Narratives, data and assumptions used to model development scenarios and climate sub-scenarios for Rwanda

SEI report. June 2018

Oliver Johnson
Louise Karlberg
Mbeo Ogeya
Tom Ogol
Francisco Flores
Taylor Binnington

Stockholm Environment Institute
World Agroforestry Centre , United Nations Avenue
Gigiri P.O. Box 30677, Nairobi 00100 Kenya
Tel: +254 20 722 4886, info-Africa@sei.org
www.sei.org
Author contact: Oliver Johnson
oliver.johnson@sei.org
Editing: Caspar Trimmer
Layout: Richard Clay
Cover photo credit: Oliver Johnson / SEI

Stockholm Environment Institute is an international non-profit research and policy organization that tackles environment and development challenges.
We connect science and decision-making to develop solutions for a sustainable future for all.
Our approach is highly collaborative: stakeholder involvement is at the heart of our efforts to build capacity, strengthen institutions, and equip partners for the long term.
Our work spans climate, water, air, and land-use issues, and integrates evidence and perspectives on governance, the economy, gender and human health.
Across our eight centres in Europe, Asia, Africa and the Americas, we engage with policy processes, development action and business practice throughout the world.

Contents

Introduction

Agricultural transformation and energy transition will be key for Rwanda to achieve its ambition of becoming a middle-income country in the coming decades. These development processes are often considered complementary and synergistic, but this is not a given. In order to explore the potential co-evolution of agricultural transformation and energy transition in Rwanda, and to highlight the trade-offs and synergies between them, SEI and the Albertine Rift Conservation Society (ARCOS) have undertaken participatory scenario-building activities using SEI's energy and water planning tools: Long-range Energy Alternatives Planning (LEAP) and Water Evaluation and Planning (WEAP).[1] We believe our results can help inform the upcoming process of developing Rwanda's Vision 2050 and current implementation of its medium-term National Strategy for Transformation and Prosperity (2018–2024) (Republic of Rwanda 2017).

This document presents an overview of the development scenarios for Rwanda that we co-created with stakeholders[2] and explored using LEAP and WEAP. It first presents two different narratives of how Rwanda might develop by 2050. It then presents how we translated these narratives into the scenarios in the models, using certain assumptions and data. The results of the analysis will be published shortly.

National development ambitions in Rwanda

Rwanda has committed itself to becoming a middle-income country by 2020, to decrease the national poverty rate to 30%, and to increase the average life expectancy to 55 years by the year 2020 (Republic of Rwanda 2012). The country's Vision 2020 and Economic Development and Poverty Reduction Strategies (EDPRS I and II) both set out clear intentions to intensify agriculture and increase national energy output (Republic of Rwanda 2007; Republic of Rwanda 2013). For example, agriculture is expected to grow by 8.5% annually and energy generation is expected to grow from 45 MW in 2006 to 563 MW in 2018, mainly through development of hydropower. These ambitions are also present at a sub-national level, with district development plans including provisions to modernise agriculture, invest in energy production and expand many water-intensive activities, such as mining, industrial development, and ecotourism.

The country is also developing its EDPRS III and Vision 2050, which will build further upon these existing ambitions.

These development goals place increasing pressure on limited water and biomass resources. Competition over water resources demanded by hydropower, irrigation, and water supply to major towns and various industries has the potential to create serious conflict. Meanwhile, biomass scarcity causes the country to import biomass from neighbouring countries as well as having to allocate croplands to wood plantations, such as eucalyptus; 21% of biomass consumption in 2009 has been characterised as unsustainable uses of biomass, and "the constant flow of charcoal into Kigali exerts a considerable pressure on the wood resources of the country" (Drigo et al. 2013, p.vii). In addition, an intensified agricultural sector will demand more energy and water per hectare, although a modernised energy sector less dependent on traditional biomass is likely to require less land.

In order to better understand the linkages between different sectors in future scenarios, Rwanda developed its Green Growth and Climate Resilience Strategy (GGCRS) in 2011 (Republic of Rwanda 2011). The GGCRS was developed to guide decisions around natural resource management, investments and policy as well establish demonstration initiatives to support climate resilience activities and community livelihoods, in particular:

- *Land and agricultural transformation:* ensuring sustainable land-use and natural resources management resulting in food security and the preservation of biodiversity and ecosystem services;
- *Energy transition:* achieving energy security and low carbon energy supply, while avoiding deforestation; and
- *Societal impacts:* societal protection, including reduced vulnerability to climate change.

1 For more details on LEAP and WEAP see www.energycommunity.org and weap21.org, respectively. This work forms part of the project "Using Water-energy-food security nexus to promote climate resilient decisions and model actions in selected landscapes along Akagera Basin" funded by Rwanda's Green Fund (FONERWA) and the Swedish International Development Cooperation Agency (Sida).

2 Stakeholders included representatives from line ministries, regulatory institutions and utilities at the national level, local governments at district-level, NGOs, civil society and the private sector.

Co-created development pathways in Rwanda

Drawing on the national plans and stakeholder engagement, below we present co-created narratives for two development pathways along which Rwanda might travel up to 2050: a *pessimistic scenario* where development is slow and national plans are weakly implemented and an *optimistic scenario* where national plans are fully implemented, leading to substantial transformation of the agricultural and energy sectors, whilst also ensuring sustainable use of resources. These are built upon and compared to a *reference scenario* in which development continues along historical trends under three climate sub-scenarios.

Reference scenario

In the reference scenario, Rwanda continues to develop according to historical trends, such as continued annual growth in population and GDP of 2.5% and 7.9%, respectively. Climate change is impacting on the availability of resources via two climate sub-scenarios related to varying rainfall patterns, increased temperature and increased humidity. The reference scenario forms the basis upon which all other scenarios are built.

Pessimistic scenario

In the pessimistic scenario, the country's ambitious development plans are weakly implemented and there is limited consideration of resource use sustainability. Development is slow, and agriculture and energy sectors fail to substantially modernise by 2050. In the agricultural sector, traditional farming techniques prevail on 80% of croplands and fertiliser use levels remain rather low. Consequently, energy needs for agriculture remain low. Meanwhile, in the energy sector, all households eventually have access to electricity but biomass continues to be the major energy source for cooking. Because of an increasing population continuing to use the same type of cookstoves, the demand for biomass for domestic use increases. In general, rural households remain unconnected to the national electricity grid. With increasing demand for land and water for agriculture, as well as increasing demands for wood fuels, there is a large threat to certain habitats such as forests and marshlands, aggravating soil degradation problems. Resource use for food and energy production is given higher priority than meeting environmental flow requirements of limnic (freshwater lake and pond) ecosystems, or biomass return flows in terrestrial systems, resulting in a gradual degradation and threat to the long-term sustainability of these ecosystems.

Optimistic scenario

In the optimistic scenario, the country achieves its development goals of modernising agriculture and energy, and manages to do so whilst ensuring sustainable use of its resources. The agricultural sector develops quickly, and by 2050, 40% of the farmland is modernised and managed more intensively than today, with higher fertiliser use, mechanisation and access to irrigation according to the national plans. Agricultural lands also expands 100 000 ha into marshlands.

In the energy sector, a successful cookstoves replacement programme is implemented and forest cover is increased by 30%, ensuring a more stable supply of fuelwood. At the same time, all households have access to electricity by 2030 and many shift towards biogas and LPG for cooking. The agricultural sector becomes dependent on energy inputs, and irrigation affects the flow of water for hydropower generation downstream. Rwanda's goals to ensure environmental protection of watersheds, soil fertility, forests, biodiversity and ecosystem services mean that regulation is required. Minimum environmental flow requirements are imposed to control water consumption from irrigation and hydropower generation in order to secure the functioning of limnic ecosystems.

Data and assumptions used in the modelling tools

In Table 1 below we set out the data and assumptions used as inputs into the LEAP and WEAP modelling software tools.

Table 1. Data and assumptions input into WEAP and LEAP

Sector	Current accounts in 2010[a]	Scenario in 2050[b]		
		Reference	Pessimistic	Optimistic
Economy and demographics[c]				
Average GDP growth	7.9%[d]	7.9%	7.9%	7.9%
GDP share				
Public service sector	25.3%			
Commercial and industrial sectors				
Agriculture and fisheries	22.0%			
Manufacturing	5.6%			
Other commercial	47.1%			
Population[e]				
Size	10.5 million			
Growth	2.5%	2.5%	2.5%	2.5%
Density	416 ppl/km^2			
Urban-rural population split	17:83			
Urban-rural household split	16.5:83.5			
Poverty rates				
Urban	22.1%			
Rural	48.7%			
Climate and ecosystems[f]				
Precipitation	1300 mm/yr			
Future change	+/-10%			
Temperature	19.6 °C			
Future change	+3°C			
Humidity	12.3%			
Future change, dew point temp	+1°C			
Environmental flow requirements[g]	30%	Low priority	Low priority	High priority
Irrigation demand		Medium priority	Medium priority	Medium priority
Hydropower water demand		Low priority	Low priority	Low priority
Domestic water demand		High priority	High priority	High priority
Soil types	Shallow soil with low water retention capacity in head-flow catchment; sandy clay loam in valley catchment			
Land use and agriculture[h,i]				
Forest land area	671 000 ha			
Plantation	287 000 ha			+30% (+86 100 ha)
Closed natural forest	108 000 ha			
Degraded natural forest	12 600 ha			

Sector	Current accounts in 2010[a]	Scenario in 2050[b]		
		Reference	Pessimistic	Optimistic
Bamboo	1 630 ha			
Natural shrubs	260 000 ha			-30% of area of forest plantations (-86 000 ha)
Wooded savannah	1 770 ha			
Agricultural land area	1690 000 ha			
Cropland	1 370 000 ha			+100 000 ha
Maize	11.5%			
Sorghum	2.4%			
Cereal	1.2%			
Cassava	19.5%			
Sweet potato	4.4%			
Irish potato	3.7%			
Banana	18.3%			
Green bean	12.1%			
Legumes	3.4%			
Vegetables	1.1%			
Fruit trees	0.6%			
Tea	1.0%			
Coffee	2.0%			
Meadow and pasture	322 000 ha			-100 000 ha
Urban land area	19 100 ha			
Agricultural practices[j]				
Low inputs ("traditional")				
Total cropland area	98%	98%	80%	60%
Productivity	0.5 LAI	0.5 LAI	0.5 LAI	0.5 LAI
High inputs ("modernised")[k]				
Total cropland area	2%	2%	20%	40%
Productivity	LAI	LAI	1.05 LAI	1.25 LAI
Net primary productivity[l]				
Forests				
Forest plantation	16 t dm/ha/yr	1.0 LAI	1.05 LAI	1.25 LAI
Closed natural forest	16 t dm/ha/yr			
Degraded natural forest	12 t dm/ha/yr			
Bamboo	10 t dm/ha/yr			
Natural shrubs	5 t dm/ha/yr			
Wooded savannah	13 t dm/ha/yr			
Agriculture				
"Traditional" crop yields / number of crops per year				
Maize	1.24 t dm/ha/yr / 2			
Sorghum	0.83 t dm/ha/yr / 2			
Cereal	0.74 t dm/ha/yr / 2			
Cassava	0.49 t dm/ha/yr / 2			
Sweet potato	1.80 t dm/ha/yr / 2			
Irish potato	1.40 t dm/ha/yr / 2			

Sector	Current accounts in 2010[a]	Scenario in 2050[b]		
		Reference	Pessimistic	Optimistic
Banana	0.84 t dm/ha/yr / 1			
Green bean	0.10 t dm/ha/yr / 2			
Legumes	0.42 t dm/ha/yr / 2			
Vegetables	0.66 t dm/ha/yr / 2			
Fruit trees	0.38 t dm/ha/yr / 1			
Tea	1.50 t dm/ha/yr / 1			
Coffee	0.50 t dm/ha/yr / 1			
Meadows and pastures	6.0 t dm/ha/yr			
Urban	0.23 t dm/ha/yr			
Energy[m]				
Electricity access (% of population)	16%			
Urban	67%	67%	100%	100%
Rural	6.4%	6.4%	100%	100%
Total electricity generation	281.17 GWh			
Electricity generation by source (% share)				
Diesel	56.9%			
Hydropower	39.8%			
Solar	0.1%			
Methane	3.2%			
Cookstove penetration (% share of hhs)[n]				
Urban wood stoves				
Fixed improved mud stove	35.1%	35.1%	20%	0%
Mud stove	12.6%	12.6%	10%	0%
Potable improved mud stove	4.5%	4.5%	0%	0%
Three-stone stove	30.4%	30.4%	20%	0%
Improved wood stove	17.3%	17.3%	10%	0%
Tier 3 wood stove	0%	0%	15%	40%
Pellet gasifier	0%	0%	25%	60%
Urban charcoal stoves				
Single-pot metal charcoal stove	61.9%	61.9%	0%	0%
Multi-pot metal charcoal stove	30.4%	30.4%	20%	0%
Camanake ivuguruye	6.3%	6.3%	30%	60%
Improved single pot charcoal stove	1.3%	1.3%	40%	0%
Modern charcoal	0%	0%	10%	40%
Rural wood stoves				
Fixed improved mud stove	35.9%	35.9%	20%	0%
Three-stone stove	32.4%	32.4%	0%	0%
Improved wood stove	26.8%	26.8%	20%	0%
Mud stove	3.7%	3.7%	0%	0%
Portable improved mud stove	1.2%	1.2%	20%	0%
Tier 3 wood stove	0%	0%	30%	70%
Pellet gasifiers	0%	0%	10%	30%

Sector	Current accounts in 2010[a]	Scenario in 2050[b]		
		Reference	Pessimistic	Optimistic
Rural charcoal stoves				
Single-pot metal charcoal stove	63.6%	63.6%	50%	0%
Multi-pot charcoal stove	19.4%	19.4%	10%	0%
Improved single-pot charcoal stove	9.1%	9.1%	5%	0%
Canamake ivuguruye	7.8%	7.8%	25%	60%
Modern charcoal	0%	0%	10%	40%
Primary fuel for cooking (% share of hhs)				
Urban				
Firewood and pellets	31.4%	31.4%	27.9%	22.5%
Charcoal	62.7%	62.7%	42.3%	22.7%
LPG	1.1%	10%	25%	50.0%
Electricity	0.7%	0.7%	0.7%	0.7%
Biogas	0.1%	0.1%	0.1%	0.1%
Others	4.0%	4.0%	4.0%	4.0%
Rural				
Firewood and pellets	92.6%	86.8%	77.9%	62.9%
Charcoal	2.9%	2.9%	2.9%	2.9%
LPG	0.1%	4%	10%	20.0%
Electricity	0.1%	0.1%	0.1%	0.1%
Biogas	0.1%	2%	5%	10.0%
Others	4.3%	4.3%	4.1%	4.1%
Mechanisation (128 l diesel/ha)	5% of high input cropland	5% of high input cropland	15% of high input cropland	50% of high input cropland
Fertiliser use	8 kg/ha/yr			45 kg/ha/yr (by 2020)

dm = dry matter, ha = hectares, hh = household, l = litre, LAI = leaf area index, LPG = liquefied petroleum gas, t = metric ton

Notes
[a] In both WEAP and LEAP models, 2010 was chosen as the base year to provide a statement of "current accounts". In WEAP, historical data for 1971–2014 was used; in LEAP historical data for 2005–2010 was used.
[b] Numbers in each scenario represent the data and assumptions used as inputs in the model to define the particular development pathway.
[c] See https://data.worldbank.org/.
[d] Based on average data for 2000–2016.
[e] Based on data for 2012.
[f] Smakhtin (2008) and Republic of Rwanda (2013).
[g] Percent of mean annual flows.
[h] Figures here represent the whole of Rwanda. Only 60% of these values were included in the Akagera catchment area modelled in WEAP, split across all catchments proportional to areas in sub-watersheds. Land-use changes in the optimistic scenario start in 2020, end in 2030 and remain constant from then onwards.
[i] Land use based on Drigo et al. (2013), NISR (2016) and https://data.worldbank.org/ and http://www.fao.org/faostat/en/#data. There is a high degree of variation between land-use data sets.
[j] Agricultural practices based on Republic of Rwanda (2012), NISR (2016) and Ministry of Agriculture and Animal Resources (2009).
[k] Irrigation takes place on these lands when the soil moisture is not enough to meet plant water demands, and there is water available for irrigation
[l] Net primary productivity based on Cao and Woodward (1998), Moore et al. (2018) and Scurlock et al. (2002).
*[m] The LEAP model was downscaled to match the WEAP model of the Akagera catchment. By overlaying a Rwanda population map onto the Akagera catchment map, we were able to estimate that the catchment area contained 72% of Rwanda's total population. For household energy demand in LEAP, the population was determined as 72% * (total population – 75% boarding school and 50% university students). By conservative estimates, boarding school students make up a majority of secondary school students, whereas around half of students at university reside there. In order to avoid double counting, they were subtracted from the population when determining household demand and instead their energy consumption contributed to public service sector energy demand. Data was compiled from Republic of Rwanda (2013), Drigo et al. (2013), Ministry of Infrastructure (2013), Africa Energy Services Group (2012), NISR (2012a) and NISR (2012b).*
[n] These figures were calculated by combining data on cooking fuels and cooking technologies.

Parameterisation and calibration of the WEAP model

Crop yields in “current accounts” were estimated by initially using the parameter values for each crop type in the WEAP crop library. Since those values were derived from crops grown under high input conditions in the United States, the leaf area index (LAI) related parameters were adjusted to 50% of their original value (Table 1, agricultural practices/low inputs/productivity). Subsequently, the harvest index of each crop was modified so that the crop yields under low input/traditional management matched measured values (Table 1, croplands/yields). The derived harvest indices were then also used for high input/modernised land-use areas, for all scenarios; that is, the harvest index remained the same in all scenarios. Instead, to estimate differences in yields as a function of management, the LAI-related parameters in the crop library were adjusted (Table 1, agricultural practices/productivity) to depict the effect of the different management regimes.

The hydrology module of WEAP was calibrated using measured stream flow data from stream gauges throughout Rwanda, by modifying the hydraulic conductivity for the two soil types described in the table above (Table 2). Because of the high uncertainty in measurements, a relatively high deviation between simulated and measured stream flows was deemed acceptable.

Table 2. Comparison between modelled and simulated stream flows

Stream-flow gauge station	Modelled (M)/ Observed (O)	Mean	Standard deviation	RMS
Mwogo / Nyabisindu	M	9.3	8.0	12.3
	O	5.5	3.0	6.3
Nyabarongo / Mwika	M	49.0	31.6	58.3
	O	37.8	14.5	40.5
Nyabarongo / Nagaru	M	84.4	51.8	99.0
	O	68.0	18.5	70.4
Nyabarongo / Kigali	M	48.4	30.8	57.3
	O	94.5	33.5	100.2
Nyabarongo / Rifune	M	207.8	115.3	237.4
	O	131.6	31.1	135.2
Nyabarongo / Risumu	M	257.7	78.1	269.2
	O	339.0	216.4	401.8

Linking WEAP and LEAP

Annual hydropower production was estimated by WEAP and used as input in LEAP in all scenarios. In addition, in the optimistic scenario 80% of the WEAP values for annual increment (net primary productivity) in forest biomass and 80% of WEAP values for crop residues were used as an input in LEAP for woody biomass available to meet demand for woodfuel and charcoal and crop residues available to meet demand for pellets. Thus, 20% of the net primary productivity in forest biomass and 20% of crop residues were left in the ecosystems to ensure a sustainable withdrawal of biomass for energy.

References

Africa Energy Services Group (2012). *Biomass Use Survey in Urban and Rural Areas in Rwanda*. Consultancy report. Rwanda Natural Resources Authority, Kigali. http://www.repository.rnra.rw/xmlui/handle/123456789/4270?show=full

Cao, M. and Woodward, F. I. (1998). Net primary and ecosystem production and carbon stocks of terrestrial ecosystems and their responses to climate change. *Global Change Biology*, 4(2). 185–98. DOI: 10.1046/j.1365-2486.1998.00125.x

Drigo, R., Munyehirwe, A., Nzabanita, V. and Munyampundu, A. (2013). *Final Report: Update and Upgrade of WISDOM Rwanda and Woodfuels Value Chain Analysis as a Basis for the Rwanda Supply Master Plan for Fuelwood and Charcoal*. Rwanda Ministry of Natural Resources, Kigali. http://www.minirena.gov.rw/fileadmin/Media_Center/Documents/Rwanda_Supply_Master_Plan_for_Fuelwood_and_Charcoal.pdf

Ministry of Agriculture and Animal Resources (2009). *Strategic Plan for the Transformation of Agriculture in Rwanda: Phase II (PSTA II)*. Republic of Rwanda, Kigali. http://www.minagri.gov.rw/fileadmin/user_upload/documents/RWANDA_SAKSS/PSTA_II__2008-12_.pdf

Ministry of Infrastructure (2013). *Energy Sector Strategic Plan 2013–2018*. Republic of Rwanda, Kigali.

Moore, S., Adu-Bredu, S., Duah-Gyamfi, A., Addo-Danso, S. D., Ibrahim, F., et al. (2018). Forest biomass, productivity and carbon cycling along a rainfall gradient in West Africa. *Global Change Biology*, 24(2). e496–510. DOI: 10.1111/gcb.13907

NISR (2012a). *Fourth Rwanda Population and Household Census: Characteristics of Households and Housing*. National Institute of Statistics of Rwanda (NISR), Kigali. statistics.gov.rw/file/2907/download?token=i09m0Bly

NISR (2012b). *Fourth Rwanda Population and Household Census: Population Census Report*. National Institute of Statistics of Rwanda (NISR), Kigali.

NISR (2016). *Seasonal Agriculture Survey Report: 2016*. National Institute of Statistics of Rwanda (NISR), Kigali. http://www.statistics.gov.rw/publication/seasonal-agricultural-survey-report-2016

Republic of Rwanda (2007). *Economic Development & Poverty Reduction Strategy: 2008–2012*. Republic of Rwanda, Kigali. siteresources.worldbank.org/INTRWANDA/Resources/EDPRS-English.pdf

Republic of Rwanda (2011). *Green Growth and Climate Resilience: National Strategy for Climate Change and Low Carbon Development*. Republic of Rwanda, Kigali. http://www.greengrowthknowledge.org/resource/green-growth-and-climate-resilience-national-strategy-climate-change-and-low-carbon-0

Republic of Rwanda (2012). *Rwanda Vision 2020: Revised 2012*. Republic of Rwanda, Kigali. http://www.minecofin.gov.rw/fileadmin/templates/documents/NDPR/Vision_2020_.pdf

Republic of Rwanda (2013). Economic Development and Poverty Reduction Strategy II: 2013–2018. http://www.minecofin.gov.rw/fileadmin/templates/documents/NDPR/EDPRS_2.pdf

Republic of Rwanda (2017). *National Strategy for Transformation and Prosperity (2018–2024)*. Republic of Rwanda, Kigali.

Scurlock, J. M. O., Johnson, K. and Olson, R. J. (2002). Estimating net primary productivity from grassland biomass dynamics measurements. *Global Change Biology*, 8(8). 736–53. DOI: 10.1046/j.1365-2486.2002.00512.x

Smakhtin, V. (2008). Basin Closure and Environmental Flow Requirements. *International Journal of Water Resources Development*, 24(2). 227–33. DOI: 10.1080/07900620701723729

Contact us

SEI Stockholm and SEI HQ

Linnégatan 87D Box 24218
104 51 Stockholm Sweden
Tel: +46 8 30 80 44
info@sei.org

Louise Karlberg
Centre Director

SEI Africa

World Agroforestry Centre
United Nations Avenue
Gigiri P.O. Box 30677
Nairobi 00100 Kenya
Tel: +254 20 722 4886
info-Africa@sei.org

Stacey Noel
Centre Director

SEI Asia

15th Floor Witthyakit Building
254 Chulalongkorn University
Chulalongkorn Soi 64 Phyathai Road
Pathumwan Bangkok 10330 Thailand
Tel: +66 2 251 4415
info-Asia@sei.org

Niall O'Connor
Centre Director

SEI Tallinn

Lai str 34 10133
Tallinn Estonia
Tel: +372 627 6100
info-Tallinn@sei.org

Lauri Tammiste
Centre Director

SEI Oxford

Florence House 29 Grove Street
Summertown Oxford
OX2 7JT UK
Tel: +44 1865 42 6316
info-Oxford@sei.org

Ruth Butterfield
Centre Director

SEI US Main Office

11 Curtis Avenue
Somerville MA 02144-1224 USA
Tel: +1 617 627 3786
info-US@sei.org

Michael Lazarus
Centre Director

SEI US Davis Office

400 F Street
Davis CA 95616 USA
Tel: +1 530 753 3035

SEI US Seattle Office

1402 Third Avenue Suite 900
Seattle WA 98101 USA
Tel: +1 206 547 4000

SEI York

University of York
Heslington York
YO10 5DD UK
Tel: +44 1904 32 2897
info-York@sei.org

Lisa Emberson
Centre Director

SEI Latin America

Calle 71 # 11–10
Oficina 801
Bogota Colombia
info-LatinAmerica@sei.org

David Purkey
Centre Director

SEI Stockholm Environment Institute

sei.org

@SEIresearch, @SEIclimate