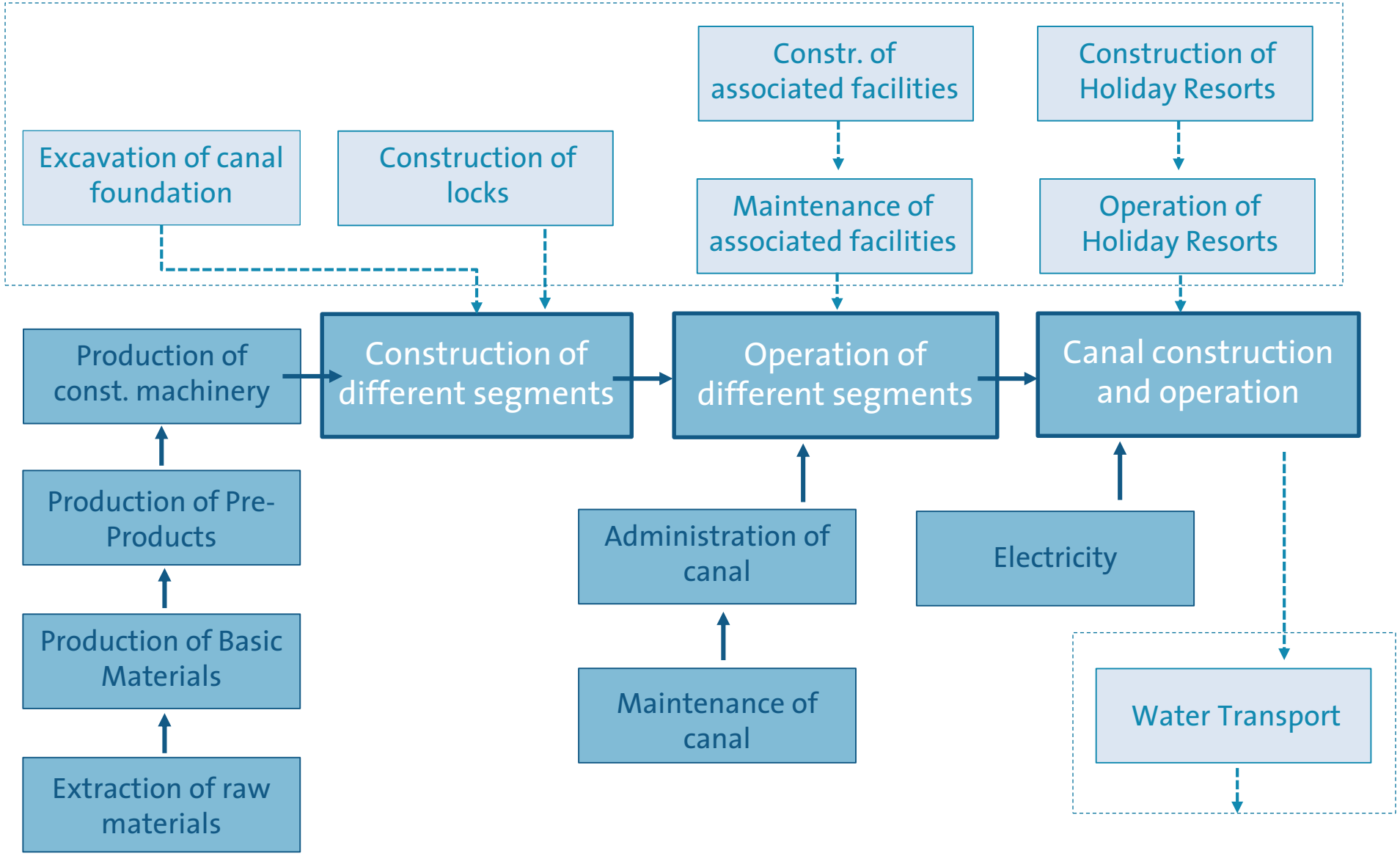
Hybrid case: Scope

Idea/ Purpose

- Compare and combine two worlds: a really large SIA / EIA study and social LCA, for a relevant case
- Compare results of social impact assessment with Social LCA:

  - What are differences and similarities?
  - What are benefits from each approach?
  - Where are “blind spots”?
  - How valid is additional information?
  - Is this combination useful, especially for the assessment of large infrastructure projects

Product system and system boundaries



PSILCA for the social LCA “extension”

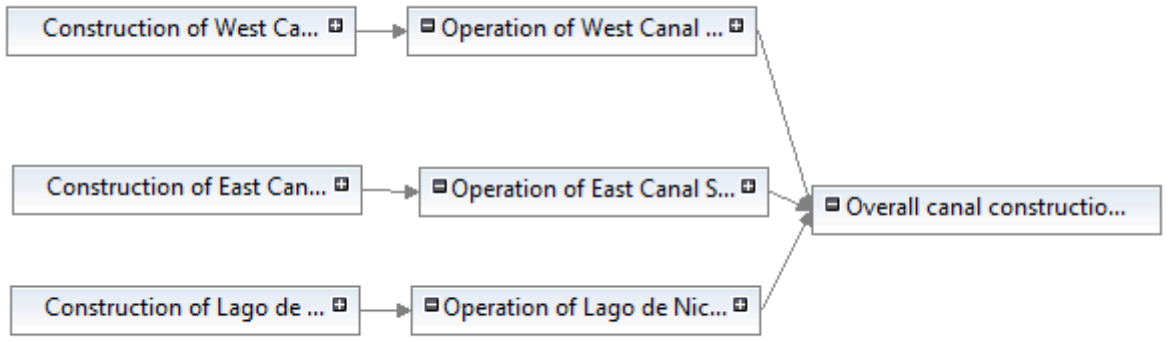
(comprehensive database for social LCA, for 196 countries, > 50 indicators, almost 16,000 sectors, reference year 2013 for IO model, 2015 for social LCA data, created by GreenDelta 2013-2016, released beginning of 2016:

- Transparent social information, pre-risk assessment
- Data quality assessment for each indicator value)

PSILCA

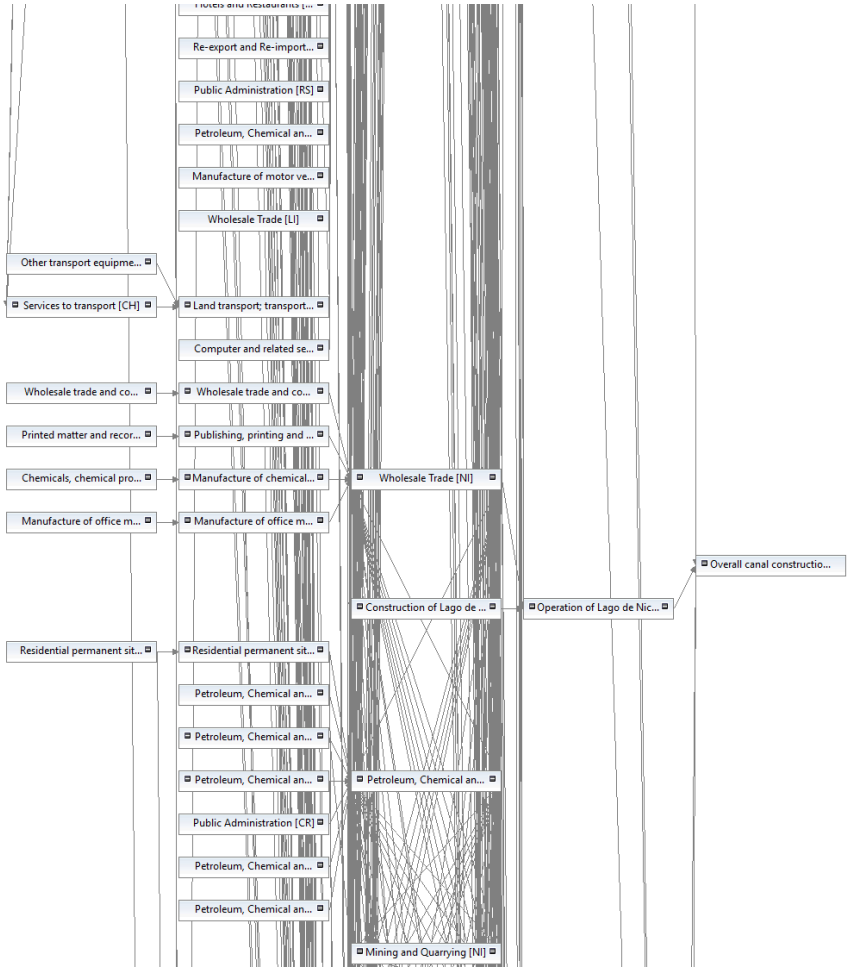
Modelled product system

Model graph taken from openLCA, foreground



Modelled product system

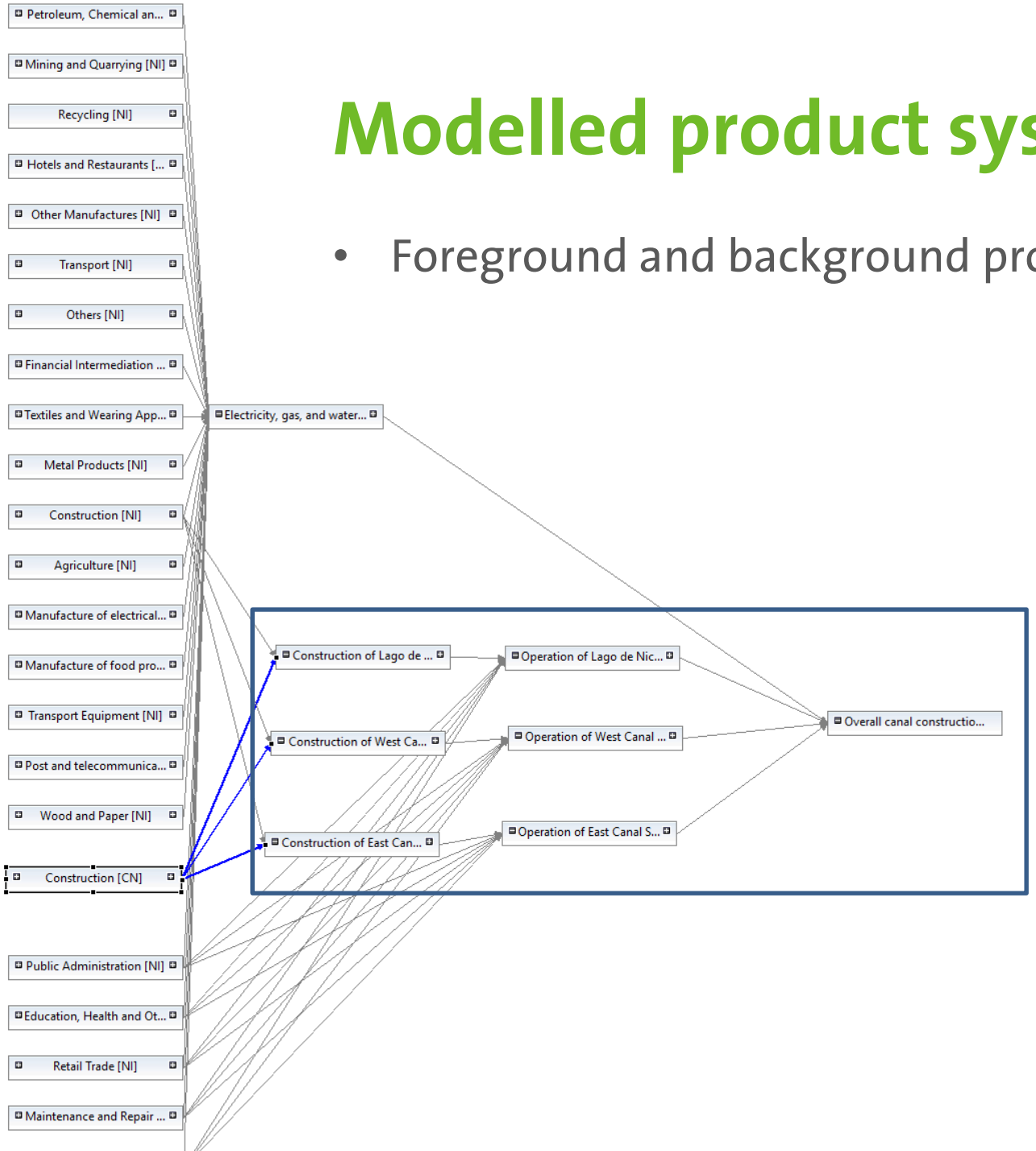
Model graph taken from openLCA, part



GreenDelta

Modelled product system

- Foreground and background processes



Considered impacts/ indicators

- Case study “indicators” are assigned to PSILCA impact categories (and not overwritten)

Original impact (=indicator)	Process	Impact category in PSILCA
Effects on Community Access to Potable Water	Construction and Operation of West Canal Segment; Construction and Operation of East Canal Segment	Industrial Water depletion
Effects on Potable Water Quality	Construction and Operation of Lago de Nicaragua Segment	Industrial Water depletion
Effects on the Nahoa Indigenous Peoples	Construction and Operation of West Canal Segment	Indigenous rights
Effects on the Rama-Kriol Indigenous Peoples	Construction and Operation of East Canal Segment	Indigenous rights
Effects on Indigenous Peoples	Construction and Operation of Lago de Nicaragua Segment	Indigenous rights
Increase in personal income	Construction and operation of whole canal	Fair Salary

Impact Assessment Method

Impact assessment method: SIA method canal de Nicaragua

Impact factors

Impact category: Industrial water depletion

Flow	Category	Flow property	Unit	Factor
Effects on Community Access to Potable Water; high risk	Local Community/A...	Duration	WU med risk hours/h	2.0
Effects on Community Access to Potable Water; medium risk	Local Community/A...	Duration	WU med risk hours/h	1.0
Effects on Potable Water quality; low risk	Local Community/A...	Duration	WU med risk hours/h	0.5
Level of industrial water use (related to renewable water resources); low risk	Local Community/A...	Duration	WU med risk hours/h	0.5
Level of industrial water use (related to renewable water resources); medium risk	Local Community/A...	Duration	WU med risk hours/h	1.0
Level of industrial water use (related to renewable water resources); no data	Local Community/A...	Duration	WU med risk hours/h	0.5
Level of industrial water use (related to renewable water resources); very high risk	Local Community/A...	Duration	WU med risk hours/h	5.0
Level of industrial water use (related to renewable water resources); very low risk	Local Community/A...	Duration	WU med risk hours/h	0.25
Level of industrial water use (related to total withdrawal); high risk	Local Community/A...	Duration	WU med risk hours/h	2.0
Level of industrial water use (related to total withdrawal); low risk	Local Community/A...	Duration	WU med risk hours/h	0.5
Level of industrial water use (related to total withdrawal); medium risk	Local Community/A...	Duration	WU med risk hours/h	1.0
Level of industrial water use (related to total withdrawal); no data	Local Community/A...	Duration	WU med risk hours/h	0.5
Level of industrial water use (related to total withdrawal); very high risk	Local Community/A...	Duration	WU med risk hours/h	5.0
Level of industrial water use (related to total withdrawal); very low risk	Local Community/A...	Duration	WU med risk hours/h	0.25

Screenshot from openLCA

Hybrid case: Inventory

Approach: Risk level

Adaptation to PSILCA scheme:

Risk/ opportunity level: Combination of ***Scale, Geographic extend and Vulnerability*** → adapted designation of magnitude, e.g.

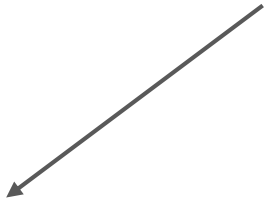
Geographic extend	Scale	Vulnerability	Adapted magnitude (scale, geogr. Ext., vuln.)	PSILCA/ openLCA	Min. Score
Local	Small, medium	Low, medium	Small	Low risk	6
Local	Small	High	Medium	Medium risk	12
Local	Medium	High	Medium	High risk	14
Local	Large	Low	Small	Low risk	10
Local	Large	Medium	Medium	High risk	13
Local	Large	High	Large	Very high risk	16
Sub-regional	Small	Low, medium	Small	Low risk	7
Sub-regional	Small	High	Medium	High risk	13
Sub-regional	Medium	Low	Small	Low risk	9
Sub-regional	Medium	Medium	Medium	Medium risk	
Sub-regional	Medium	High	Large	Very high risk	
Sub-regional	Large	Low	Medium	Medium risk	
Sub-regional	Large	Medium	Medium	High risk	
Sub-regional	Large	High	Large	Very high risk	

Geographic extend	Scale	Adapted magnitude	PSILCA/ openLCA	Score
Local	Small	Positive	Low opportunity	3
Local	Medium	Positive	Medium opportunity	5
Local	Large	Positive	Medium opportunity	7
Sub-regional	Small	Positive	Low opportunity	4

Approach: Activity variable

Adaptation to PSILCA scheme:

Activity variable = weighted working time: Factor of weighted ***Duration*** and ***Frequency*** and Worker hours of process



= Nb of workers in the segment * 160 hours * 11 months * process duration

With:

- Nb of workers in the segment: scaled by length of canal segment
- Process duration: for construction provided in study; for operation = 50 years assumed

Approach: Activity variable

- Effect: Worker hours may be different within one process depending on the indicator!

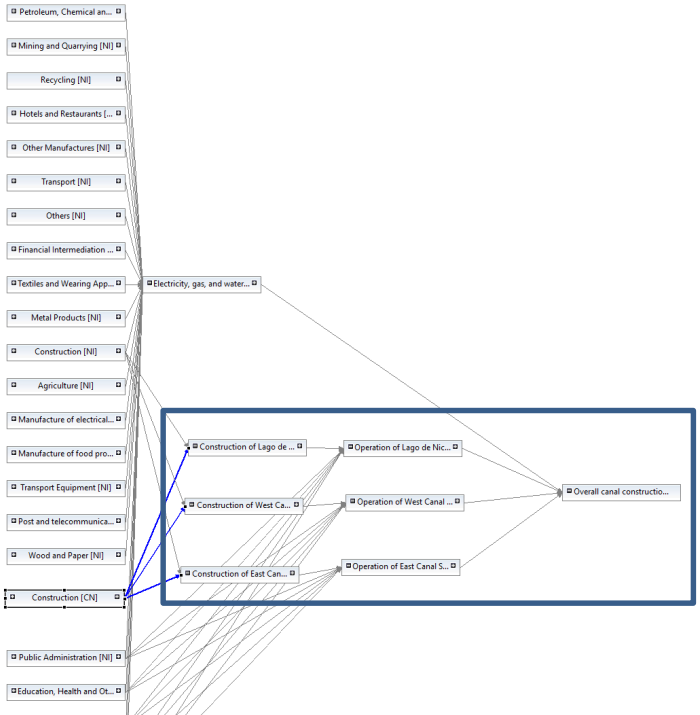
Certified environmental management systems; very high risk	Local Community/Access to material resources	2.60304E7	h
Health expenditure, total; medium risk	Society/Health and Safety (Society)	2.60304E7	h
Extraction of fossil fuels; no data	Local Community/Access to material resources	2.60304E7	h
Extraction of industrial and construction minerals; very low ...	Local Community/Access to material resources	2.60304E7	h
Rate of fatal accidents at workplace; medium risk	Workers/Health and Safety (Workers)	2.60304E7	h
Construction of West Canal Segment	PSILCA - Products/Nicaragua canal	1.00000	Item(s)
Effects on the Nahoa Indigenous Peoples; high risk	Local Community/Respect of indigenous rights	4.68547E9	h
Effects on Community Access to Potable Water; high risk	Local Community/Access to material resources	4.68547E8	h

Screenshot from openLCA

Approach: Connecting processes

Adaptation to PSILCA scheme:

- Connection of foreground processes via items
- Connection to generic processes via prices (for operation: assumption: similar to Panama Canal, scaled by length and investment costs)



Indicators

Example: *Effects on Community Access to Potable Water* in Construction of West Canal Segment

Indicator		Risk Assessment		Weighted worker hours	
Original	**PSILCA (Impact category)**	**Original**	**PSILCA**	**Original**	**PSILCA**
Effects on Commu-nity Access to Potable Water	Level of industrial water use (related to renewable water resources)	*Extend:* Sub-regional *Scale:* Large *Vulnerability:* Medium; *Magnitude:* Large *Significance:* Major	*Adapted Magnitude* (without duration and frequency): **medium** → Risk assessment: high risk	*Duration:* Short-term (whole construction phase) *Frequency:* Constant	Number of workers: **2958** Duration of west segment: 1s/2015 – 2s/2019 = **5 years** → 5.206.080 hrs per year → 5.206.080 hrs *5 years*0.01 (dur.)*1800 (frequ.)= 468.5472 Mill hrs

Indicators

Example: Construction of West Canal Segment

Screenshots from openLCA

Extraction of fossil fuels; no data	Local Community/Access to material resources	Working_time	h
Extraction of industrial and construction minerals; very low risk	Local Community/Access to material resources	Working_time	h
Rate of fatal accidents at workplace; medium risk	Workers/Health and Safety (Workers)	Working_time	h
Construction of West Canal Segment	PSILCA - Products/Nicaragua canal	1.00000	Item(s)
Effects on the Nahoa Indigenous Peoples; high risk	Local Community/Respect of indigenous rights	Working_time_long	h
Effects on Community Access to Potable Water; high risk	Local Community/Access to material resources	Working_time_short	h

Dependent parameters

Name	Formula	Value
Cost_WC	Canal_Costs*Share_WC	4.7E9
Working_time	Nb_workers_West*160*11*Construction_duration	2.60304E7
Working_time_long	Nb_workers_West*160*11*Duration_long*Frequ_Const*Construction_duration	4.685472E9
Working_time_short	Nb_workers_West*160*11*Duration_short*Frequ_Const*Construction_duration	4.685472E8

Social assessment

Name	Raw value	Risk level	Activity variable	Data quality	Comment	Source
Local Community						
Access to material resources						
Extraction of biomass (related to area)	280.609 [t/km²]	Low risk	2.60304E7 [h, Working hours]	(2;1;4;1;2)	Data from: 2011;...	SERI/
Level of industrial water use (related to renewable water resources)	0.044741641337...	Very low risk	2.60304E7 [h, Working hours]	(1;1;4;1;2)	Data from: 2010;...	FAO
Extraction of fossil fuels		No data	2.60304E7 [h, Working hours]			
Extraction of ores	1.05 [t/cap]	Very low risk	2.60304E7 [h, Working hours]	(2;1;4;1;2)	Data from: 2011;...	SERI/
Level of industrial water use (related to total withdrawal)	4.764 [% of total]	Very low risk	2.60304E7 [h, Working hours]	(2;2;4;1;2)	Data from: 2011;...	FAO
Extraction of industrial and construction minerals	1.2585 [t/cap]	Very low risk	2.60304E7 [h, Working hours]	(2;1;4;1;2)	Data from: 2011;...	SERI/
Certified environmental management systems	0.0 [# per 10k e...	Very high risk	2.60304E7 [h, Working hours]	(2;1;2;1;2)	normalised with ...	ISO 2
Extraction of biomass (related to population)	6.1953 [t/cap]	Medium risk	2.60304E7 [h, Working hours]	(2;1;4;1;2)	Data from: 2011;...	SERI/
Effects on Community Access to Potable Water	Medium [Scale]	High risk	4.68547E8 [h, Weighted Worker hours]	(2;1;2;1;1)	Extend: Sub-regi...	Nicar

Indicators

Example: *Increase in personal income* in Overall Canal Construction and Operation

- Positive impact!

Process: Overall canal construction and operation

Inputs

Flow	Category	Amount	Unit	Costs	Uncertainty	Prov
Operation of West Canal Segment	PSILCA - Products/Nicaragua c...	1.00000	Item(s)		none	
Operation of Lago de Nicaragua Segment	PSILCA - Products/Nicaragua c...	1.00000	Item(s)		none	
Operation of East Canal Segment	PSILCA - Products/Nicaragua c...	1.00000	Item(s)		none	
Electricity, gas, and water supply - NI	Nicaragua/Industries	Electricity_costs	USD		none	

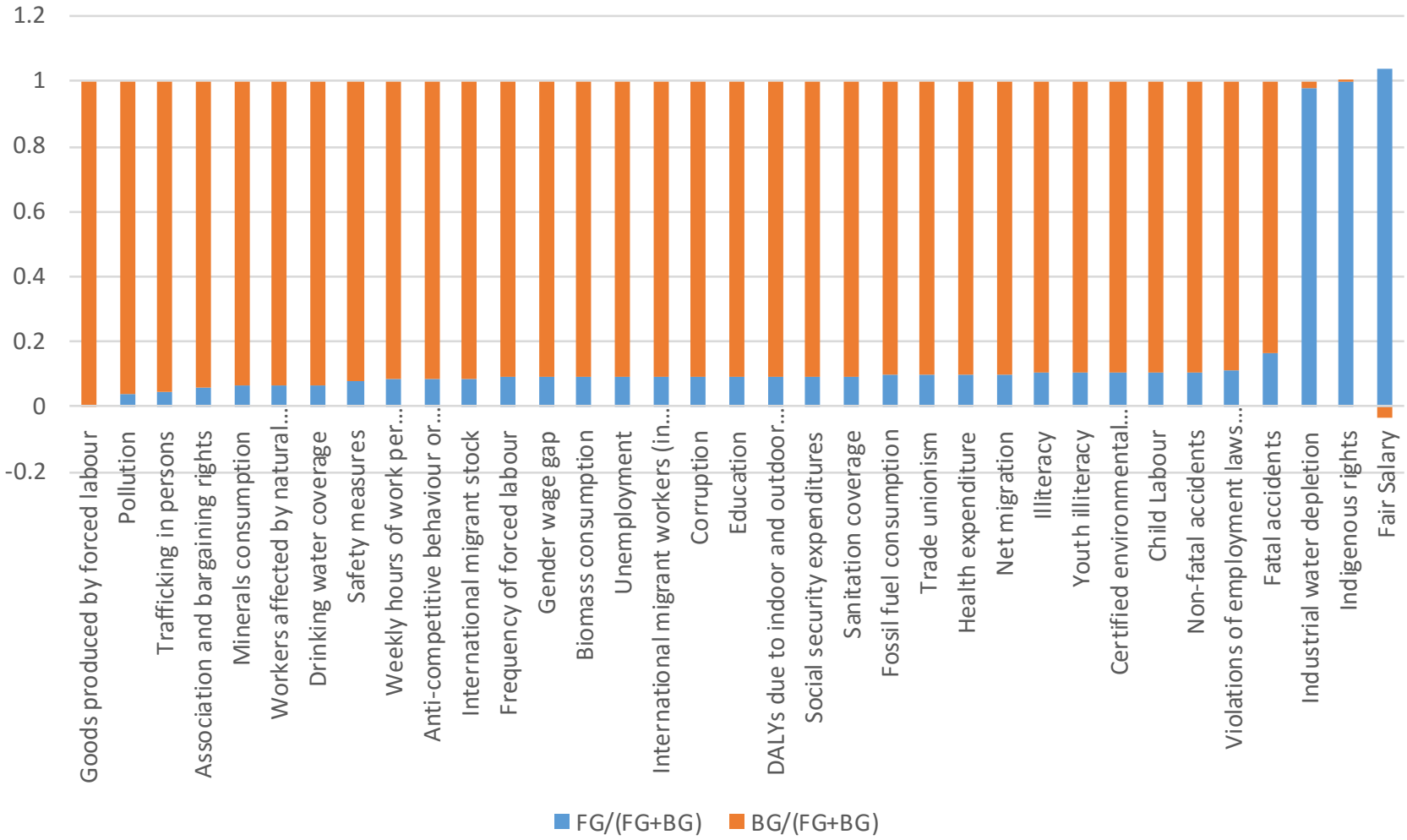
Outputs

Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty
Increase in personal income; high opportunity	Workers/Fair Salary	Working_time*-1	h		none
Canal construction and operation	PSILCA - Products/Nicaragua canal	1.00000	Item(s)		none

Screenshots from openLCA

Hybrid case: Preliminary results

Impacts: Foreground vs. background system



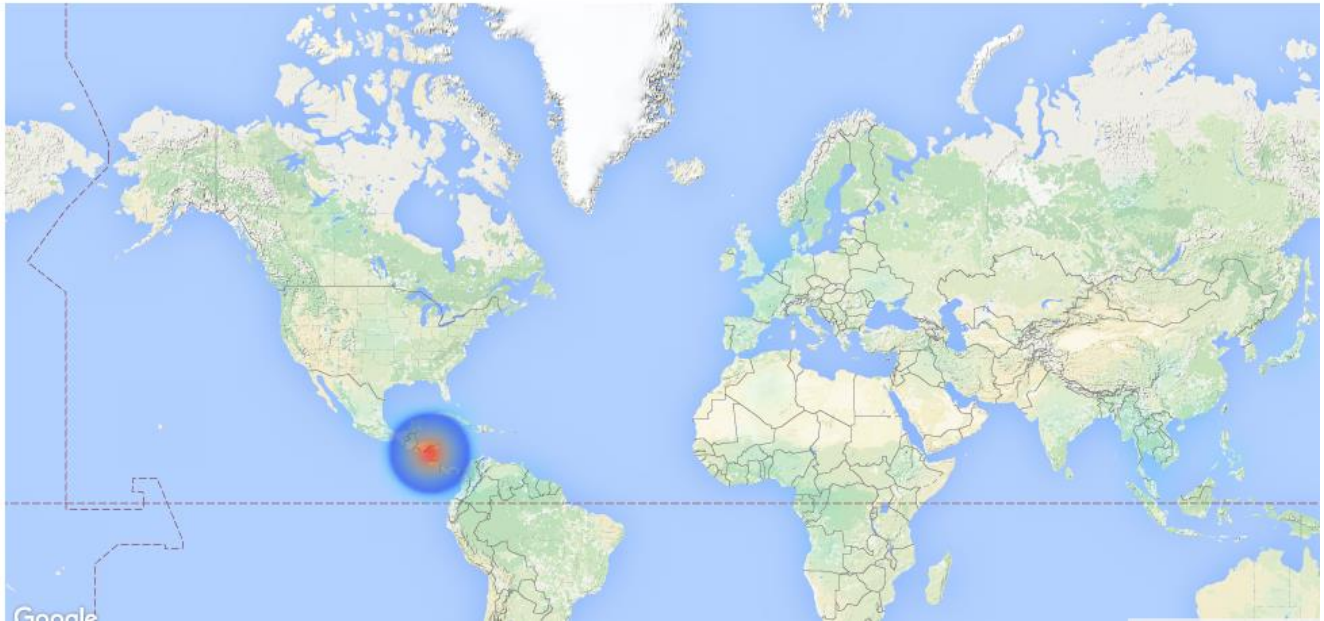
Impact hotspot: Indigenous rights

Impact category: Indigenous rights Cut-off: 0 % Exclude zero entries

Contribution tree for locations

Location/Process	Amount	Unit
Nicaragua - NI	7.23470E12	IR med risk hours
China - CN	3.63127E9	IR med risk hours
United States - US	1.37049E8	IR med risk hours
Russian Federation - RU	1.15457E8	IR med risk hours
Costa Rica - CR	2.40821E7	IR med risk hours
Canada - CA	1.49431E7	IR med risk hours
Honduras - HN	1.01901E7	IR med risk hours
	8.18046E6	IR med risk hours
El Salvador - SV	8.03975E6	IR med risk hours
India - IN	7.39004E6	IR med risk hours
Iran, Islamic Republic of - IR	7.00019E6	IR med risk hours
Mexico - MX	6.31983E6	IR med risk hours
Hong Kong - HK	5.51844E6	IR med risk hours

Map (beta)



Impact hotspot: Indigenous rights

Impact category: Indigenous rights

Contribution	Process	Amount	Unit
100.00%	Overall canal construction and operation - NI	7.21931E12	IR med risk ho...
99.31%	Operation of East Canal Segment - NI	7.16983E12	IR med risk ho...
43.81%	Construction of East Canal Segment - NI	3.16278E12	IR med risk ho...
00.00%	Education, Health and Other Services - NI	0.00205	IR med risk ho...
00.00%	Maintenance and Repair - NI	0.00172	IR med risk ho...
00.00%	Public Administration - NI	0.00150	IR med risk ho...
00.00%	Wholesale Trade - NI	0.00039	IR med risk ho...
00.00%	Retail Trade - NI	0.00027	IR med risk ho...
00.68%	Operation of West Canal Segment - NI	4.90464E10	IR med risk ho...
00.01%	Operation of Lago de Nicaragua Segment - NI	4.38176E8	IR med risk ho...
00.00%	Electricity, gas, and water supply - NI	0.00012	IR med risk ho...

Impact contributions: forced labour

Impact category: Goods produced by forced labour | Cut-off: 0 % | Exclude zero entries

Contribution tree for locations

Location/Process	Amount	Unit
China - CN	2.59700E6	GFL med risk hours
India - IN	4.26261E5	GFL med risk hours
Myanmar - MM	4.14568E4	GFL med risk hours
Ethiopia - ET	1.79390E4	GFL med risk hours
Angola - AO	1.67536E4	GFL med risk hours
	1.33009E4	GFL med risk hours
Nigeria - NG	3169.14387	GFL med risk hours
Russian Federation - RU	105.22965	GFL med risk hours

Map (beta)

Locations

Impact category: Goods produced by forced labour

Contribution	Process	Amount	Unit
100.00%	Overall canal construction and operation - NI	3.11598E6	GFL med risk h
47.36%	Operation of East Canal Segment - NI	1.47558E6	GFL med risk h
38.70%	Construction of East Canal Segment - NI	1.20582E6	GFL med risk h
38.68%	Construction - CN	1.20514E6	GFL med risk h
00.02%	Construction - NI	684.11963	GFL med risk h
08.59%	Maintenance and Repair - NI	2.67635E5	GFL med risk h
00.04%	Public Administration - NI	1190.59353	GFL med risk h
00.03%	Education, Health and Other Services - NI	839.23695	GFL med risk h
00.00%	Wholesale Trade - NI	71.78410	GFL med risk h
00.00%	Retail Trade - NI	20.77074	GFL med risk h
34.25%	Operation of Lago de Nicaragua Segment - NI	1.06729E6	GFL med risk h
32.62%	Construction of Lago de Nicaragua Segment - NI	1.01652E6	GFL med risk h
01.62%	Maintenance and Repair - NI	5.03725E4	GFL med risk h
00.01%	Public Administration - NI	224.08520	GFL med risk h
00.01%	Education, Health and Other Services - NI	157.95532	GFL med risk h
00.00%	Wholesale Trade - NI	13.51070	GFL med risk h
00.00%	Retail Trade - NI	3.90932	GFL med risk h
18.39%	Operation of West Canal Segment - NI	5.73067E5	GFL med risk h
00.00%	Electricity, gas, and water supply - NI	39.49647	GFL med risk h

Hybrid case: Interpretation

(Preliminary) conclusions & interpretation

- Combining SIA & EIA and S-LCA is possible, and requires:
  - Alignment of indicators
  - Alignment of the activity variable(s)
  - Alignment of the interpretation (in SIA: mitigation; vulnerability considered)
- Compared to the effort for the „IA“ study, effort for S-LCA is small when using a database
- The combination adds a life cycle perspective to the case, and provides new insights:
  - For some indicators, the hot spot impact may be in the supply chain
  - On site mitigation can address these hot spots
- LC information is typically more generic than the information provided by IA

Thank you!

GreenDelta
sustainability consulting + software

Contact
Dr. Andreas Ciroth
GreenDelta GmbH
Müllerstrasse 135, 13349 Berlin
ciroth@greendelta.com
www.greendelta.com

Social LCIA

- Quantitative assessment
- Entire Life cycle can be included
- Social Hotspots and impact contributions in foreground as well as in background processes can be detected (other countries and sectors)