



DEVELOPMENT AND APPLICATION OF A RESILIENCE MODEL FOR THE RESTORATION OF THE RIO DOCE BASIN, BRAZIL

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CARY L. EHRMAN, CEnvP, IAP2

RAMBOLL

IMPACTS

48.3
million m³ of mud

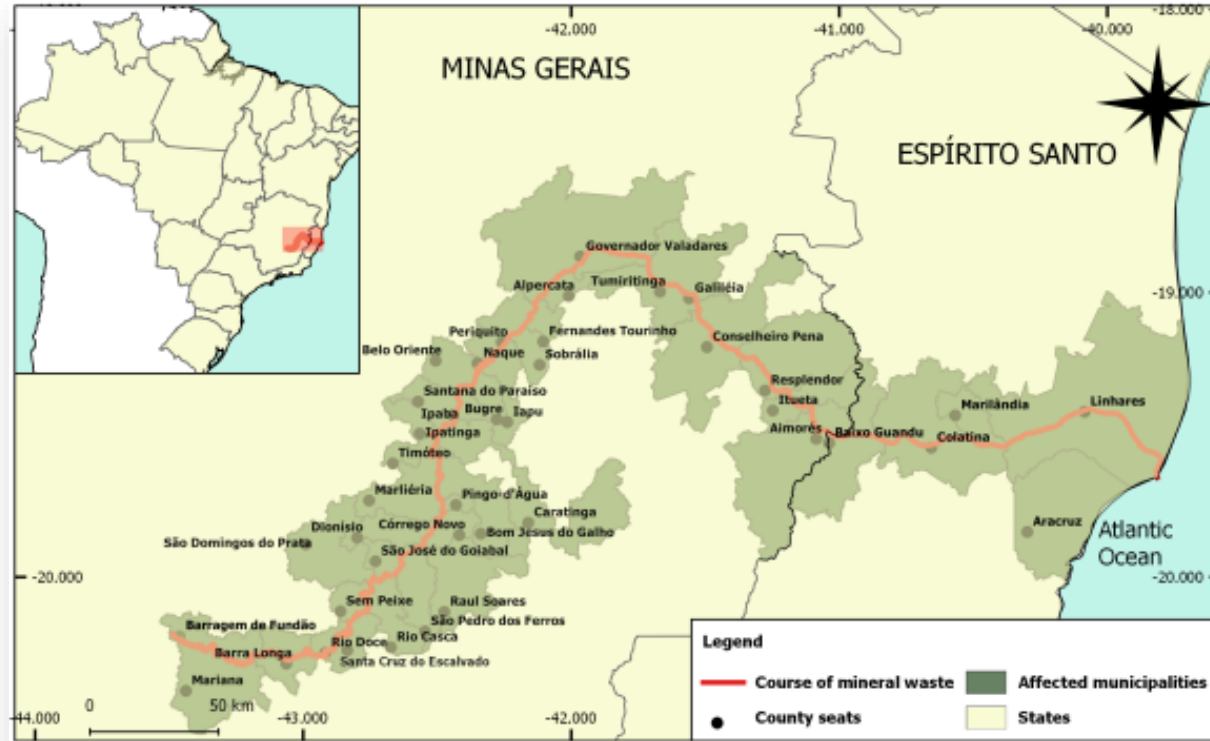
650
km from accident site
to Atlantic Ocean

500
homes affected

11
tons of dead fish

41
municipalities affected

1,469
hectares of damaged
river floodplain



PROJECT: INDEPENDENT TECHNICAL ADVISORY SERVICES

- Ramboll Project: Independent Technical Advisory Services:
 - 41 proposed environmental and social programs.
 - Pre- and post-accident conditions.
 - Risks related to gaps.
 - Habitat and socioeconomic restoration goals and priorities.
 - Adjustment of existing programs / adoption of new programs.



Restoration the basin of the Rio Doce should have the larger goal of building a more resilient, sustainable future.



SAMARCO'S 41 PROGRAMS

PG001 - Register of Impacted

PG002 - Reimbursement and Compensation

PG003 - Protection and Recovery of Quality of Life of Indigenous Peoples

PG004 - Quality of Life of Other Peoples and Traditional Communities

PG005 - Social Protection

PG006 - Communication, Participation, Dialogue and Social Control

PG007 - Assistance to Animals

PG008 - Reconstruction of Bento Rodrigues, Paracatu de Baixo and Gesteira

PG009 - Recovery of UHE Risoleta Neves Reservoir

PG010 - Recovery of Communities/Infrastructure between Fundão and Candonga

PG011 - Recovery of Schools and Reintegration of School Community

PG012 - Historical Memory, Cultural and Artistic

PG013 - Tourism, Culture, Sports and Leisure

PG014 - Physical and Mental Health of Impacted Population

PG015 - Socioeconomic Technologies

PG016 - Resumption of Aquaculture and Fishing Activities

PG017 - Resumption of Agricultural Activities

PG018 - Diversification of Regional Economy

PG019 - Micro and Small Businesses

PG020 - Encouraging Local Hiring

PG021 - Emergency Financial Assistance

PG022 - Management of Socio-Economic Programs

PG023 - Management of Tailings

PG024 - Containment Systems to Control Tailings Release and Treatment of River

PG025 - Recovery of Area 1

PG026 - Recovery of APPs and Recharge Areas

PG027 - Spring Recovery

PG028 - Conservation of Aquatic Biodiversity

PG029 - Strengthening Screening Structures and Reintroduction of Wildlife

PG030 - Conservation of Terrestrial Fauna and Flora

PG031 - Collection/Treatment of Sewage and Destination of Solid Wastes

PG032 - Water Supply Systems Improvement

PG033 - Environmental Education and Preparation for Environmental Emergencies

PG034 - Preparation for Environmental Emergencies

PG035 - Information for Population - Area 1

PG036 - National and International Communication

PG037 - Environmental Risk Management - Area 1

PG038 - Research and Monitoring of the Doce River Watershed

PG039 - Consolidation of Conservation Units

PG040 - Implementation of CAR and PRAs - Area 1

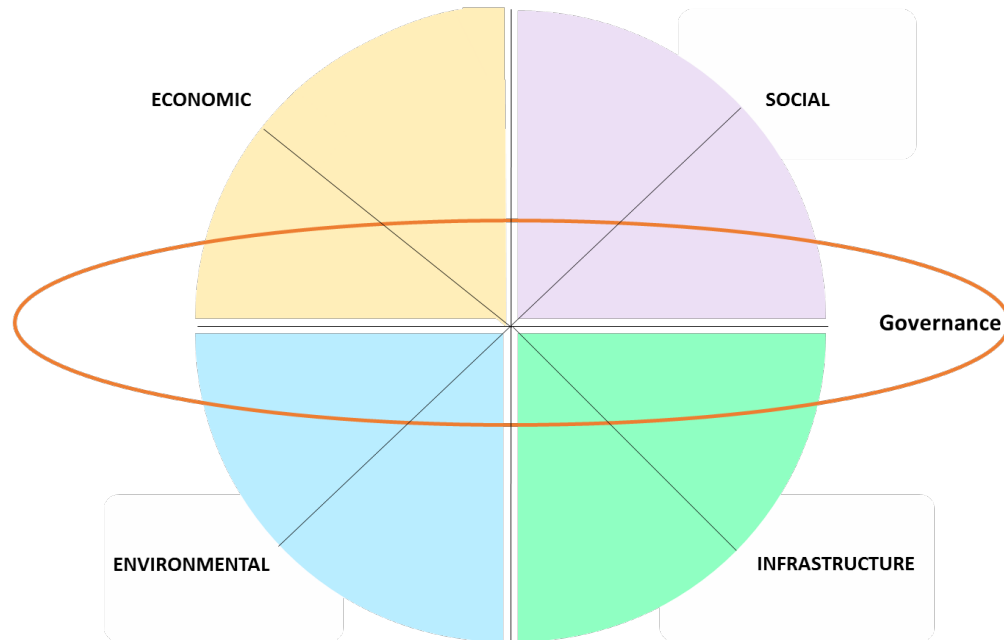
PG041 - Environmental Recovery Plan Management

RESILIENCE MODEL NEEDS AND OBJECTIVES

THEORY

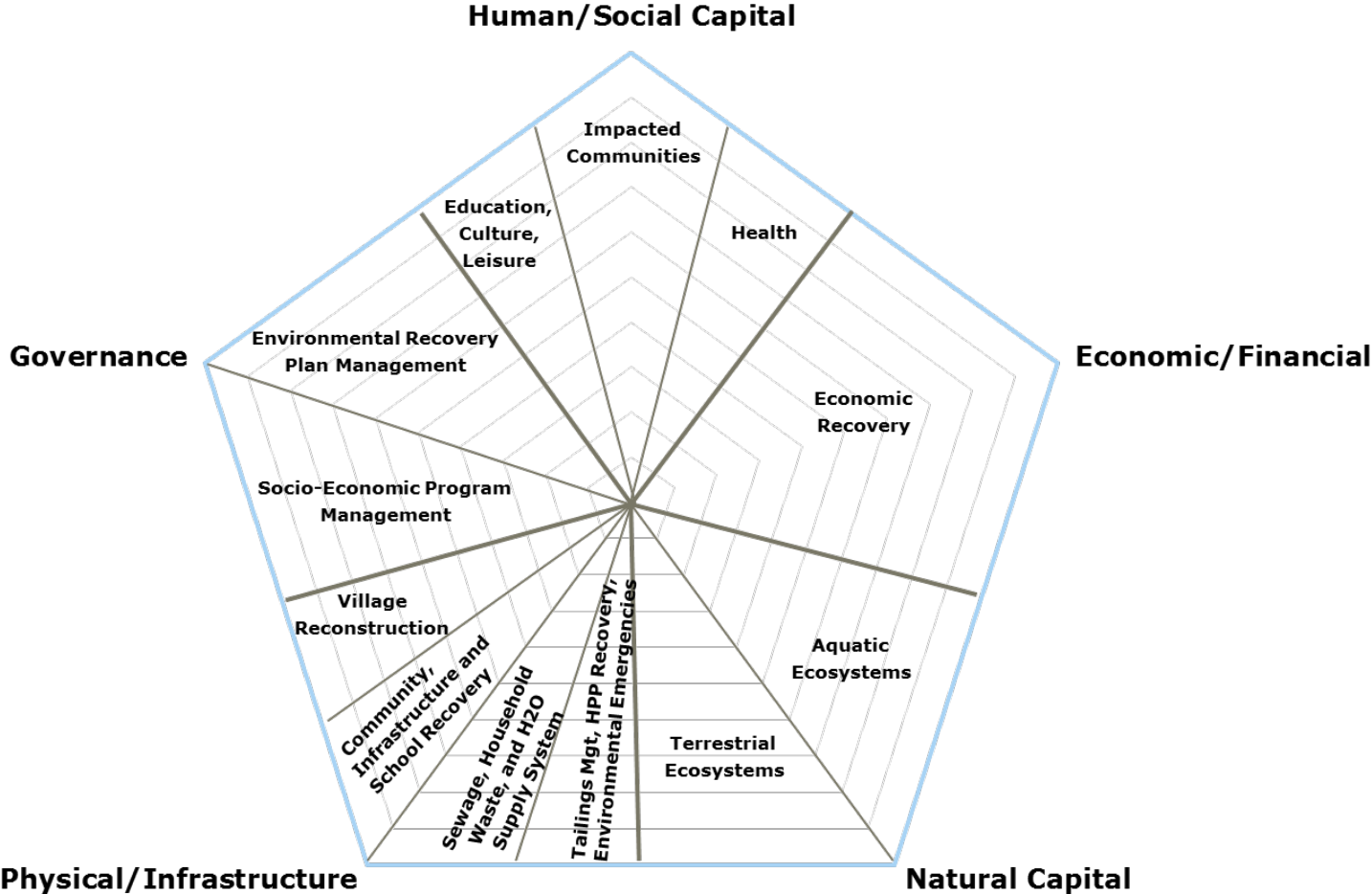
VS.

PRACTICE

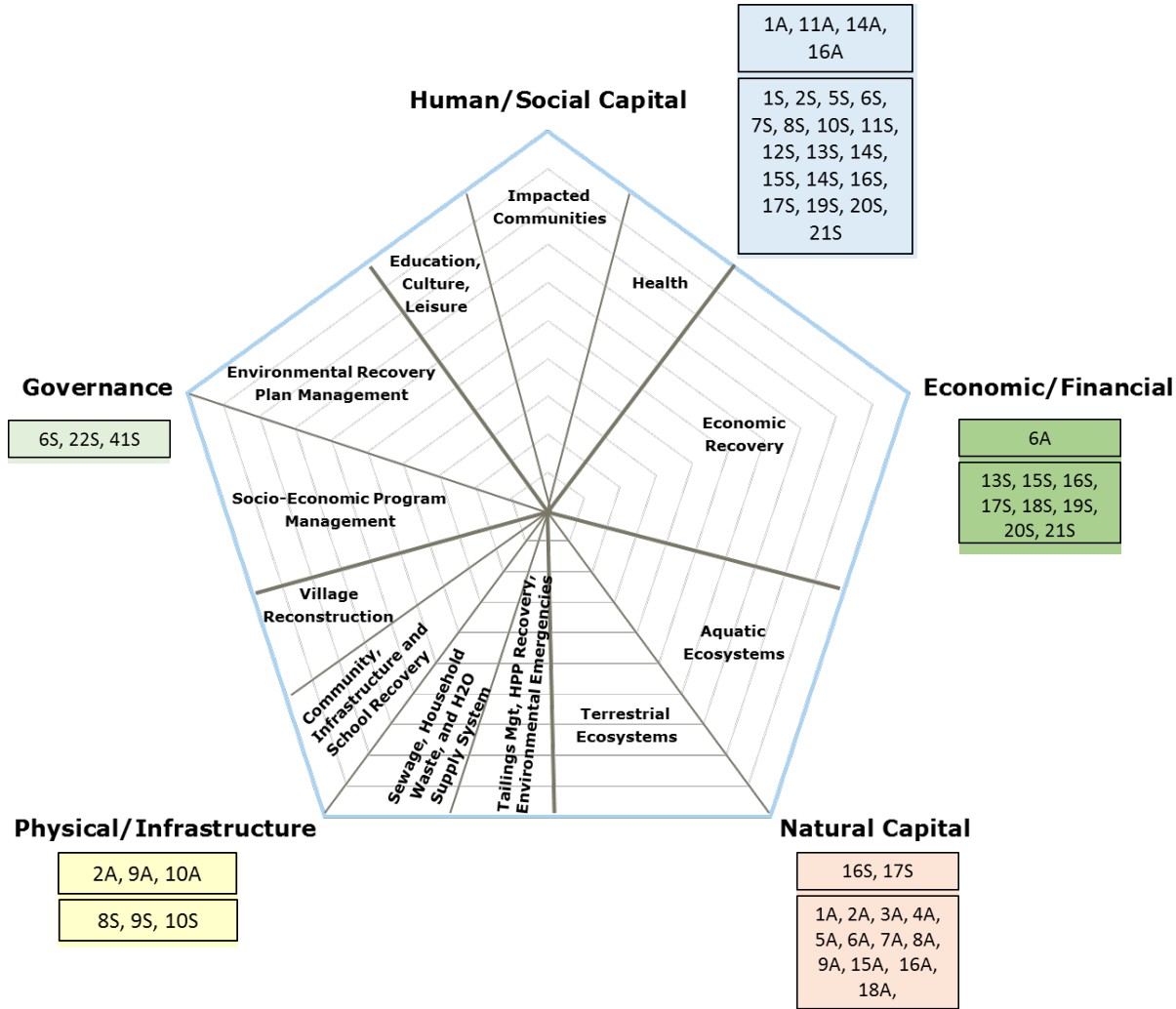


- Structure the evaluation process:
 - Framework to enhance understanding of impacts using set of indicators.
 - Assess and monitor the progress of environmental and socioeconomic strategies and actions.
- Support proactive stakeholder engagement.
- Provide visual representation of performance.
- Optimize solutions.

RESILIENCE MODEL CONSTRUCTION: 5 DIMENSIONS, 12 CATEGORIES

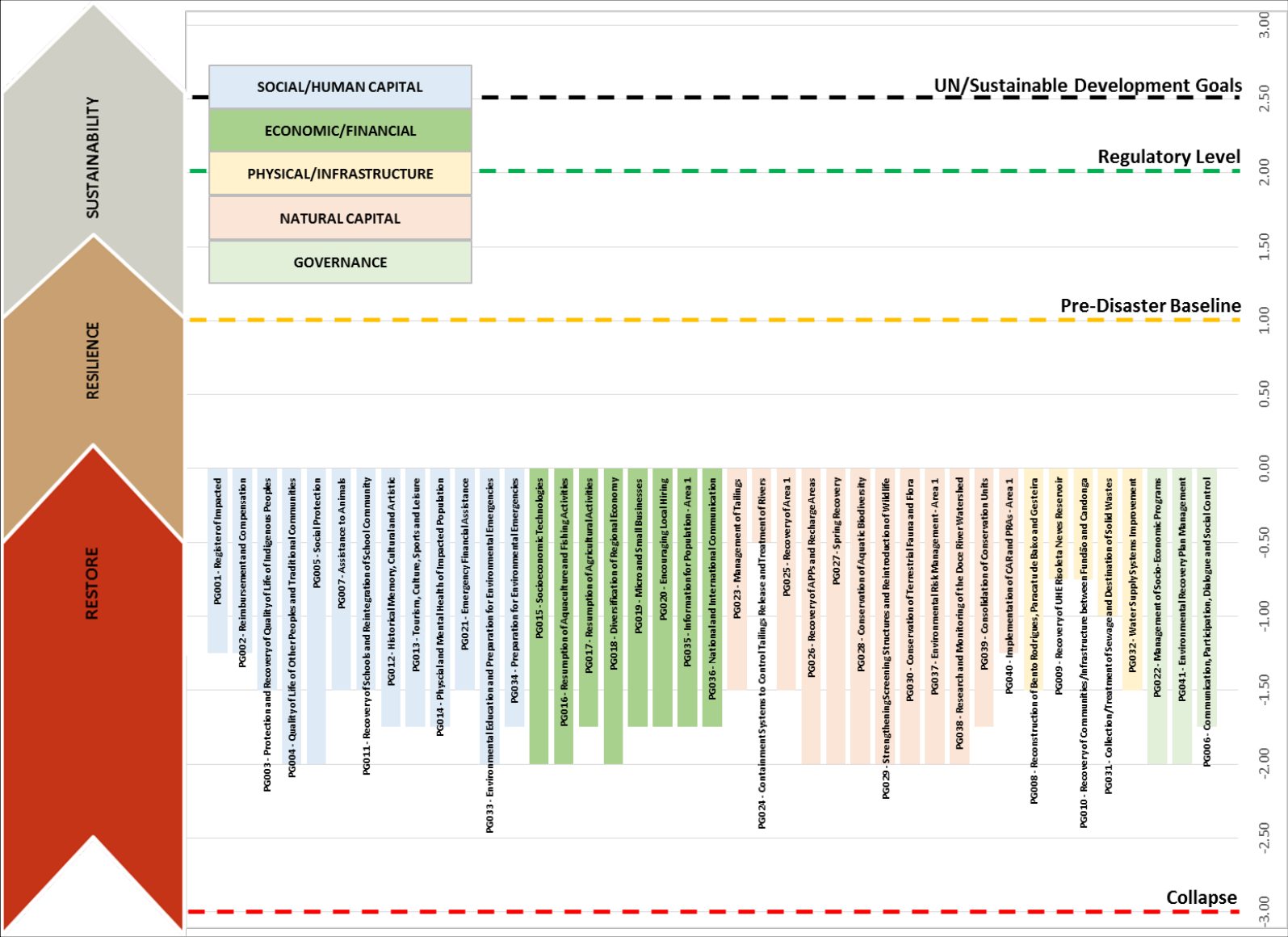


ASSESSMENT OF 41 PROGRAMS



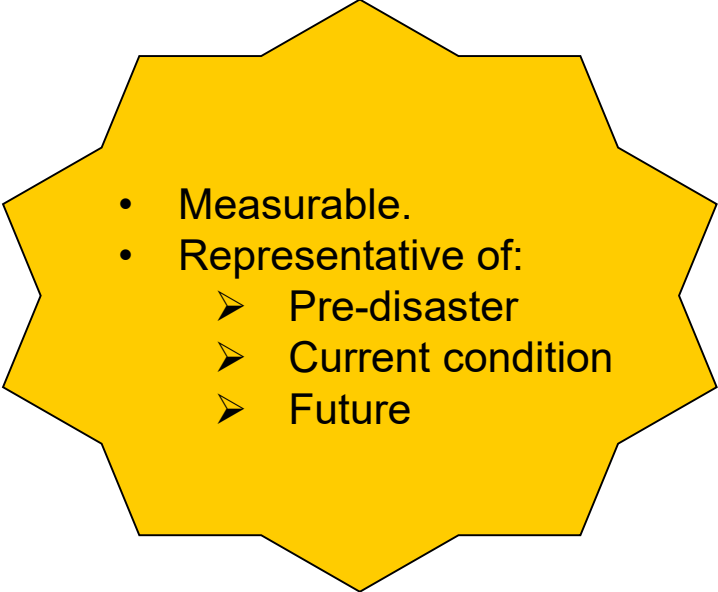
DIMENSION	PROGRAM	SCORE
SOCIAL / HUMAN CAPITAL	PG001 - Register of Impacted	-1.25
	PG002 - Reimbursement and Compensation	-1.25
	PG003 - Protection and Recovery of Quality of Life of Indigenous Peoples	-1.50
	PG004 - Quality of Life of Other Peoples and Traditional Communities	-2.00
	PG005 - Social Protection	-2.00
	PG007 - Assistance to Animals	-1.50
	PG011 - Recovery of Schools and Reintegration of School Community	-1.50
	PG012 - Historical Memory, Cultural and Artistic	-1.75
	PG013 - Tourism, Culture, Sports and Leisure	-1.75
	PG014 - Physical and Mental Health of Impacted Population	-1.75
	PG021 - Emergency Financial Assistance	-1.50
	PG033 - Environmental Education and Preparation for Environmental Emergencies	-2.00
	PG034 - Preparation for Environmental Emergencies	-1.75
	ECONOMIC / FINANCIAL	PG015 - Socioeconomic Technologies
PG016 - Resumption of Aquaculture and Fishing Activities		-2.00
PG017 - Resumption of Agricultural Activities		-1.75
PG018 - Diversification of Regional Economy		-2.00
PG019 - Micro and Small Businesses		-1.75
PG020 - Encouraging Local Hiring		-1.75
PG035 - Information for Population - Area 1		-1.75
PG036 - National and International Communication	-1.75	
NATURAL CAPITAL	PG023 - Management of Tailings	-1.50
	PG024 - Containment Systems to Control Tailings Release and Treatment of Rivers	-0.50
	PG025 - Recovery of Area 1	-1.50
	PG026 - Recovery of APPs and Recharge Areas	-2.00
	PG027 - Spring Recovery	-2.00
	PG028 - Conservation of Aquatic Biodiversity	-2.00
	PG029 - Strengthening Screening Structures and Reintroduction of Wildlife	-2.00
	PG030 - Conservation of Terrestrial Fauna and Flora	-2.00
	PG037 - Environmental Risk Management - Area 1	-2.00
	PG038 - Research and Monitoring of the Doce River Watershed	-2.00
	PG039 - Consolidation of Conservation Units	-1.75
PG040 - Implementation of CAR and PRAs - Area 1	-1.25	
PHYSICAL / INFRASTRUCTURE	PG008 - Reconstruction of Bento Rodrigues, Paracatu de Baixo and Gesteira	-1.50
	PG009 - Recovery of UHE Risoleta Neves Reservoir	-0.75
	PG010 - Recovery of Communities/Infrastructure between Fundão and Candonga	-0.75
	PG031 - Collection/Treatment of Sewage and Destination of Solid Wastes	-1.00
GOVERNANCE	PG032 - Water Supply Systems Improvement	-1.50
	PG006 - Communication, Participation, Dialogue and Social Control	-1.75
	PG022 - Management of Socio-Economic Programs	-2.00
	PG041 - Environmental Recovery Plan Management	-2.00

RESULTS OF ASSESSMENT



INDICATOR DEVELOPMENT

- Over 150 indicators were developed to represent the 5 dimensions and 12 aspects of the assessment:
 - The Social/Human Capital dimension included such metrics as “*Resumption of fishing activities in the Rio Doce and the sea.*”
 - The Governance dimension included “*Level of satisfaction with participation in informed decision-making.*”
 - The Physical/Infrastructure dimension included “*Volume of tailings removed.*”
 - The Natural Capital dimension included “*Percentage of riparian areas recovered.*”
 - The Economic/Financial dimension included “*Recovery of farms.*”

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- Measurable.
 - Representative of:
 - Pre-disaster
 - Current condition
 - Future

QUANTIFICATION OF INDICATORS

This indicator seeks to quantify the degree to which the affected environment has been mapped as

Pre-Event					Post-Event					Desired State				
-2	-1	0	+1	+2	-2	-1	0	+1	+2	-2	-1	0	+1	+2
		X			X									X
		X			X									X
		X			X									X
		X			X									X
		X			X									X
		X			X									X
		X				X								X
		X					X							X
		X			X									X

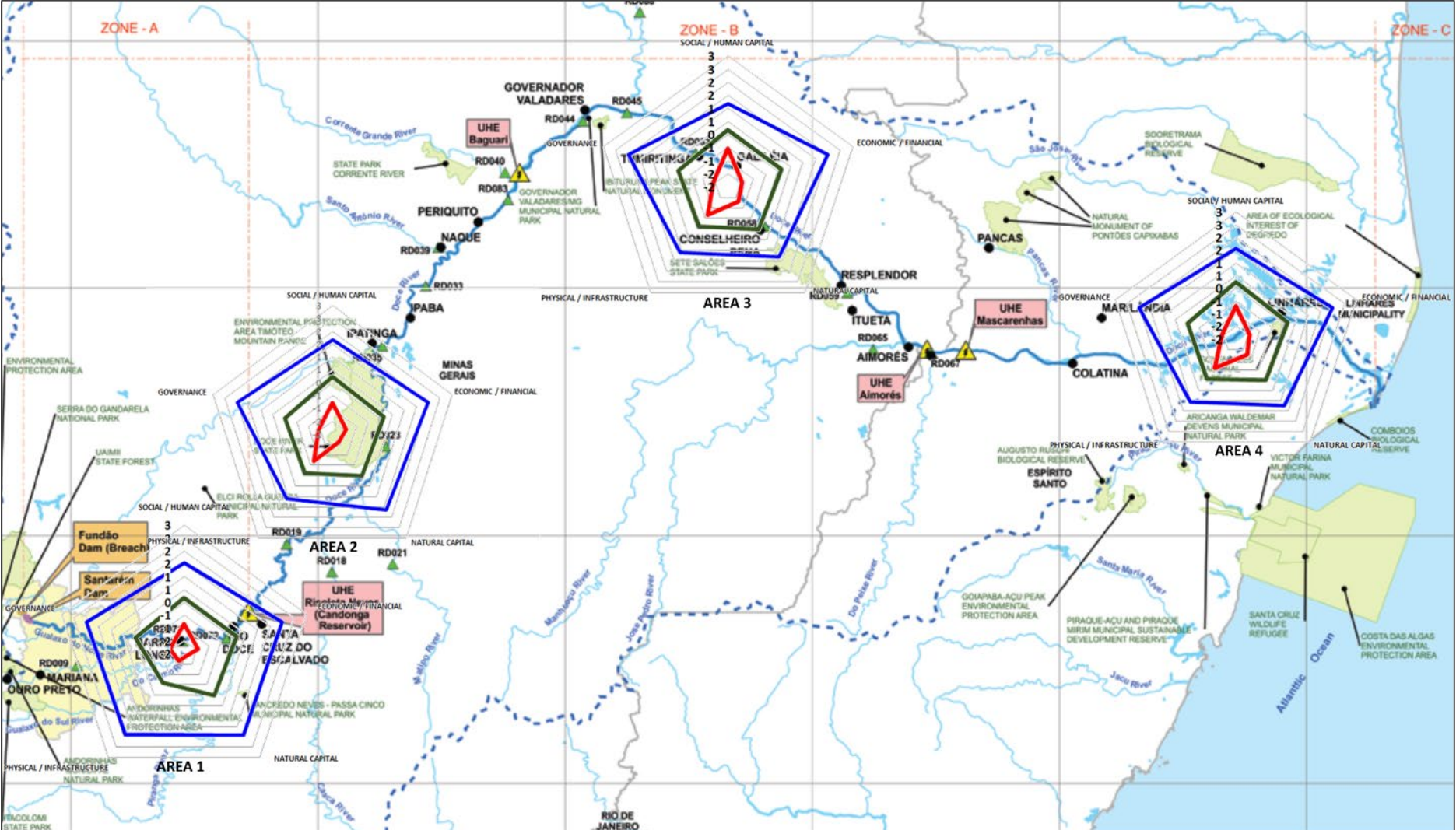
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if

 $\geq 40\%$; and a score of -2 will be given if the resulting ratio is $< 40\%$.

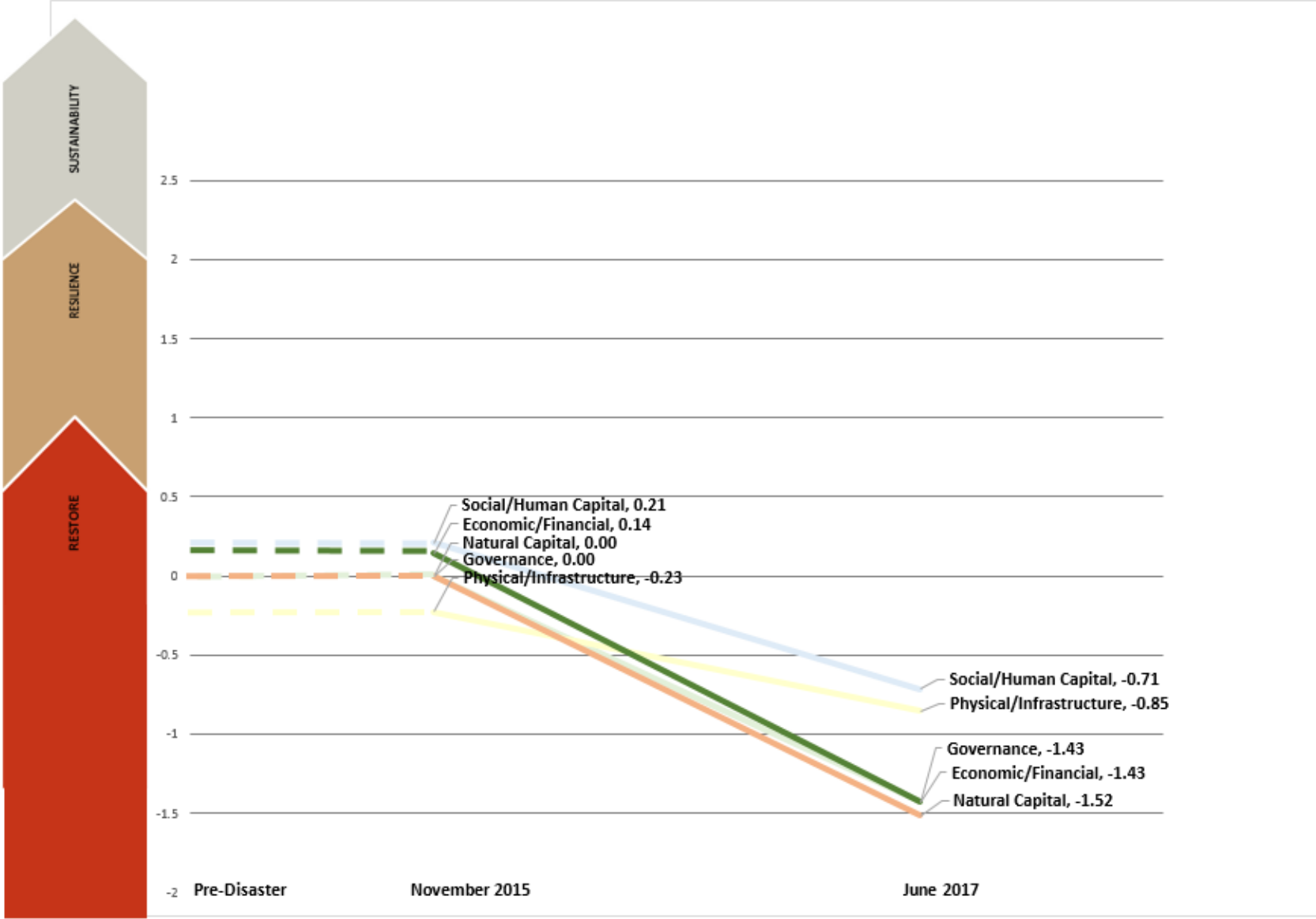
RIO DOCE BASIN AREA 1 RESULTS

RESILIENCE MODEL ASSESSMENT					
RESULTS - PRE-DISASTER		RESULTS - POST-DISASTER		RESULTS - REGULATORY LEVEL (DESIRED STATE)	
SOCIAL / HUMAN CAPITAL	0.18	SOCIAL / HUMAN CAPITAL	-0.84	SOCIAL / HUMAN CAPITAL	1.54
ECONOMIC / FINANCIAL	0.14	ECONOMIC / FINANCIAL	-1.43	ECONOMIC / FINANCIAL	2.00
NATURAL CAPITAL	0.00	NATURAL CAPITAL	-1.90	NATURAL CAPITAL	1.93
PHYSICAL / INFRASTRUCTURE	-0.59	PHYSICAL / INFRASTRUCTURE	-1.65	PHYSICAL / INFRASTRUCTURE	1.88
GOVERNANCE	0.00	GOVERNANCE	-1.43	GOVERNANCE	2.00
				AREA 1	

RESULTS ACROSS THE RIO DOCE BASIN



RESULTS – BUILDING RESILIENCE OVER TIME



CO-AUTHORS



EUGENIO SINGER

Principal
Brazil Country Director
Environment & Health



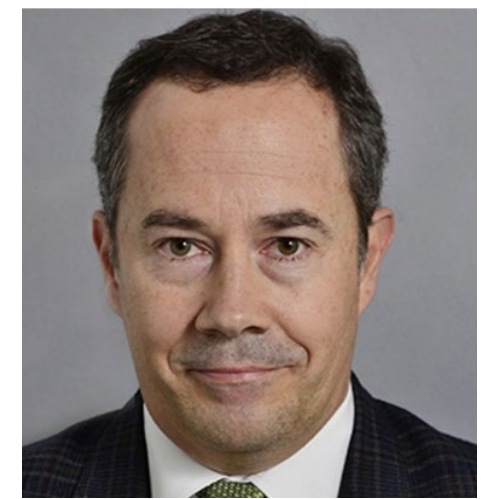
HUGO DIOGO

Managing Consultant
Environment & Health



RICHARD WENNING

Principal
Ecological Services Leader
Environment & Health



RICARDO CAMARGO

Managing Consultant
Environment & Health

QUESTIONS?